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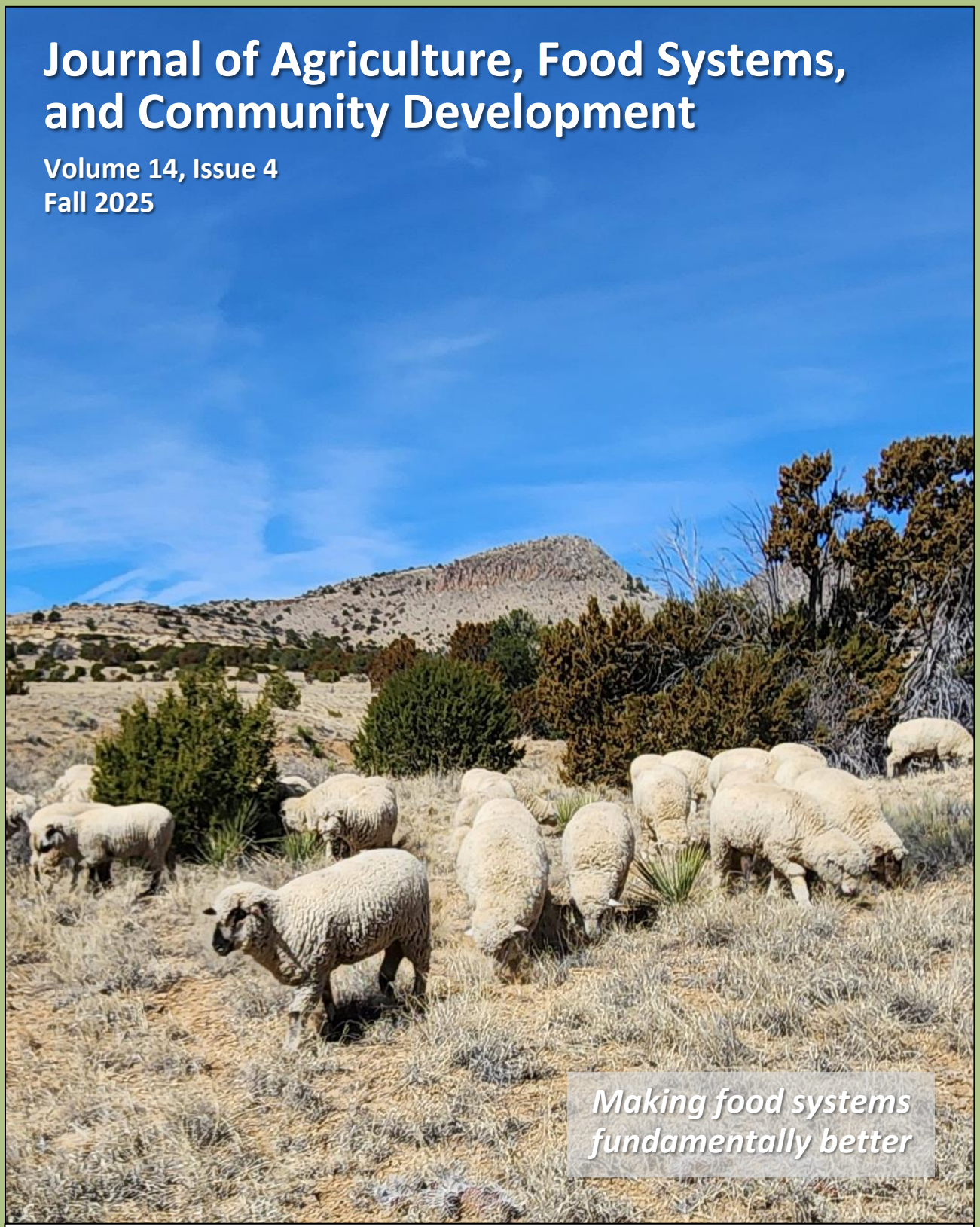

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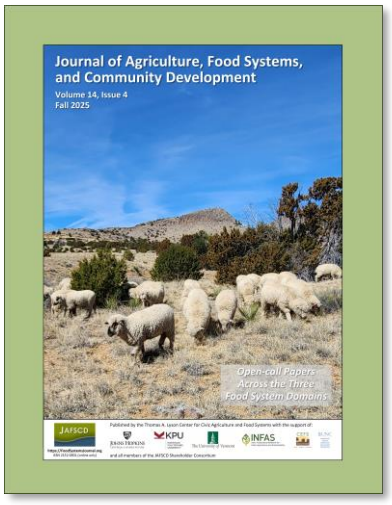

On our cover: Sheep graze peacefully on a golden fall afternoon at Talus Wind Ranch, which overlooks the Galisteo Basin in northern New Mexico. The ranch participated in the New Mexico Grown Meat Pilot Program reported in the article in this issue, *Farm-to-institution in the Southwest: An evaluation of the New Mexico Grown Meat Pilot Program*.

Photo by Timothy Willms, Owner, Talus Wind Ranch

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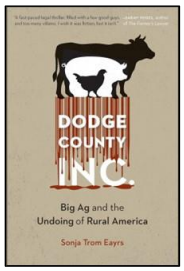
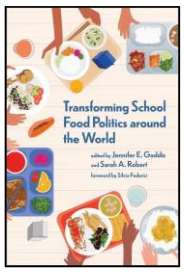
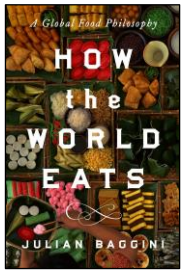
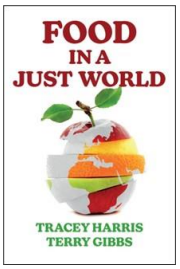
Paper on Fostering Resilient Food and Farm Systems Through Research Networks

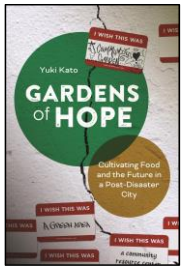
Reviews











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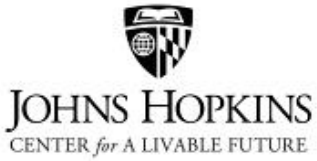
Johns Hopkins Center for a Livable Future 	**University of Kentucky** The Food Connection 
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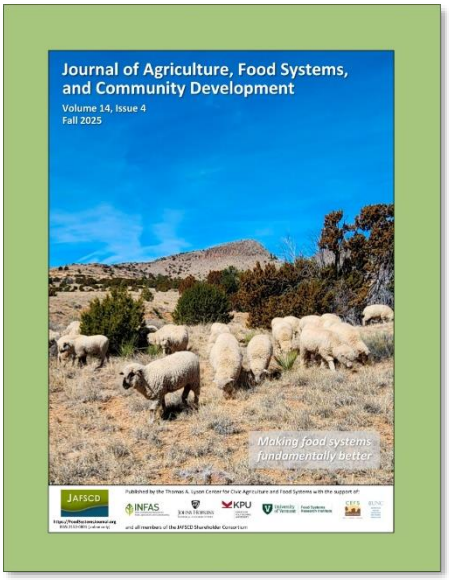
In This Issue
Duncan Hilchey

Making food systems fundamentally better



Published online October 2, 2025

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On the cover of our fall issue (completing our 14th year of publication) is a photo by Timothy Willms, owner of Talus Wind Ranch. Willms participated in the New Mexico Grown Meat Pilot Program reported in the article in this issue, *Farm-to-institution in the Southwest: An evaluation of the New Mexico Grown Meat Pilot Program*, by **Kathryn Coakley, Acadia W. Buro, Caitlyn Sandoval, Bryan Crawford-Garrett,** and **Francisco Soto Mas**. Willms' heritage sheep are well-suited to the high desert, so their grazing is a fitting use of the land—which can be traced back centuries under Navajo stewardship. Moreover, Talus Wind Ranch's commitment to local food security is laudable. JAFSCD applauds the return of appropriate-scale raising of heritage sheep in this region, among the poorest in the United States. We hope to see its expansion in the coming years with increased livelihood opportunities, sustainable grazing practices, and place identity branding, especially for Pueblo communities.

In his Economic Pamphleteer column, *The case for radical changes in U.S. farm policies*, **John Ikerd** argues that Americans have largely focused on how to make the food system less bad, rather than fundamentally better. To that end, he once again proffers a thoughtful proposal: sustainable farm tax credits for producers making the transition to more environmentally benign practices.

This is followed by two viewpoints and a commentary. In their viewpoints, **Lilly Zeitler** explores food sharing as a valuable measure of social capital, while **Arsene Mushagalusa Balasha** suggests that there may

On our cover: Sheep graze peacefully on a golden fall afternoon at Talus Wind Ranch, which overlooks the Galisteo Basin in northern New Mexico, USA. The ranch participated in the New Mexico Grown Meat Pilot Program reported in the article in this issue, *Farm-to-institution in the Southwest: An evaluation of the New Mexico Grown Meat Pilot Program*. Learn more about Talus Wind Ranch.

— Photo by Timothy Willms, Owner, Talus Wind Ranch

be a better way to farm fragile ecosystems for the benefit of people. In her commentary, **Ann Charles Vegdahl** reflects on her engagement with youth in food safety training, offer a rich set of good practices for other research scientists who are starting to promote their work with school-aged children.

Once again, we have accepted papers across the three domains of the food system. In the production domain, all four papers are about addressing the needs of small farmers in the Global South. In *Exploring the Bangladesh smallholder livestock sector through network analysis: Insights, assessment results, and future directions*, **Christian Kelly Scott, Jennifer Himmelstein, Jini Kades,** and **Arlinda Hajzeri** find that while connectivity among youth and women helped them succeed, more targeted technical assistance may be required to help them overcome structural barriers to development. In *Adapting to climate change on the farm: Experiences of small-scale ecological farmers in two regions of China*, **Qihua Feng, Zhenzhong Si,** and **Steffanie Scott** find that, while there are appreciation and capacity for climate adaptation among small growers, doing so will require significant grassroots organizing and public support. In *Strategic mix priorities as drivers of agripreneurial performance: Evidence from smallholder organic vegetable farmers in Tamil Nadu State of India*, **K Raman, Rani J., Anubhuti Dwivedi,** and **Maroof Ahmad Mir** find that focusing on product quality, diversity, and differentiation are likely to yield more benefit than cost reduction strategies alone. And **Milena Almeida Vaz, Hemerson dos Santos Vitorino, Natacha Oliveira de Souza, Jéssica Aretz Cunha Rodrigues da Silva,** and **Denise Dias da Cruz** explore the scope of grassroots stakeholder knowledge and use of natural resources in *Family farmers' environmental perception of ecosystem services in the Brazilian semi-arid region*.

Turning to marketing and supply chains, **Kathryn Coakley, Acadia W. Buro, Caitlyn Sandoval, Bryan Crawford-Garrett,** and **Francisco Soto Mas** provide an early evaluation of an innovative initiative to bridge livestock producers and buyers in *Farm-to-institution in the Southwest: An evaluation of the New Mexico Grown Meat Pilot Program.* Next, **Kristen Becker, Khush Bakht Aalia, Olufolajimi Talabi, Youri Dijkxhoorn, Emma Termeer, Archie Jarman, Bart de Steenhuijsen Piters,** and **Erin McGuire** use an informal tomato value chain in Nigeria to identity barriers and potentials for small producers in *Leveraging the innovation potential of informal midstream actors to enhance food systems outcomes*. In *Beyond self-report surveys: Leveraging multimodal large language models (MLLMs) for farmers market data harvesting from public digital resources,* **Huy Pham and Yue Cui** share the development of their cost-saving AI system that automatically harvests data about farmers markets for use by market managers and policy-makers. In *"Not a siloed effort": Partnership strategies supporting regional grain value chains in the Upper Northeast, USA*, **Elise Neidecker, Thomas Safford, Matthew Hoffman, Michelle Miller, Heather Darby,** and **Analena Bruce** explore the fundamentals of trust and transparency in building successful business relationships. And in *Local food system resilience in discourse and community practice: Findings from southern Wisconsin*, **Jules Reynolds** offer a case study of a farm-to-table program with a focus on how farmers' "relational autonomy" (freedom to act) within a local network, as well as within a rigid neoliberal economic system, is important part of its sustainability.

In the food security domain, we publish seven papers. In *Realizing nutrition equity in urban food systems: Insights from food justice leaders about mechanisms of implementation*, **Darcy Freedman, Morgan Taggart, Michael Walton, Linea Webb, Ismail Samad, Don Gaddis, Carol White, Shirley Bell-Wheeler, Dawn Glasco, Owusua Yamoah,** and **Emily Nelson** get to the crux of what matters most in realizing equitable urban food systems in the context of gentrification. Similarly, in *Assessing access and use of nutrition support programs, food insecurity, and health status in urban Native American families with young children in Montana: A case study*, **Thomas McClure, Kim Gilchrist, Alexandrea Erin Manuel, Christian Goes-Ahead Lopez, Cherith Smith, Jonathan Graham, Sarah Black,** and **Blakely Brown** explore the lived experience of Indigenous households with children living in cities and identify the unique barriers to this underserved group.

Then, in *Adaptation of the U.S. Food Security Survey Module in a small rural Dominican Republic community: A pilot to assess food insecurity*, **Mesfin Bezuneh, Zelealem Yiheyis, Frank Dadzie, Pedro-Juan Del Rosario,** and **Luis Ortiz** describe their novel use of a Global North tool to measure a Global South problem. Similarly,

Samuel Ikendi, Francis Owusu, Dorothy Masinde, Carmen Bain, and **Ann Oberhauser** explore the impact of a land-grant university's livelihood education program on the food security of a Global South target group in *Food insecurity coping strategies among households with average dietary diversity and caloric intake scores in rural Uganda.*

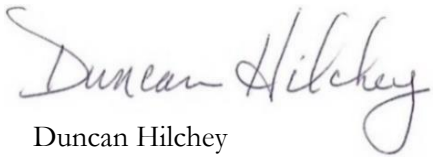
Next, we offer three papers focused on food pantries as critical emergency food system infrastructure. In *Evaluating school-based food pantries using a health equity perspective*, **Kaitlyn Harper, Nichole Espineli, Roni Neff,** and **Taz Shah** study pantries in the primary and secondary school context. In *Exploring college student experiences with little pantries: A qualitative study addressing campus food insecurity*, **Youngmi Kim, Jennifer Murphy, Jessica Hoy,** and **John C. Jones** study unique un-personed pantries in the higher education context. And in *Food insecurity and social connections among university food pantry users before and during COVID-19*, **Anthony Campbell, Jennifer F. Jettner,** and **Katherine Crawford** explore the experience of college students in the context of the onset of a pandemic.

In this issue we also offer two transdomain papers. In *Buying into waste: The role of consumer food purchasing behaviors, knowledge, attitudes, and opinions concerning food date labels*, **Jelili A. Adebiyi, Noleen R. Chikowore,** and **Angel S. Forde** find that U.S. consumers' fundamental misunderstanding of expiration dates is unintentionally leading to food waste in the American food system. Finally, in their paper entitled *Implementing the systems-based breeding approach: Lessons learned from the European Union LIVESEED project* (submitted to our call for papers on "fostering socially and ecologically resilient food and farm systems through research networks" back in 2023), **Edwin Nuijten, Monika M. Messmer, Pedro Mendes-Moreira, Adrián Rodríguez-Burruezo, Véronique Chable,** and **Edith T. Lammerts van Bueren** identify the key ingredients to fostering transformative food system change in the context of organic plant breeding.

We wrap the issue with five book reviews: **Stacey F. Stearns** reviews *Dodge County, Incorporated: Big Ag and the Undoing of Rural America*, by Sonja Trom Eayrs; **Kevin John Morgan** reviews *Transforming School Food Politics Around the World*, edited by Jennifer E. Gaddis and Sarah A. Robert*;* **Noelle Elizabeth Beecroft** reviews *How the World Eats: A Global Food Philosophy*, by Julian Baggini; **Megan Knight** reviews *Food in a Just World*, by Tracey Harris and Terry Gibbs; and **Maegan Krajewski** reviews *Gardens of Hope: Cultivating Food and the Future in a Post-Disaster City*, by Yuki Kato.

I would like to conclude that as I write this overview of the fall 2025 issue, the U.S. federal government is shutting down for its 11th time since 1980. The resulting furloughs of public employees who fund, study, and regulate the American food system is devastating to workers, to the viability of family farmers, and to the safety and affordability of the food supply. JAFSCD stands with the farmers, organizations, and agencies that are affected by the shutdown in calling for our leaders to quickly find a way forward that protects family farmers and our most vulnerable citizens.

Yours in resilience,



Duncan Hilchey
Publisher and editor-in-chief

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THE ECONOMIC PAMPHLETEER
JOHN IKERD

The case for radical changes in U.S. farm policies

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Over the past decade, I have written numerous columns and articles advocating transformational changes in farm policies (Ikerd, 2015, 2019, 2020, 2022). I have freely admitted that my proposals have been too radical to be considered relevant in previous farm bill debates. However, I think public support is growing for radical changes in both farm and food policies. Furthermore, the current bureaucratic chaos in Washington, D.C., may provide an opportune political environment for radical change.

It is time to truly start thinking "outside the box"—in this case, outside the box of the U.S. Department of Agriculture (USDA). The inclusion of farm and food policies in the 2025 federal budget reconciliation bill, the "One Big Beautiful Bill Act of 2025," provides opportunities to change the way farm and food assistance policies are funded and administered. The bill didn't change previous funding priorities. It provides increased funding for industrial commodity producers, reduced funding for food assistance programs, community development, and local foods, and redirects climate change funding to subsidize conservation practices for commodity producers. However, funding agri-food programs through the regular budgeting process, rather than a separate "farm bill," weakens the grip of the industrial

John Ikerd is professor emeritus of agricultural economics, University of Missouri, Columbia. He was raised on a small farm and received his B.S., M.S., and Ph.D. degrees from the University of Missouri. He worked in the private industry prior to his 30-year academic career at North Carolina State University, Oklahoma State University, the University of Georgia, and the University of Missouri. Since retiring in 2000, he spends most of his time writing and speaking on issues of sustainability. Ikerd is author of six books and numerous professional papers, which are available at http://johnikerd.com and https://ikerdj.mufaculty.umsystem.edu.

Why an Economic Pamphleteer? In his historic pamphlet *Common Sense*, written in 1775–1776, Thomas Paine wrote of the necessity of people to form governments to moderate their individual self-interest. In our government today, the pursuit of economic self-interest reigns supreme. Rural America has been recolonized, economically, by corporate industrial agriculture. I hope my "pamphlets" will help awaken Americans to a new revolution—to create a sustainable agri-food economy, revitalize rural communities, and reclaim our democracy. The collected Economic Pamphleteer columns (2010–2017) are available at https://bit.ly/ikerd-collection

agricultural establishment on farm and food policies.

Policies focused on industrial agriculture would be more appropriately administered in the Department of Commerce, and biofuels by the Department of Energy. Agriculture and related industries compose less than 6% of the GDP, and commercial agriculture has more in common with industry than agriculture (USDA Economic Research Service, 2025a). Industrial agriculture should be regulated as any other industry is and compete with other industrial sectors for government funds. USDA Rural Development programs probably would find a more accommodating and supportive environment than they have had in the USDA in a renamed Department of Housing and Community Development.

It is time to truly start thinking "outside the box"—in this case, outside the box of the U.S. Department of Agriculture (USDA).

Supplemental food assistance programs evolved in the USDA because they were initiated as a means of disposing of surplus agricultural commodities. More than 80% of current SNAP recipients live in urban areas (USDA Food and Nutrition Service, 2022, p. 2). Supplemental nutritional assistance programs could be more logically administered in a new Department of Domestic Food Security (DDSF). Government programs supporting organic, regenerative, resilient, and other sustainable farming systems would also be in the new DDSF. The focus on food assistance programs would be on *short-run* food security: meeting the nutritional needs of today. Sustainable farming programs would focus on *long-run* food security: meeting the food needs of the future as well as today.

The only defensible public purpose for policies specific to farming and food production is to ensure domestic food security. Food security was the justification for the farm bills of the 1930s, 1940s, and 1950s, and had been for food stamps and their replacement, the Supplemental Nutrition Assistance Program (SNAP), since the 1960s (Ikerd, 2022). Markets have never met the nutritional needs of all within any society.

Today, however, government-subsidized crops fuel our cars, provide cheap feed for concentrated animal feeding operations (CAFOs), and help the balance of trade, and they produce a lot of empty calories that contribute to malnutrition or *nutritional* insecurity. Giving money to malnourished people who have no means of selecting, accessing, or preparing nutritious food is better than letting people starve, but it does not ensure nutritional food security. Paying commodity producers to just slow the depletion of soil fertility and mitigate pollution actually threatens *long-run* food security by subsidizing the production systems that continue to deplete and pollute.

The vast majority of people, including most mainstream farmers, know there is something fundamentally wrong with the current systems of farming, food processing, and food retailing. The agri-food systems are not working for consumers who are suffering from a variety of diet-related health issues. They are not working for the smaller diversified family farmers who are forced to rely on off-farm income to make a living. They are not working for the rural communities that have supported and been supported by farming families. They are not working for the land; agricultural chemicals and biological wastes pollute the soil, air, and water. Current farm policies are not even working for the large commodity producers who feel trapped in farming systems that conflict with their social and ethical values. If you are going in the wrong direction, it is good to slow down—but ultimately, you need to stop and change direction.

Unfortunately, there is no widely shared vision of realistic farm and food policies that would be fundamentally better than those of today. Most farm and food policy debates have been about ways to make today's failed systems less bad rather than how to make them fundamentally better. Most debates about farm policy center on whether to allocate more or less money to subsidize commodity production and more or less to compensate farmers for adopting conservation and environmental protection practices, such as cover crops and buffer strips. Most debates also focus on

budgeting more or less money for supplemental food assistance programs.

The rest of this column focuses on suggestions for radically different farm policies. I will make the case in future columns for radical changes in policies affecting access to farmland, government food assistance, and community development.

Most farm and food policy debates have been about ways to make today's failed systems *less bad* rather than how to make them *fundamentally better*.

First, we need to quit subsidizing commodity production and start sharing the risks with farmers who want to begin, or transition to, ecologically and socially sustainable farming systems. Government programs that currently absorb the risks of unsustainable commodity production must be systematically replaced with programs that absorb the risks of transitioning from industrial to sustainable farming systems. The transition will take time because farming sustainably is *knowledge- and management-intensive*. It takes time and commitment to learn to farm sustainably. Degraded agroecosystems also take time and attention to heal and restore their fertility and natural productivity.

Farmers would need to be assured of consistent, dependable support … to regenerate soil fertility, restore agroecosystem integrity, and nurture a new generation of management-intensive farmers.

Farmers beginning or transitioning to sustainable farming would need to be assured of consistent, dependable support over a period sufficient to regenerate soil fertility, restore agroecosystem integrity, and nurture a new generation of management-intensive farmers. The best way to ensure adequate long-run government funding as the number of sustainable farms and farmers grows might be to fund the transition program through the U.S. Internal Revenue Service (IRS) rather than the new DDSF. Compensation for transition risks and potentially higher sustainable farming costs would be encoded in IRS rules, rather than determined by farm bills crafted by the industrial agricultural establishment, as has been the case in the past.

One way to absorb transition risks would be through refundable tax credits. Most tax credits are nonrefundable, meaning that if taxpayers owe less tax than the amount of the credit, they do not receive the full benefit of the credit. If they have no taxable income, the credit is worthless. In contrast, a refundable tax credit is paid to the taxpayer even if their taxable income is less than the tax credit. Examples include the off-road vehicles Fuel Tax Credit for farmers and the Earned Income Tax Credit for low-income taxpayers (IRS, 2025). The Child Tax Credit is partially refundable.

The refundable tax credit for sustainable farming would ensure that farmers who develop and implement an approved plan to establish or transition to a sustainable farming system can maintain a family income equal to or at parity with nonfarm families in their area. This was the intent of early farm bills that ensured parity prices for agricultural commodities (Ikerd, 2022). The program would be limited to individual farmers and farm couples who file income taxes jointly. Family corporations and Limited Liability Corporations (LLCs) would be excluded, as these are means of consolidating farms for industrial production. If calculations on the individual or joint IRS tax return resulted in an "after-tax income" less than the median nonfarm after-tax income of individuals or families for the area, the refundable tax credit would make up the difference.

On the current IRS Form 1040, the "total other payments and tax credits" would be added to "taxable income" to calculate total individual or household income. "Taxes owed," if any, would be subtracted from "total income" to calculate "after-tax income." The farm household's after-tax income would be compared to the median after-tax income for nonfarm households for the area,

provided by the IRS. If the farm household's after-tax income is smaller than nonfarm household incomes, the difference would be a "farm income tax credit." The farm income tax credit would be added to any taxes withheld or estimated taxes paid to calculate the total amount to be refunded by the IRS. If the farm household's after-tax income is larger, there would be no additional tax credit or adjustment in taxes owed to the IRS. The same basic process would be followed for individual tax returns.

The total amount of refundable farm tax credits would need to be limited, possibly to the median nonfarm income for the area. If losses from the farming operation resulted in a negative income for a farm household, then the farm household's after-tax income would be less than the median nonfarm income by the amount of the loss. In this case, the loss would be mitigated, but not eliminated, by the sustainable farming tax credit. The farm would be required to show progress toward becoming "economically sustainable" to remain eligible for the farm tax credit.

The multiyear plans for transitioning to sustainable farming would be developed in collaboration with a cadre of Cooperative Extension and USDA Natural Resource and Conservation Service field staff. Land-grant universities would need to collaborate with experienced farmers to re-educate field staff. They would need to learn to develop and monitor the implementation of plans for sustainable whole-farm systems rather than promote industrial farming technologies and best management practices. Farmers would be required to verify that they are following approved plans for transition to or maintaining sustainable farming systems to qualify for the farm tax credit.

The cost of sustainable farm tax credits would likely be less than the costs of current commodity programs. The median incomes for farm households have been higher than for nonfarm households since the early 2000s, when the government started essentially guaranteeing profitability for producers of commodities covered by government programs. In 2023, the median for farm households was US$97,984 compared with US$80,610 for nonfarm households (USDA ERS, 2025b). The sustainable farming tax credit would be for those who are motivated to farm sustainably but lack the economic means to do so, rather than those trying to maximize incomes and wealth. The tax credit would also allow farm families currently dependent on off-farm income to transition to being full-time family farmers.

The sustainable farming tax credit would be for those who are motivated to farm sustainably, rather than those trying to maximize incomes and wealth.

Since the mid-1990s, government subsidies for commodity producers have averaged around US$20 billion per year, with approximately 80% of the subsidies going to the largest 10% of recipients (Schechinger & Faber, 2023). These funds should be systematically reduced and then eliminated to allow sustainable farmers to expand to meet an increasing share of domestic food needs. The refundable farm tax credits would not require congressional appropriations. There are only about 1.2 million farmers in the U.S. who rely on farming as their primary occupation (USDFA NASS, 2024). Sustainable farm tax credits of US$20 billion would provide US$50,000 each to 400,000 transitioning farmers, which could decline to US$20,000 each to 1,000,000 farmers as farms progress in profitability and the number of sustainable farmers grows.

Once government subsidies for commodity production are removed and sustainable farming reaches its full potential, there will be less need for government programs to support sustainable farmers. However, resource conservation, regeneration, and protection require long-term investments that cannot compete economically with investments that result in resource extraction, depletion, and pollution. Current commodity-based government programs either subsidize or permit continuing extraction, depletion, and pollution by industrial agriculture. Government programs that ensure domestic food security, by one means or another, must make it economically feasible to farm sustainably—even if such programs seem radical.

References

Ikerd, J. (2015). The Economic Pamphleteer: Food sovereignty: New mandate for food and farm policy. *Journal of Agriculture, Food Systems, and Community Development*, *5*(2), 11–14. https://doi.org/10.5304/jafscd.2015.052.004

Ikerd, J. (2019). The Economic Pamphleteer : A "Green New Deal" for farm and food policy. *Journal of Agriculture, Food Systems, and Community Development*, *9*(1), 3–5. https://doi.org/10.5304/jafscd.2019.091.008

Ikerd, J. (2020). The Economic Pamphleteer: U.S. farm policy alternatives for 2020. *Journal of Agriculture, Food Systems, and Community Development*, *9*(4), 5–8. https://doi.org/10.5304/jafscd.2020.094.015

Ikerd, J. (2022). Farm and food policies for a sustainable future. *The Business, Entrepreneurship & Tax Law Review*, *6*(1), Article 6. https://scholarship.law.missouri.edu/betr/vol6/iss1/6

Internal Revenue Service [IRS]. (2025, July 8). *Refundable tax credits*. https://www.irs.gov/credits-deductions/individuals/refundable-tax-credits

Schechinger, A., & Faber, S. (2023, February 1). *Updated EWG Farm Subsidy Database shows largest producers reap billions, despite climate crisis*. Environmental Working Group. https://www.ewg.org/research/updated-ewg-farm-subsidy-database-shows-largest-producers-reap-billions-despite-climate

USDA Economic Research Service. (2025a, January 8). *Ag and food sectors and the economy*. https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy#:~:text

USDA Economic Research Service. (2025b, January 27). *Farm household well-being—Income and wealth in context*. https://www.ers.usda.gov/topics/farm-economy/farm-household-well-being/income-and-wealth-in-context#:~:text

USDA Food and Nutrition Service. (2022). *Characteristics of U.S. Department of Agriculture's Supplemental Nutrition Assistance Program households: Fiscal year 2020* [Research summary]. https://fns-prod.azureedge.us/sites/default/files/resource-files/Characteristics2020-Summary.pdf

USDA National Agricultural Statistics Service [USDFA NASS]. (2024). *2022 Census of Agriculture Highlights: Farm producers* [Publication no. ACH22-2]. https://www.nass.usda.gov/Publications/Highlights/2024/Census22_HL_FarmProducers_FINAL.pdf

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VIEWPOINT

Is food sharing a better measure of social capital in some contexts?

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The role of social capital in mediating health is increasingly well recognized (Eriksson, 2011; Ferlander, 2007; Hawe & Shiell, 2000; Kawachi & Berkman, 2023; Lomas, 1998). Social capital refers to the resources and benefits individuals gain through their social interactions and networks (Bourdieu, 1986), such as "horizontal associations" between people ("networks of civic engagement") (Putnam, 1993) and institutional relationships (Bourdieu, 1986; Grootaert, 1998; World Bank, 1998). Social capital affects food and diet intake by influencing resources for food procurement, enhancing knowledge on food and nutrition (health literacy) (Chen et al., 2019), alleviating psychosocial distress (Mieziene et al., 2022), buffering against shocks and extreme weather events (Chriest & Niles, 2018), increasing food access and availability (Martin et al., 2004; Nosratabadi et al., 2020), and promoting access to both formal and informal institutional support (King, 2017). With mounting evidence on the importance of social capital, food and diet researchers are now tasked with integrating social capital questions into their studies of diet quality and food choice.

In this viewpoint, I share my experience attempting to integrate social capital questions into a household and diet quality survey as part of my doctoral research on Indigenous food environment transitions in Northern Thailand. By sharing my survey design and implementation experience, I hope to raise unresolved issues surrounding the assumptions made by large institutions in their

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questionnaires. I argue for caution in adopting ready-made survey questions and advocate for tailoring culturally-appropriate, context-specific and scale-sensitive survey questions.

Compiling a survey questionnaire can be an unexpectedly daunting and overwhelming task, especially for early-career researchers, who often receive no training in survey design and implementation. Selecting the right questions to distill key variables of interest can become a fiddly exercise of finetuning nearly identical questions, only to discard them during the piloting phase. Survey design is difficult for multiple reasons. Firstly, the questions must be easy to understand and to answer. What is more, the responses must generate enough variation within the study population to test statistical relationships. Ensuring sufficient variation is highly sensitive to scale: questions that capture variation at a national, provincial or district level may not work at a community level where shared community-level characteristics could result in more similar responses.

As a doctoral student, I embarked on the challenging task of survey design, naively anticipating it would take a few weeks. In reality, survey design and piloting took many months. Given the increasingly well-established relationships between social capital and diet (Mbugua & Nzuma, 2020; Peterson et al., 2022), I aimed to include questions on social capital in my household and diet survey. I discovered, to my relief, that the World Bank had already developed a social capital questionnaire (Grootaert et al., 2004). Combined with the Gallup Poll's Thailand-adapted Diet Quality Questionnaire (Global Diet Quality Project, 2023), I thought I had hit the doctoral efficiency jackpot with ready-to-go survey questions. However, within several days of piloting the survey, I realized that the World Bank social capital questions would not work in my field sites of Indigenous Pgaz K'Nyau communities in Northern Thailand.

To briefly describe my main field site: The entire 70-person community is extended family related either directly or through marriage. Because everyone is family, neighbors wander in and out of one another's homes and are always welcome to sit down and eat. "Come eat rice" is a ubiquitous greeting called out to any passerby. While incomes can be as low as US$20 per month, no one in the community goes hungry. Rice is planted and harvested using reciprocal labor. The community is mostly self-sufficient with its own rice production and has even instituted a rice bank to ensure village-level food security. The social structure functions primarily on high social capital to an extent that may seem unfathomable to high-level experts designing survey questionnaires for low-income countries. Questions about crime, violence, numbers of social interactions, and whether you could trust your neighbors were not designed for a densely interrelated village. With many questions, I would be met with either a quizzical expression or outright laughter, as if I had told a great joke. A typical question-and-answer exchange while piloting surveys would go as follows:

> "How many people do you talk to in a given week?"
>
> [laughter]
>
> "Everyone who crosses my path. I talk to everyone."
>
> [more laughter]

Suffice it to say, I was not conducting this survey in a large urban center, but in a tightly knit community where social interactions were too frequent for survey respondents to recall. As question after question faltered during piloting, I quickly realized the World Bank social capital questions were not well suited for the context. The questions were either too difficult to answer, not applicable in the context, or generated unreliable responses or insufficient variation (see Table 1).

I began searching for alternative, culturally appropriate measures of social capital by participating in everyday life. From participant observation, I witnessed how food sharing was pervasive in both daily social interactions and special occasions. For instance, after group foraging excursions to gather mushrooms, crabs, and banana blossoms, I would invariably be given all the forest foods collected to share with my host grandmother (a respected village elder). Neighbors would deliver foraged ferns (*Diplazium esculentum*) or a cultivated mint variety

(*Elsholtzia griffithii*) neatly wrapped in banana leaves to one another. Special occasions, such as funerals, weddings, temple parties, Christmas, and New Year's, revolved around food sharing. During my diet quality survey, 15% of food items consumed the previous day were shared (Zeitler et al., 2024, 2025). From communal meals to sharing foraged food items, food sharing was integral to the reciprocal relations binding the community together.

While food sharing practices were widespread, the community was not homogenous. Some households certainly had more resources and means than others through steady employment, larger land holdings, or social status. I began to wonder whether food sharing could reflect these subtle nuances of social capital even within a cohesive community with overall high social capital. I decided to trial two simple questions on food sharing in my pilot questionnaire:

> In the last week, how many times have neighbors shared food with you?
>
> In the last week, how many times have you shared food with neighbors?

I found that the questions were intuitive: everyone could understand and answer the questions. Unlike social capital questions on decision-making power, food sharing was not an abstraction, but an easily relatable everyday practice. Importantly, the food sharing questions generated much-needed variation for statistical analyses, even at a small-scale community level (answers ranged from 0 to 10 times per week).

In the final stages of survey design, I discarded the World Bank's core social capital questions for the reasons listed in Table 1 but retained the questions on food sharing as a valuable proxy for social relations and networks. If social capital is an "endless effort at institution" to "produce and reproduce lasting, useful relationships that can secure material or symbolic profits" (Bourdieu, 1986, p. 22), then food sharing would be an appropriate measure of social capital in Pgaz K'Nyau communities. Through everyday reciprocal food exchanges, Pgaz K'Nyau Peoples maintained food availability: by sharing surplus, one is more likely to receive during times of scarcity. Food sharing also promotes greater diversity of foods consumed ('material profits'). By signaling generosity and virtuous behavior (important values in all religions practiced in Pgaz K'Nyau communities—Christianity, Buddhism, and animism), food sharing also generates what Bourdieau refers to as the 'symbolic profits' of status and reputation as a form of social capital.

While my own research was limited to a few small communities, the question of whether food sharing reflects social capital applies to many societies worldwide. Regular and ritualistic food sharing is central to the cultures of Hadza Peoples in Tanzania (Marlowe, 2004), Hausa Peoples in Nigeria (Etkin, 2009, pp. 145–170), !Kung San Peoples in the Kalahari (Wiessner, 1981), Ache Peoples in Paraguay (Kaplan et al., 1985), Tsembaga Maring in New Guinea (Rappaport, 1984), and throughout Polynesia (Bell, 1931; Hogbin, 1932; Kirch, 2001), to list a few well-known examples from the food anthropology literature. More recently, in the Solomon Islands, 9% of foods were acquired through food sharing with kin and community (Bogard et al., 2021). In Native Alaskan communities, approximately 30% of high-status 'super-households' procure 70% of the wild meat shared and consumed in communities (Wolfe & Walker, 1987). Pacific Northwest Peoples host potlatch feasts to redistribute wealth and convey social status through reciprocal systems of food sharing and gift exchange (Barnett, 1968). Social status and relations are signaled through food sharing in diverse cultures, reflecting access to capital and resources (Dietler & Hayden, 2001; Gurven & Jaeggi, 2015).

Food sharing and exchange are not limited to hunter-gatherer or agrarian subsistence societies in rural areas. Urban dwellers in the present day are experimenting with collectives for growing, cooking, and eating to rediscover community and sustainable lifestyles, for instance, through urban gardening, Slow Food *convivia*, or as a food waste reduction strategy (Bakharev et al., 2023; Davies & Evans, 2019; Davies et al., 2019; Etkin, 2009, pp. 25–27). Diverse societies around the world, both rural and urban, continue to build social relations and community through the everyday practice of

generosity, reciprocity, and care that is food sharing.

With this brief critique, I do not wish to discredit or discard the admirable work of researchers developing useful tools at respected institutions. I hope to invite other researchers, especially those at an early career stage, to critically reflect and, where appropriate, challenge and reimagine well-established metrics and data collection instruments. Refining data collection tools is an iterative process to which we can all contribute, including early career researchers. No tool is perfect, and certainly no tool is perfect for every context and at every scale. Especially for the messy world of social relations, we can continue to explore alternative measures of social capital that are appropriate for each context and analytic scale. While food sharing and social capital are not synonymous, there are substantial overlaps between the two in many societies. In small villages in the hills of Northern Thailand and in many communities worldwide, food sharing is how social relations are reinforced each day. In such contexts, food sharing offers a viable alternative for measuring social capital.

Table 1. Issues Encountered while Piloting the World Bank Social Capital Core Questionnaire

World Bank Core Social Capital Question	Common Responses	Issue Encountered
I would like to start by asking you about the groups or organizations, networks, associations to which you or any member of your household belong. These could be formally organized groups or just groups of people who get together regularly to do an activity or talk about things. Of how many such groups are you or any one in your household a member?	Most women are members of the women's group, the women's weaving cooperative, and participate in NGO activities, such as the Thai Association for Forest Conservation (e.g., tree planting). Most women get together regularly to weave, cook. or chat.	Too little variation.
About how many close friends do you have these days? These are people you feel at ease with, can talk to about private matters, or call on for help.	Almost everyone in the village is friends with one another and either directly related or related through marriage.	Too difficult to answer. Too little variation.
If you suddenly needed to borrow a small amount of money [RURAL: enough to pay for expenses for your household for one week; URBAN: equal to about one week's wages], are there people beyond your immediate household and close relatives to whom you could turn and who would be willing and able to provide this money?	The women's group provides lending services, so almost everyone in the village can borrow money from a women's collective with many members. However, the second part of the question excluding family members does not work in a village where everyone is related.	Too little variation. Not applicable in the context.
Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?	Everyone knows everybody in the village and agrees that most people can be trusted.	Too little variation.
In general, do you agree or disagree with the following statements? A. Most people in this village/neighborhood are willing to help if you need it. B. In this village/neighborhood, one has to be alert or someone is likely to take advantage of you.	Everyone helps everyone else with reciprocal labor, food sharing, childcare, and everyday small tasks.	Too little variation.
If a community project does not directly benefit you but has benefits for many others in the village/neighborhood, would you contribute time or money to the project?	Every able-bodied person contributes time and labor to communal projects, such as road repair, firebreak maintenance, etc. Most people do not have money to contribute.	Too little variation.

In the past 12 months did you or anyone in your household participate in any communal activities, in which people came together to do some work for the benefit of the community?	Everyone surveyed contributes to every communal activity, including those of other religions (e.g. Christians help at Buddhist events and vice versa), except in exceptional circumstances (e.g., illness).	Too unreliable, as most answered that they go to all events, but numbers varied between respondents, indicating recall errors.
If there was a water supply problem in this community, how likely is it that people will cooperate to try to solve the problem?	The village water source in the forest is managed by a village elder. Everyone who is able contributes time and labor to weir construction (check dams) to increase water-holding capacity in the watershed.	Too little variation.
In the past month, how many times have you made or received a phone call?	The village has no cell phone service.	Not applicable in the context.
What are your three main sources of information about what the government is doing (such as agricultural extension, workfare, family planning, etc.)?	The village is part of a participatory governance model. The municipality holds meetings directly with the villagers where they can vote on which projects should be funded and prioritized. Government initiatives are communicated directly by government officials in their Indigenous language.	Too little variation. Not applicable in the context.
There are often differences in characteristics between people living in the same village/ neighborhood. For example, differences in wealth, income, social status, ethnic or linguistic background/race/caste/tribe. There can also be differences in religious or political beliefs, or there can be differences due to age or sex. To what extent do any such differences characterize your village/neighborhood? Do any of these differences cause problems? Which two differences most often cause problems? Have these problems ever led to violence?	There are religious and gender differences (both approximately 50-50) and a wide variety of ages. Almost all community members are Indigenous Pgaz K'Nyau, so there is almost no ethnic diversity. Social differences have never led to any problems or violence in the history of the community.	Too little variation. Not applicable in the context.
How many times in the past month have you gotten together with people to have food or drinks, either in their home or in a public place?	People are constantly eating in one another's homes, because almost everybody in the village is related. Food sharing is a large part of everyday life. Accurately remembering the number of social gatherings for an entire month is impossible for most respondents.	Too difficult to answer.
Were any of these people…. A. Of different ethnic or linguistic background/ race/ caste/ tribe? B. Of different economic status? C. Of different social status? D. Of different religious groups?	People often eat in their neighbor's homes who practice a different religion. All members of the community are low-income, so there is little difference in economic status.	Too little variation.
In general, how safe from crime and violence do you feel when you are alone at home?	There is no crime in the village.	Too little variation. Not applicable in the context.
Do you feel that you have the power to make important decisions that change the course of your life?	Most people simply did not understand this question. The question is framed outside the day-to-day realities of agricultural subsistence and wage labor livelihoods.	Too difficult to answer.

References

Bakharev, V. V., Mityashin, G. Y., & Stepanova, T. V. (2023). Food security, food waste and food sharing: The conceptual analysis. *Pisevye Sistemy/Food Systems*, *6*(3), 390–396. https://doi.org/10.21323/2618-9771-2023-6-3-390-396

Barnett, H. G. (1968). *The nature and function of the potlatch* [Doctoral dissertation, University of Oregon]. Original work published in 1938.

Bell, F. L. S. (1931). The place of food in the social life of Central Polynesia. *Oceania*, *2*(2), 117–135. https://doi.org/10.1002/j.1834-4461.1931.tb01661.x

Bogard, J. R., Andrew, N. L., Farrell, P., Herrero, M., Sharp, M. K., & Tutuo, J. (2021). A typology of food environments in the Pacific region and their relationship to diet quality in Solomon Islands. *Foods*, *10*(11), Article 2592. https://doi.org/10.3390/foods10112592

Bourdieu, P. (1986). The forms of capital. In J. Richardson (Ed.), *Handbook of theory and research for the sociology of education* (pp. 241–258). Greenwood.

Chen, W. L., Zhang, C. G., Cui, Z. Y., Wang, J. Y., Zhao, J., Wang, J. W., Wang, X., & Yu, J. M. (2019). The impact of social capital on physical activity and nutrition in China: The mediating effect of health literacy. *BMC Public Health*, *19*(1), Article 1713. https://doi.org/10.1186/s12889-019-8037-x

Chriest, A., & Niles, M. (2018). The role of community social capital for food security following an extreme weather event. *Journal of Rural Studies*, *64*, 80–90. https://doi.org/10.1016/j.jrurstud.2018.09.019

Davies, A. R., Cretella, A., & Franck, V. (2019). Food sharing initiatives and food democracy: Practice and policy in three European cities. *Politics and Governance*, *7*(4), 8–20. https://doi.org/10.17645/pag.v7i4.2090

Davies, A., & Evans, D. (2019). Urban food sharing: Emerging geographies of production, consumption and exchange. *Geoforum*, *99*, 154–159. https://doi.org/10.1016/j.geoforum.2018.11.015

Dietler, M., & Hayden, B. (Eds.). (2001). *Feasts: Archaeological and ethnographic perspectives on food, politics, and power*. University of Alabama Press. https://doi.org/10.2307/jj.30347352

Eriksson, M. (2011). Social capital and health--implications for health promotion. *Global Health Action*, *4*(1), Article 5611. https://doi.org/10.3402/gha.v4i0.5611

Etkin, N. L. (2009). *Foods of association: Biocultural perspectives on food and beverages that mediate sociability*. University of Arizona Press.

Ferlander, S. (2007). The importance of different forms of social capital for health. *Acta Sociologica*, *50*(2), 115–128. https://doi.org/10.1177/0001699307077654

Global Diet Quality Project. (2023). *Thailand*. https://www.dietquality.org/countries/tha

Grootaert, C., Narayan, D., & Veronica, N. J. (2004). *Measuring social capital: An integrated questionnaire* (World Bank Working Paper No. 18). World Bank. https://doi.org/10.1596/0-8213-5661-5

Gurven, M., & Jaeggi, A. V. (2015). Food sharing. In R. Scott & S. Kosslyn (Eds.), *Emerging trends in the social and behavioral sciences* (pp. 1–12). John Wiley & Sons. https://doi.org/10.1002/9781118900772.etrds0133

Hawe, P., & Shiell, A. (2000). Social capital and health promotion: A review. *Social Science and Medicine*, *51*(6), 871–885. https://doi.org/10.1016/S0277-9536(00)00067-8

Hogbin, H. I. (1932). Polynesial ceremonial gift exchanges. *Oceania*, *3*(1), 13–39. https://doi.org/10.1002/j.1834-4461.1932.tb00050.x

Kaplan, H., Hill, K., Cadeliña, R. V., Hayden, B., Hyndman, D. C., Preston, R. J., Smith, E. A., Stuart, D. E., & Yesner, D. R. (1985). Food sharing among Ache foragers: Tests of explanatory hypotheses [and comments and reply]. *Current Anthropology*, *26*(2), 223–246. https://doi.org/10.1086/203251

Kawachi, I., & Berkman, L. (2023). Social cohesion, social capital, and health. In L. F. Berkman & I. Kawachi (Eds.), *Social epidemiology* (pp. 174–190). Oxford University Press. https://doi.org/10.1093/oso/9780195083316.003.0008

King, C. (2017). Informal assistance to urban families and the risk of household food insecurity. *Social Science & Medicine*, *189*, 105–113. https://doi.org/10.1016/j.socscimed.2017.07.030

Kirch, P. V. (2001). Polynesian feasting in ethnohistoric, ethnographic, and archaeological contexts: A comparison of three societies. In M. Dietler, & B. Hayden (Eds.), *Feasts: Archaeological and ethnographic perspectives on food, politics, and power* (pp. 168–184). University of Alabama Press. https://doi.org/10.2307/jj.30347352.11

Lomas, J. (1998). Social capital and health: Implications for public health and epidemiology. *Social Science & Medicine*, *47*(9), 1181–1188. https://doi.org/10.1016/S0277-9536(98)00190-7

Marlowe, F. W. (2004). What explains Hadza food sharing? In M. Alvard (Ed.), *Socioeconomic aspects of human behavioral ecology* (pp. 69–88). Emerald Publishing. https://doi.org/10.1016/S0190-1281(04)23003-7

Martin, K. S., Rogers, B. L., Cook, J. T., & Joseph, H. M. (2004). Social capital is associated with decreased risk of hunger. *Social Science & Medicine*, *58*(12), 2645–2654. https://doi.org/10.1016/j.socscimed.2003.09.026

Mbugua, M., & Nzuma, J. (2020). Effect of social networks on household dietary diversity: Evidence from smallholder farmers in Kisii and Nyamira counties, Kenya. *African Journal of Agricultural and Resource Economics*, *15*(3), 230–243. https://doi.org/10.53936/afjare.2020.15(3).15

Mieziene, B., Emeljanovas, A., Novak, D., & Kawachi, I. (2022). Social capital promotes a healthier diet among young adults by reducing psychological distress. *Nutrients*, *14*(23), Article 5187. https://doi.org/10.3390/nu14235187

Nosratabadi, S., Khazami, N., Ben Abdallah, M., Lackner, Z., Band, S. S., Mosavi, A., & Mako, C. (2020). Social capital contributions to food security: A comprehensive literature review. *Foods*, *9*(11), Article 1650. https://doi.org/10.3390/foods9111650

Peterson, C., Ortiz, R., & Rocconi, L. (2022). Community food security: The multi-level association between social capital, economic capital, and diet quality. *International Journal of Community Well-Being*, *5*, 571–585. https://doi.org/10.1007/s42413-022-00170-w

Putnam, R. (1993, April 1). The prosperous community: Social capital and public life. *The American Prospect*. https://prospect.org/infrastructure/prosperous-community-social-capital-public-life/

Rappaport, R. A. (1984). *Pigs for the ancestors: Ritual in the ecology of a New Guinea people* (2nd ed.). Waveland Press.

Wiessner, P. (1981). Measuring the impact of social ties on nutritional status among the !kung San. *Social Science Information*, *20*(4–5), 641–678. https://doi.org/10.1177/053901848102000403

Wolfe, R. J., & Walker, R. J. (1987). Subsistence economies in Alaska: Productivity, geography, and development impacts. *Arctic Anthropology*, *24*(2), 56–81. https://www.jstor.org/stable/40316144

World Bank. (1998). *The initiative on defining, monitoring and measuring social capital: Text of proposals approved for funding* (Social Capital Initiative Working Paper No. 2). https://documents1.worldbank.org/curated/en/111741468767413539/pdf/292800PAPER0In1defining010sci0no-02.pdf

Zeitler, L., Downs, S., & Powell, B. (2024). Adapting food environment frameworks to recognize a wild-cultivated continuum. *Frontiers in Nutrition*, *11*, Article 1343021. https://doi.org/10.3389/fnut.2024.1343021

Zeitler, L., Phatthanaphraiwan, S., Downs, S., & Powell, B. (2025). Foraging, farming or shopping? A decision matrix approach for food environment assessments. *International Journal of Environmental Research and Public Health*, *22*(5), Article 711. https://doi.org/10.3390/ijerph22050711

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VIEWPOINT

Farming fragile ecosystems: Rethinking agriculture in the Congolese marshlands for sustainable management and secure livelihoods

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Introduction

Wetlands are among the most critical and productive ecosystems, providing a wide range of ecosystem services that support ecological stability and the livelihoods of many communities (Chuma et al., 2024; Johnes et al., 2020). Recent research by Chuma et al. (2024) has developed a typology of wetlands in the Democratic Republic of Congo (DRC), differentiating between peatlands, swamps, inland valleys, and marshes. In this viewpoint, I focus on marshes—fragile ecosystems characterized by water-saturated soils and dominated by herbaceous plants such as grasses and reeds—which are cleared and drained annually to establish crop fields in eastern DRC. Marshlands contain rich alluvial soils with high organic matter and nutrient content, enriched by runoff from nearby hills, making them lands of economic and agronomic interest for rural communities (Johnes et al., 2020; Verhoeven & Setter, 2010). But what drives the use of marshland areas in South Kivu Province, DRC, despite their status as fragile ecosystems intended to be preserved?

In South Kivu, marshes have historically been used for agricultural production, including crops such as beans, maize, and sorghum. In recent years, however, farmers have intensified vegetable and sugarcane cultivation. The demand for land in Bukavu has increased due to a large-scale rural exodus, driven by armed conflicts and growing insecurity in the region. Fierce competition for land between residential expansion and farming has prompted many households to cultivate nearby marshland areas (Figure 1).

Another key factor driving marshland cultivation is the decline in upland agricultural productiv-

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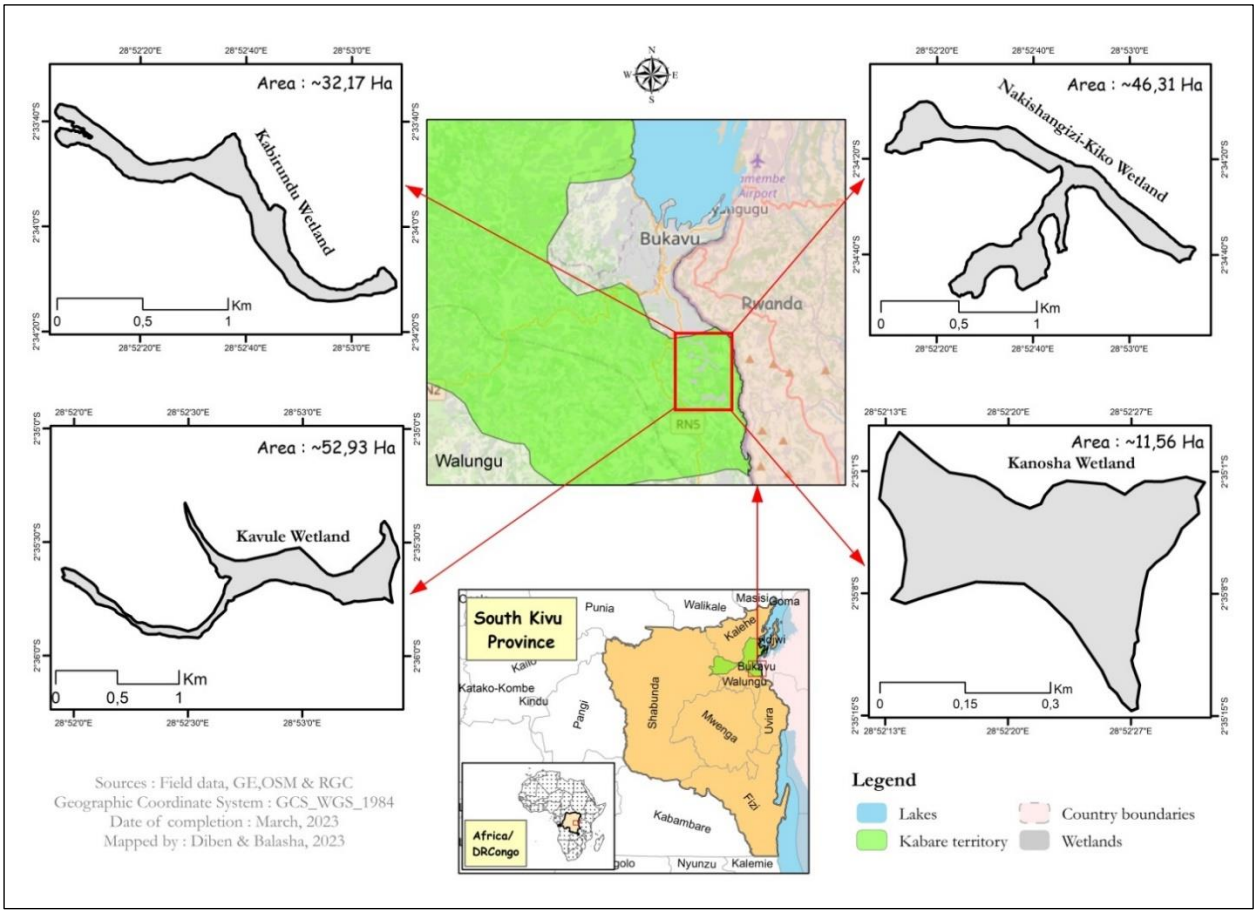
ity due to soil fertility loss, which has prompted farmers to intensify vegetable and sugarcane cultivation in marshlands and gradually develop fish farming as well (Balasha et al., 2023b; Chuma et al., 2021). The marshlands offer opportunities for off-season farming and support the cultivation of water-intensive crops such as sugarcane and diverse vegetables, including cabbage, squash, and eggplant (Balasha et al., 2023a; Chuma et al., 2021). Despite the crucial ecosystem services that marshes provide to communities and their vulnerability, discussions on how to reconcile agricultural production with wetland conservation remain limited. Here, I examine livelihood security through crop diversification in marshlands and the economic empowerment of women farmers, and explore how farming practices in these ecologically sensitive areas can be adapted to minimize their environmental impact.

Securing Livelihood through Crop Diversification in Congolese Marshlands

One of the primary benefits of marshland agriculture is its role in supporting household food production and income diversification. Due to year-round water availability and fertile soils, marshlands allow for continuous crop production even during the dry season. This is particularly important in eastern DRC, where rainfed upland farming is increasingly affected by climate variability (Azine et al., 2025; Balasha et al., 2023a). In the marshlands around Bukavu, crop diversification is a common practice among farmers. It is widely regarded as one of the most ecologically feasible, cost-effective, and rational strategies for reducing uncertainty in agriculture, particularly among small-scale farmers. This approach involves cultivating multiple crop varieties—either of the same or different species—through prac-

Figure 1. Map of the Marshlands around the City of Bukavu, Eastern Democratic Republic of Congo (DRC)



tices such as crop rotation and intercropping (Makate et al., 2016).

Compared to monoculture, crop diversification enhances biodiversity on farms, strengthens resilience to environmental stresses such as pest outbreaks, and improves the ability of agro-ecosystems to recover and maintain productivity (Jensen et al., 2020). Marshland farmers report that crop diversification reduces their reliance on chemical pesticides and fertilizers and enhances soil fertility through complementary crop interactions. Reducing the use of chemical pesticides and fertilizers protects fragile wetland ecosystems from pollution, maintaining the ecological balance and essential functions of marshes.

Economic Empowerment of Women Farmers through Marshland Agriculture

Marshland agriculture plays a crucial role in the economic empowerment of women farmers by providing opportunities for income generation and food security. Previous research indicates that 79% of women adopt crop diversification as a strategy to adapt to climate change and reduce food shortages, with 65% farming on marshlands to achieve financial independence (Balasha et al., 2021, 2023a). In marshlands, women and men farmers use crop diversification to reduce the risks of crop failure caused by pest outbreaks and climate change pressures; in a sentiment shared by many farmers, "if one crop fails due to environmental hazards, another can survive and help us." In Kabare marshlands, one of the key factors influencing crop diversification and farmers' crop choices is the nature of land tenure. Secure land tenure through inheritance or land purchase (ownership) provides farmers with the security and incentives to diversify crops, cultivate long-cycle crops such as sugarcane, taro, and cassava, and invest in fish farming. Women often cultivate plots obtained through informal or rental arrangements, growing vegetables such as amaranth, cabbage, and squash for sale in local markets. These fast-growing crops generate quick income, which supports women's financial independence, household food security, and decision-making power. This is illustrated by a woman farmer who said, "Unlike the income from sugarcane, which my husband manages as he pleases, the money I earn from vegetables gives me financial autonomy because I control it myself." On many farms, women are solely responsible for agricultural work, as their husbands and young male adults have migrated to artisanal mining sites in Misisi and Fizi, leaving women to bear the full burden of farming and household responsibilities. This was illustrated by one woman farmer, who said,

> Heavy tasks like drainage and field clearing used to be done by men. All the work now falls on me because my husband, who used to help in the fields, has left to seek income in the gold mine at Missi. The vegetables I grow feed my family, and the surplus I sell allows me to clothe [my children] and pay for my children's school fees.

Marshland Agriculture and Environmental Trade-offs

In addition to agricultural food production, marshlands provide building materials and regulatory functions such as water filtration, carbon storage, and support for community cultural identity (Chuma et al., 2024). However, these services are increasingly threatened by unsustainable farming practices due to a lack of technical support, information, and environmental safeguards. One of the major issues is the systematic drainage of marshes to make them suitable for agriculture, which threatens plant and animal species adapted to highly flooded environments. In addition, the exploitation of marshes for brick production further exacerbates their degradation. Moreover, many farmers rely on highly hazardous pesticides (such as dichlorvos, mancozeb, profenofos, and chlorpyrifos) to control pests.

Masumbuko et al. (2024) and Balasha et al. (2023b) argue that without proper guidance, pesticide use can contaminate water sources, harm aquatic life, and pose serious health risks to both farmers and the environment. At the same time, chemical fertilizers are increasingly being introduced (Lambrecht et al., 2014). However, farmers' limited knowledge of chemical fertilizers and weak regulatory oversight make their use a

potential threat to the long-term sustainability of marshland ecosystems.

While promoting organic inputs such as manure would be ideal, repeated conflicts and disease outbreaks have drastically reduced livestock populations in South Kivu, limiting the availability of organic matter. This was illustrated by one farmer, who said,

> Before, I used to collect manure from my rabbits, guinea pigs, and goats to fertilize my cropland. However, I no longer have any, because diseases killed almost all of them, and the few that remained were stolen. This has negatively affected the yield of my fields and my livelihood.

Pathways to Sustainable Marshland Agriculture

Promoting sustainable marshland conservation practices is essential to continue benefiting from the vital ecosystem services they provide. Effective marshland conservation requires a collaborative approach involving community participation, researchers, clear wetland management policies, and relevant public authorities operating within well-defined regulatory frameworks (Chuma et al., 2024). In the marshlands around Bukavu, several promising agroecological initiatives are already underway, such that farmers are planting anti-erosion hedges, using organic matter, applying mulch, and practicing crop diversification. These techniques help reduce dependency on synthetic inputs and enhance soil health; they should be scaled up in similar agroecosystems. Promoting flood-tolerant crops well suited to marshlands would help to minimize crop failures during flooding periods. I have observed that many farmers are beginning to consider fish farming as an alternative to food crops. There is hope that farmers will adopt new practices in the future if they receive critical technical support and information, as one farmer shared, "I've learned about integrated rice and fish farming in flooded environments. I plan to give it a try." The stakeholders mentioned above are encouraged to promote a marshland zoning strategy that clearly defines areas designated for cultivation, conservation, water retention, and ecological buffer zones. This process must be participatory, engaging farmers—particularly women farmers—who are key users of these shared and fragile landscapes. Properly implemented, marshland zoning can reconcile agricultural use with biodiversity conservation in wetlands (Zeng et al., 2012).

Conclusion

Marshlands offer various ecosystem services that support community livelihoods and development. However, sustainable marshland use is threatened by systematic drainage, the widespread application of highly hazardous pesticides, and a critical lack of agricultural information, including land-use management plans. Yet, this trajectory is not inevitable. I argue that scaling up agroecological practices, implementing land zoning, and ensuring farmers' access to information and their participation in the development of wetland management policies can simultaneously secure livelihoods and conserve the ecological functions of marshes. I also look forward to seeing meaningful actions, such as incentivizing the adoption of the best management practices among farmers, to support successful wetland conservation in the DRC.

References

Azine, P. C., Mugumaarhahama, Y., Mutwedu, V. B., Mondo, J. M., Chuma, G. B., Buchekabiri, A., Mutume, T., Bagula, E. M., Ayagirwe, R. B.-B., Baenyi, S. P., Bacigale, S. B., & Karume, K. (2025). Assessing smallholder farmers' vulnerability to climate change and coping strategies in South Kivu Province, eastern Democratic Republic of Congo. *Environmental Systems Research*, *14*, Article 2. https://doi.org/10.1186/s40068-025-00393-8

Balasha, A. M., Katungo, J.-H. K., Balasha, B. M., Masheka, L. H., Ndele, A. B., Cirhuza, V., Buhendwa, J.-B. A., Akilimali, I., Cubaka, N., & Bismwa, B. (2021). Perception et stratégies d'adaptation aux incertitudes climatiques par les exploitants agricoles des zones marécageuses au Sud-Kivu [Farmers' perception of climate uncertainties and adaptation strategies in the swampy areas of South Kivu]. *VertigO—la revue électronique en sciences de l'environnement*, *21*(1). https://doi.org/10.4000/vertigo.31673

Balasha, A. M., Munyahali, W., Kulumbu, J. T., Okwe, A. N., Fyama, J. N. M., Lenge, E. K., & Tambwe, A. N. (2023a). Understanding farmers' perception of climate change and adaptation practices in the marshlands of South Kivu, Democratic Republic of Congo. *Climate Risk Management*, *39*, Article 100469. https://doi.org/10.1016/j.crm.2022.100469

Balasha, A. M., Mulume, D. A,, Mwisha, S. W., Fyama, J. N. M., & Kalumbu, J. T. (2023b). Utilisation des pesticides en cultures maraîchères sur l'île d'Idjwi à l'est de la République démocratique du Congo: Connaissances et pratiques des agriculteurs [Pesticide use in vegetable production on the Idjwi Island in eastern Democratic Republic of Congo: Farmers' knowledge and practices]. *Cahiers Agricultures, 32*, Article 5. https://doi.org/10.1051/cagri/2022033

Chuma, G. B., Mondo, J. M., Karume, K., Mushagalusa, G. N., & Schmitz, S. (2021). Factors driving utilization patterns of marshlands in the vicinity of South-Kivu urban agglomerations based on Rapid Assessment of Wetland Ecosystem Services (RAWES). *Environmental Challenges*, *5*, Article 100297. https://doi.org/10.1016/j.envc.2021.100297

Chuma, G. B., Wellens, J., Gustave, M. N., & Schmitz, S. (2024). How rural communities relate to nature in sub-Saharan regions: Perception of ecosystem services provided by wetlands in South-Kivu. *Sustainability*, *16*(16), Article 7073. https://doi.org/10.3390/su16167073

Jensen, E. S., Carlsson, G., & Hauggaard-Nielsen, H. (2020). Intercropping of grain legumes and cereals improves the use of soil N resources and reduces the requirement for synthetic fertilizer N: A global-scale analysis. *Agronomy for Sustainable Development*, *40*, Article 5. https://doi.org/10.1007/s13593-020-0607-x

Johnes, P. J., Gooddy, D. C., Heaton, T. H. E., Binley, A., Kennedy, M. P., Shand, P., & Prior, H. (2020). Determining the impact of riparian wetlands on nutrient cycling, storage and export in permeable agricultural catchments. *Water*, *12*(1), Article 167. https://doi.org/10.3390/w12010167

Lambrecht, I., Vanlauwe, B., Merckx, R., & Maertens, M. (2014). Understanding the process of agricultural technology adoption: Mineral fertilizer in eastern DR Congo. *World Development*, *59*, 132–146. https://doi.org/10.1016/j.worlddev.2014.01.024

Makate, C., Wang, R., Makate, M., & Mango, N. (2016). Crop diversification and livelihoods of smallholder farmers in Zimbabwe: Adaptive management for environmental change. *SpringerPlus*, *5*, Article 1135. https://doi.org/10.1186/s40064-016-2802-4

Masumbuko, D. R., Mwitangabo, A. N., Basengere, E. B., Zamukulu, P. M., Mubalama, L. K., & Mushagalusa, G. N. (2024). Small-scale market gardeners' knowledge, attitudes and practices regarding the use of chemical pesticides in the Kabare territory (South-Kivu) in eastern D.R. Congo. *Heliyon*, *10*(12), Article e32917. https://doi.org/10.1016/j.heliyon.2024.e32917

Verhoeven, J. T. A., & Setter, T. L. (2010). Agricultural use of wetlands: Opportunities and limitations. *Annals of Botany*, *105*(1), 155–163. https://doi.org/10.1093/aob/mcp172

Zeng, Q., Zhang, Y., Jia, Y., Jiao, S., Feng, D., Bridgewater, P., & Lei, G. (2012). Zoning for management in wetland nature reserves: A case study using Wuliangsuhai Nature Reserve, China. *SpringerPlus*, *1*, Article 23. https://doi.org/10.1186/2193-1801-1-23

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COMMENTARY

Engaging young audiences: A reflective commentary on food safety outreach to school-aged children

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Introduction

Science outreach plays a pivotal role in fostering understanding of scientific concepts, enhancing community engagement, and inspiring the next generation of scientists. This engagement with the public is significant for land-grant universities, which were established with the mission to enhance agriculture education and research and to ensure that knowledge is accessible to the public (Mcdowell, 2003). Included in the mission is a dedicated effort aimed at younger audiences, including elementary, middle, and high school students. Such engagements are valuable at stimulating early interest in science. There is evidence that engaging students with hand-on scientific exploration and inquiry enhances their understanding and fosters a positive attitude toward science (Clark et al., 2016; Ecklund et al., 2012). Career fairs, specifically, can serve as valuable platforms for such outreach, particularly with bridging the persistent gap between academia and public understanding. They can help to inform, engage, and inspire students and encourage them to explore various career paths, including agriculture and food science. Young people consume food without fully appreciating the intricate components of the food system, which encompasses agricultural production, harvesting, processing, distribution, and retail. This system is highly interconnected and complex, involving multiple stakeholders such as farmers, processors, distributors, retailers, and consumers.

Food safety is one critical aspect of the complex food system; an effective food safety program can prevent widespread outbreaks of illness and protect public health. Therefore, outreach initiatives focused on food microbiology and food safety among a younger audience promote not only public health but also consumer confidence in the food they are eating. For example, educating kindergarten through eighth graders (K-8) students on the role of microbes can lead to better food handling and hygiene practices at home, effectively nurturing a more informed next generation of con-

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sumers (Macbeth et al., 2021). More importantly, it can create a ripple effect where children may educate their families and peers, enhancing community engagement in food safety issues.

I am an extension faculty in the Department of Food Science at Cornell AgriTech in Geneva, New York. My primary responsibilities at the Cornell Microbial Food Safety, Quality and Outreach Program are to support food businesses with microbiological testing and technical expertise to improve food safety and quality. This work keeps me deeply rooted in science and applied research aligning closely with the land-grant mission of translating academic research into practical solutions. In recent months, I've experienced a significant increase in requests to participate in outreach efforts in my local community of Geneva. While these invitations were initially unexpected, they have proven to be rewarding by reaffirming the essential role that extension specialists play in fostering science literacy and community engagement beyond the university walls. Engaging with a younger audience has not only deepened my appreciation for the land-grant mission but also has highlighted the unique positions that scientists hold in inspiring the next generation and building trust in science.

In this reflection, I share three unique outreach activities in the Geneva School District and offer lessons learned through these efforts, with the goal of guiding other scientists and extension agents who are interested in community engagement and may not be sure where to begin.

1. Introducing Food Safety to Elementary Students at a Career Fair Engagement

As part of my outreach efforts, I participated in the Geneva North Street Elementary career fair, where I interacted with third- to fifth-grade students. The event provided an opportunity to introduce foundational concepts in food safety and microbiology to a young and inquisitive audience. To facilitate learning, I prepared a variety of interactive and visual materials:

- **Fermentation demonstration:** A poster board illustrated a simple experiment comparing the metabolic activity of baker's yeast when exposed to different sugar sources (e.g., sucrose vs. artificial sweeteners). The poster highlighting microbial metabolism and fermentation.
- **"Safe or Not Safe?" game:** A custom-designed activity presenting real-life food safety scenarios. Students were asked to evaluate behaviors such as handwashing, cross-contamination, and the use of food thermometers. This interactive game fostered critical thinking about hygiene and foodborne illness prevention.
- **Microscopy station:** Prepared petri dish samples were made available for viewing under a microscope, allowing students to observe microbial colonies and appreciate the hidden world of microbes.
- **Microbe word search:** A vocabulary-based activity featuring fermented foods (e.g., kimchi, yogurt, bread, wine) aimed at reinforcing the concept of beneficial microbes.
- **Career information sheet:** A handout titled "What is a Food Microbiologist?" outlined the educational pathways, core competencies, and typical responsibilities associated with the profession.

Reflections and Lessons Learned

- **Focus enhances engagement:** While I arrived with a broad array of materials, I found that elementary students responded best to one or two well-structured, hands-on activities. Overloading the session with content reduced the opportunity for deeper engagement.
- **Interactivity drives learning:** The "Safe or Not Safe?" game was particularly effective. Its relatable scenarios encouraged participation and helped students connect food safety principles to their daily routines. However, time constraints limited the depth of discussion.
- **Visual aids and storytelling are powerful:** The fermentation poster and petri dish samples sparked curiosity and prompted thoughtful questions, underscoring the importance of visual and narrative elements in science communication.
- **Audience-appropriate content is crucial:** Some materials were too advanced for the target age group of 3rd-5th graders. Simplifying the lan-

guage and focusing on concrete examples would have improved their comprehension and engagement.

2. Inspiring High School Students Toward Science Careers

The second outreach initiative took place at Geneva High School, where I was invited by a food science teacher to speak with her students over breakfast. This session provided an opportunity to engage with older students who had a foundational interest in science. Drawing from my earlier outreach experience, I approached this visit with a more structured and audience-specific plan. I delivered a presentation titled "A Sneak Peek into the Life of a Food Microbiology Extension Associate," designed to offer students a realistic perspective on the scope and impact of my work. To complement the presentation, I brought petri dishes displaying diverse microbial colonies. These visual aids served as a tactile and engaging component, helping students visualize microbial diversity and understand that not all microbes are harmful.

The presentation was organized into three thematic sections:

1. **Shelf-life evaluation:** I described how I assist food producers in determining product shelf life under various storage conditions, emphasizing the role of microbial stability in food quality and safety.
2. **Industry case study:** I shared a real-world example involving a local juice manufacturer facing spoilage issues. The case illustrated how applied microbiological testing, troubleshooting, and technical consultation resolved their production challenges.
3. **Research integration:** I highlighted ongoing research projects in our lab, demonstrating how extension professionals serve as a bridge between academic research and industry applications.

Reflections and Lessons Learned

- **Audience engagement varies by age group:** Despite careful preparation, student engagement was limited. Of the 30 students present, only a small subset actively participated. This highlighted the need for more dynamic or relatable content for high school audiences.
- **Timing influences attention:** The session occurred near the end of the academic year, a period often marked by reduced student focus. This likely contributed to the lower levels of attention and interaction.
- **Visuals and interactivity remain effective:** While the lecture-style format was less impactful, the petri dish demonstration and discussion on "beneficial vs. pathogenic" microbes generated interest and helped dispel common misconceptions.
- **Relatability enhances career messaging:** In retrospect, incorporating personal anecdotes from my own educational journey, particularly from high school and college, could have made the career pathway more tangible and relatable for students.

3. Tailoring Food Safety for Middle Schoolers

The third outreach event took place at the Geneva Middle School career fair, just days after my previous engagements. With two recent experiences to draw from, I approached this event with increased confidence and a more streamlined strategy. My goal was to deliver a clear, accessible message while simplifying the complexity of the content. To better align with the attention span and interests of middle-school students, I prepared a concise, one-page handout titled "What Does a Food Microbiologist Do?" The handout offered a brief overview of my daily responsibilities, such as testing food products, conducting research, and advising companies on food safety practices. It also mentioned the skills essential to the profession, including problem-solving, communication, attention to detail, and patience, and outlined a simplified educational pathway for students interested in pursuing a similar career. To complement the handout, I brought a small selection of petri dishes displaying diverse microbial colonies, which I had found to be consistently effective in sparking curiosity across age groups.

The career fair itself was lively and well-attended, featuring more than 20 booths

representing a wide range of professions. Many of these booths offered promotional giveaways like candy, snacks, and branded merchandise, which naturally drew students' attention. In contrast, my colleagues and I from Cornell AgriTech arrived without such items, which initially made it more challenging to attract students in an environment filled with sensory stimuli and competing distractions.

Reflections and Lessons Learned

- **Sensory appeal drives initial engagement:** Middle school students were strongly drawn to booths offering tangible rewards. In the absence of giveaways, it was more challenging to compete for attention in a crowded and dynamic setting.
- **Active engagement is essential:** Rather than waiting for students to approach, I initiated conversations by making eye contact, greeting them by name, and introducing myself. This proactive approach significantly improved interaction.
- **Relatability opens doors:** Informal, spontaneous moments such as a student complimenting my outfit provided opportunities to build rapport and transition into meaningful discussions about science and careers.
- **Depth over volume:** Although I interacted with fewer students compared to more visually or materially appealing booths, the conversations I had were substantive. Several students asked insightful questions, suggesting that even brief interactions can have valuable educational impact when approached with intention.

Conclusion

These three outreach experiences spanning elementary, middle, and high school audiences offered valuable insights into the diverse ways scientific engagement can be tailored to different developmental stages. While each setting presented unique challenges, collectively they reaffirmed the importance of clear communication, adaptability, and personal connection in science outreach. For an extension faculty member at a land-grant institution, these efforts reflect a core part of its mission: to make science accessible, relevant, and inspiring to the communities we serve. By incorporating elements of the food system like food safety and food product distribution into outreach activities, students were introduced to the complex system that brings safe food from farm to table. Whether through hands-on demonstrations, career conversations, or spontaneous moments of curiosity, these interactions not only fostered scientific interest among students but also deepened my own understanding of how impactful and rewarding public engagement can be. Moving forward, I hope these reflections encourage other scientists to embrace outreach as a meaningful extension of their work. All the outreach materials developed for these programs are freely available upon request.

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References

Clark, G., Russell, J., Enyeart, P., Gracia, B., Wessel, A., Jarmoskaite, I., Polioudakis, D., Stuart, Y., Gonzalez, T., MacKrell, A., Rodenbusch, S., Stovall, G. M., Beckham, J. T., Montgomery, M., Tasneem, T., Jones, J., Simmons, S., & Roux, S. J. (2016). Science educational outreach programs that benefit students and scientists. *PLoS Biology*, *14*(2), Article e1002368. https://doi.org/10.1371/journal.pbio.1002368

Ecklund, E. H., James, S. A., & Lincoln, A. E. (2012). How academic biologists and physicists view science outreach. *PLoS ONE*, *7*(5), Article e36240. https://doi.org/10.1371/journal.pone.0036240

Macbeth, A. J., Zurier, H. S., Atkins, E., Nugen, S. R., & Goddard, J. M. (2021). Engaged food science: Connecting K-8 learners to food science while engaging graduate students in science communication. *Journal of Food Science Education*, *20*(1), 31–47. https://doi.org/10.1111/1541-4329.12215

Mcdowell, G. R. (2003). Engaged universities: Lessons from the land-grant universities and extension. *The ANNALS of the American Academy of Political and Social Science*, *585*(1), 31–50. https://doi.org/10.1177/0002716202238565

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Exploring the Bangladesh smallholder livestock sector through network analysis: Insights, assessment results, and future directions

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Abstract

Livestock production is a key livelihood strategy in rural Bangladesh, especially for smallholder farmers who often face barriers such as limited access to business services and markets. Increased livestock production is linked to improved household income, nutrition, and health outcomes. This study analyzes the USAID-funded Livestock Production for Improved Nutrition (LPIN) Activity, focusing on how livestock service providers' (LSPs) access to business service providers—analyzed through networks—affects their performance. We find that LSPs with higher network connectivity have significantly greater sales and serve more clients. LPIN-supported LSPs had higher sales but did not serve more clients compared to non-assisted peers. Barriers such as limited access to quality services, gender gaps, and sector-specific challenges were analyzed.

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Disclosure Statement

The authors report there are no competing interests to declare.

Data Availability Statement

Due to privacy agreement with study participants open access to the dataset is not available.

Youth and female, youth-owned LSPs showed high network centrality, but this did not always translate into better performance. These findings indicate that while connectivity matters, other structural barriers must be addressed to improve outcomes and foster inclusive growth in the livestock sector. Policy efforts that facilitate higher-quality, reliable business service linkages could be particularly advantageous if they are effectively targeted. Our results demonstrate actors' willingness to leverage these services to become leading sector network performers.

Keywords
international development, market access, livestock management, Bangladesh, gender, agriculture, network analysis

Introduction

It is crucial to recognize the significance of supporting small-scale livestock farmers in developing nations by working through key market system actors. These requirements include improving access to veterinary services, quality inputs, and market opportunities—critical components for enhancing food security, expanding information networks, and reducing poverty in rural regions ([CGIAR-IEA], 2016; Wahyono et al., 2023). This manuscript evaluates the effectiveness of a market systems development initiative—the United States Agency for International Development (USAID)-funded Feed the Future Bangladesh Livestock Production for Improved Nutrition Activity (LPIN)—using network analysis to explore how connections influence livestock service providers' (LSPs) performance. The study identifies the key successes and persistent challenges in service delivery and offers practical insights on the use of social network analysis as a tool for assessing development interventions in the livestock sector.

The livestock industry has played an increasingly prominent role in supporting livelihoods across much of Bangladesh over the past 70 years (CGIAR-IEA, 2016; Rahman et al., 2014). The sector supports skilled and unskilled employment, market engagement, and a means of subsistence for many (Shamsuddoha, 2009). Increasingly, the livestock sector in the country stands to benefit tremendously from coordination from stakeholders to inform inclusive agricultural and economic policy decisions (Rahman & Chandra Das, 2021; Rahman et al., 2014; Shamsuddoha, 2009). The LPIN project, activated from 2015 to 2021 and implemented by ACDI/VOCA, took a market systems approach, enhancing LSP service quality, reach, and profitability. It aimed to sustainably improve livestock productivity, nutrition, and incomes for rural households. The project engaged with LSPs to increase access to livestock services, inputs, information, and markets, providing technical assistance and animal healthcare services to over 180,000 farmers (87% female). The project intentionally integrated gender and social inclusion (GSI) considerations, targeting women's engagement. The LPIN assisted LSPs in the following sectors: milk collector; animal health (AH) worker with an input shop; AH worker without an input shop; alternative fodder seller; artificial insemination (AI) technician (tech); feed retailer and dealer; and food entrepreneur. On average, the LSPs earned 286 USD and served 510 clients monthly. Strengthening the capacities and outreach of LSPs (measured by income, number of clients, and available services) were core elements of LPIN's strategy to achieve its stated objectives of improved livestock productivity, nutrition, and incomes. The project sought to better understand the complex relationships between LSPs and livestock sector market actors that provide capacity-building services.

Prior studies often focus on the number of service or assistance connections as opposed to the number of market actors that provide targeted business support (Stofer et al., 2022; Wahyono et al., 2023). This has resulted in limited relevant sources for comparison and has overlooked factors that are crucial to sustainability and performance. This work seeks to address this research gap. This study was conducted in 2021 with the overarching goals of: a) understanding how LPIN influenced LSPs' networks, and b) making recommendations on how stakeholders may learn from LSP networks to enhance potential initiatives aimed at enhancing their economic capabilities. To do this, the following research questions were formulated: 1) How has the LPIN activity influenced the LSP model

(networks, sales, and clients) and how (if at all) are LSP network metrics related to their sales or client number; 2) Did LSP characteristics influence network access?; and 3) Which market actors are high- or low-performing in terms of access to service providers? The results of this assessment are intended not only to assess the impact of the LPIN activity but also to inform the work of stakeholders in this area.

Literature Review

Agricultural and food system networks have gained increasing attention for their ability to highlight how relationships among actors influence access to resources, information, and markets, particularly in rural and low-resource settings (Palmer et al., 2023; Rocker et al., 2022; Stofer et al., 2022). These networks have practical implications for communities, farmers, and entrepreneurs by shaping participation in economic systems and influencing development outcomes. In this context, social network analysis (SNA) has emerged as a valuable methodological tool to assess how these connections function and where gaps may exist. SNA allows for the identification of central actors, isolated groups, and information flows in agricultural systems, which can help development programs assess their effectiveness (Krebs & Holley, 2002; Rocker et al., 2022). Moreover, network analysis has been widely used in business and entrepreneurship studies, offering insights into the role of social ties in facilitating access to novel information (Burt, 1993), building trust (Uzzi, 1997), and securing start-up resources (Mailfert, 2007; Scott & Richardson, 2021). This interdisciplinary foundation supports our use of network analysis in evaluating the LPIN project, as it provides a means to explore how LSPs interact with business service actors and how these relationships affect their success in the market system.

This work expands upon these efforts in the distinct sociocultural context of Bangladesh and the agro-economic context of the livestock sector. The livestock and dairy sector represents a sector with prominent contributions to community well-being in Asia, aiding with, for example, poverty reduction, increasing incomes, decreasing food insecurity, and public health improvements. The sector makes these contributions through its potential to enhance the human and social capital of farmers, champion cooperative learning environments, and engage inclusively across local and regional economic scales (Akter & Farrington, 2011; Farouque et al., 2024; Hernandez et al., 2021; Wahyono et al., 2023).

In some areas of Bangladesh, more than 97% of households rely on agricultural activities for their livelihoods (Rahut et al., 2010). Smallholders are prominent actors in the agriculture and livestock market sector in Bangladesh, while noting they face many constraints (farm size, household labor, and income) to enhanced market integration (Gani & Hossain, 2015; Rahut, et al., 2010). Many participatory approaches and stakeholder engagement show the value of including diverse actors in agricultural development (Gerhart & Howard, 2023; Graddy-Lovelace & Roman-Alcalá, 2024; Little et al., 2024; Mujjabi et al., 2024). This is exemplified through the work of Reardon et al. (2012) in classifying inclusive small-scale sectors as contributing to a 'quiet revolution' in the Asian agri-food system, where imminent development takes place led by small-scale farmers and small off-farm entrepreneurs. This demonstrates how social and economic constraints in small-scale value chains, both upstream and downstream, can pose major hurdles to the advancement of the sector and community economic development in Bangladesh (CGIAR-IEA, 2016; Gomes et al., 2024; Hernandez et al., 2021; Rahman et al., 2014; Roborgh et al., 2024).

Women entrepreneurs in Bangladesh have been growing in prominence across many economic sectors, with recent evidence documenting how women face specific barriers (e.g., access to financing , limited training opportunities, awareness of support services, and overt gender discrimination) to economic inclusion (Afroze et al., 2014; Hossain et al., 2021; Shoma, 2019). Women are actively engaged in the livestock sector in Bangladesh, with many exhibiting an enhanced level of empowerment resulting from their involvement in the sector, especially in cattle and poultry production (Mostari et al., 2021; Nath et al., 2024). However, studies have highlighted the economic and social barriers facing women entrepreneurs in Bangladesh, discussing limitations in accessing cap-

ital, information, and business networks (Afroze et al., 2014; Akter & Farrington, 2011; Head et al., 2015; Jost et al., 2016; Nath et al., 2024; Schuler et al., 2010; Shoma, 2019). Exploring strategies for scaling up small-scale farmers to access larger retail markets can provide valuable lessons for market access and profitability in the livestock sector in Bangladesh (Gerhart & Howard, 2023). These themes (scaling-up connections to markets and increased economic engagement by the most isolated and vulnerable individuals) parallel pro-poor economic growth policies that focus on the nature of coordination problems experienced by the poorest individuals and small-scale agricultural practitioners in Asia and Africa (Kydd & Dorward, 2004). Increasing economic involvement and empowerment has been shown to have far-reaching socioeconomic benefits (e.g., poverty alleviation, enhanced women's resilience, and improved access to credit and education) in the country (Akter & Farrington, 2011; Hossain & Matin, 2007; Jost et al., 2016; Shoma, 2019; Sraboni et al., 2014).

Development organizations and scholars have highlighted a lack of information as a critical barrier to addressing women's empowerment and anti-poverty initiatives (Hossain & Matin, 2007). This research seeks to address research gaps in providing information about how the livestock sector socially functions for different populations (e.g., gender differences) in Bangladesh. By identifying the areas where network isolation (a lack in quality and quantity of social connections) may constrain certain actors, we are able to better inform future research and development initiatives.

Methodology

This study was conducted to evaluate the ACDI/VOCA LPIN activity and gain new insights into the program effectiveness. It sought to employ an innovative methodological strategy using social network analysis paired with traditional metrics of project success.

Study Site

Bangladesh is a densely populated South Asian nation where most of the total working population is engaged in livestock or agricultural production (Shamsuddoha, 2009). Most of the livestock that are being produced are bovine, sheep and goats, poultry, and fish; their products are key to providing a source of household income across the country (CGIAR-IEA, 2016; Rahman et al., 2014). Over the last 50 years, the livestock sector in Bangladesh has , been identified as an area where sustainable development initiatives hold tremendous potential to improve the distribution, growth, and performance of resources if certain technical, institutional, and social barriers are ameliorated (Rahman et al., 2014; Shamsuddoha, 2009).

The LPIN project was a USAID Feed the Future initiative implemented by ACDI/VOCA from 2015 to 2021 in the Barisal, Dhaka, Khulna, and Chattogram Divisions in Bangladesh. The project sought to impact rural household nutrition by improving engagement and product utilization in the livestock sector (ACDI/VOCA, 2015). In a separate impact evaluation, the project was found to be successful in raising awareness of livestock and nutrition issues and improving household meat consumption (United States Agency for International Development [USAID], 2021).

Data Collection

To answer the study research questions, we assessed relationships between LPIN and non-LPIN-assisted LSPs with their market system actors, specifically service-providing firms. Sales and clients served were considered as success indicators. In March-April 2020, LPIN staff conducted face-to-face surveys with 230 LSPs. Informed consent was obtained for all participants.

Of the 2,002 total LSPs the project assisted, 115 LSPs were randomly selected using stratified sampling with replacement, ensuring representation across each sector type (e.g., AH worker, feed dealer) and key demographic categories (gender, age group). This method allowed us to capture a diverse and representative subset of the LPIN-assisted population for meaningful comparison with non-assisted LSPs.

Out of the total estimated 3,600 LSPs, 115 non-LPIN assisted LSPs were selected with the assistance of local livestock offices. The sample size was chosen to provide a minimum of 10% margin of error and a 95% confidence level for

accurate statistical representation of the target population. Sample size was proportionally allocated to represent the categories (i.e., the strata) of female adult, female youth, male youth, and male adult. Targeted oversampling of female LSPs was conducted to increase the power needed to examine effects at the level of these strata (Vaughan, 2017). All information collected was LSP self-reported data, although it is important to note that LPIN-assisted LSPs' were made aware of iterative LPIN reporting requirements regarding firm sales and the number of customers when the relationships were first established.

Data was entered directly into the KoboCollect data collection platform (Kobo Toolbox, 2020). Networks were constructed by an enumerator asking LSPs a series of name generator questions to identify the firms in key service areas. The network consisted of two types of actors: LSPs (focal nodes–survey respondents) and service firms (alters–the firms named by the respondents in their network questions). Survey respondents were asked "what is the name of the provider that you primarily use for this service" for a variety of services.[1] The primary focus of the analysis of this report centers around ego-network analysis of the LSPs. Ego-network analysis examines a focal actor (focal node or ego) and the set of actors (non-focal nodes or alters) that are directly connected to the focal actor through a stated network tie (Marsden, 2002). Ego-centric analysis is useful for examining how information is accessible to key network actors and helps identify important sources of information (Haythornwaite, 1996). This was chosen because of the focus on the primary respondents in our research questions (meaning the focal LSP is the center of analysis), as opposed to drawing broad conclusions about the wider networks and ancillary firms. However, whole network (an analysis that plots all of the ego-networks together and connects the networks that named the same firms or alters, as seen in Figure 1) and firm-specific (focusing on only the non-focal nodes or alters that were named as connections by the respondents) analyses were used to inform the wider findings and calculate some measures of centrality. Analysis used the Kumu network analysis software platform (Kumu Inc., 2021) and the SPSS statistical software for inferential statistical tests.

Analytical Methods

Initially, network measures were examined from the perspective of respondent LSPs, or ego-centric analysis. These measures included degree, closeness, eigenvector centrality, and K-2 reach. A higher degree of centrality and network size demonstrate that project respondents have more local connections and a larger ego network compared to control respondents. Literature suggests that, theoretically, higher closeness centrality means that project respondents are generally better connected to the wider network and are potentially more prominent actors in the network compared to control respondents. Higher eigenvector centrality demonstrates that project respondents are better situated to be leaders in the wider network than control respondents (Newman, 2006). K-2 reach shows that project respondents are better connected to other respondents through an immediate connection compared to control respondents, suggesting more opportunities for market and social interaction (Duxbury, 2020).

To determine whether network metrics, sales, and clients served (i.e., our dependent variables) were significantly different between LSPs with various characteristics (i.e., our independent variables), we used a minimum p-value of <.05 for network metrics among the full sample. When examining comparative groups, a p-value of <0.1 was used, due to the reduced sample size for the analytical scope. For instance, a p-value of <0.1 was used for tests involving the sales variable, as sales ranges are notably different for different types of LSPs. Spearman's rho, chi-squared tests, and independent two-sample t-tests were used to examine bivariate relationships. Analysis of variance regression models was used to examine multivariate relationships when examining multiple categories of LSPs.

[1] Services asked about in the survey included training in different milk collection and management processes; linkages to milk collection centers, input suppliers, or other private sector firms; sharing knowledge around vaccinations, animal health, and improved nutrition and food security practices; access to fodder and forage materials; silage processing, and 'other'.

Limitations

Data was collected over the phone due to the COVID-19 pandemic, making it difficult to complete surveys in one call. Information for what service each firm provided to a surveyed LSP was not captured, disallowing analysis of specific types of service gaps. Because of the data collection limitations, detailed information regarding the prominence and specific nature of network ties was not captured. Therefore, some forms of network statistics were not deployed (Breiger, 1974; Duxbury, 2020; Larremore et al., 2014).

Results

Females made up 18.7% of respondents (Table 1). The average respondent age was 37.8 years old, and 13.5% of the LSPs were owned by someone under the age of 30, referred to as youth ownership. Ninety-seven percent of respondents indicated that their LSP was solely owned. For LSPs with multiple owners, if one of the owners is a female, the LSP is considered female-owned in the analysis. Three percent of the LSPs were owned by a female under the age of 29 (referred to as female youth-owned). The group (female/youth-owned) has been highlighted in the analysis due to the important role that entrepreneurial women play in the Bangladesh livestock sector (Akter & Farrington, 2011; Rahman et al., 2014).

Traditional metrics of LSP success include estimated clients served per year (averaged 680.3) and estimated annual sales (BDT৳ 266,941.7[2]). The network, represented in Figure 1, can be seen in the full sociogram representation, where "Respondent" refers to LSPs and "Provider" refers to the service provider firms that the respondents named.

LSP's differential network statistics, in terms of access to service providers, demonstrate a variety of disparate characteristics between various types of LSP respondents. The average degree of centrality, or number of connections for each LSP, is 2.15

Table 1. Descriptive Statistics for LSP Survey Respondents

	Sample *n*	Mean	Std. Dev.
Annual sales (in BDT)	230	266,941.7	417,491.3
Project LSPs	*115*	*303,176.5*	*556,974.7*
Control LSPs	*115*	*230,707.0*	*193,021.1*
Clients served annually	230	680.3	1,349.9
Project LSPs	*115*	*647.8*	*1,281.5*
Control LSPs	*115*	*712.8*	*1,419.9*
Business age (in years)	227	7.6	8.6
Project LSPs	*112*	*6.8*	*10.4*
Control LSPs	*115*	*8.4*	*6.3*
Sector entrance (in years)	216	6.1	5.7
Project LSPs	*112*	*4.6*	*4.1*
Control LSPs	*104*	*7.6*	*6.7*

		Yes (1)	No (0)
Yes = LPIN assisted LSP No = control group	230	50.0%	50.0%
Gender (female)	230	18.7%	81.3%
Youth ownership (15-29)	230	13.5%	86.5%
Female youth ownership	230	3.0%	97.0%
Network isolate	230	17.0%	83.0%
Single owned LSP	230	97.4%	2.6%
Sector:	230		
Milk collector		14.4%	85.7%
AH worker w/ input shop		10.9%	89.1%
AH worker w/o input shop		20.4%	79.6%
Alternative fodder seller		12.2%	87.8%
AI tech		17.4%	82.6%
Feed retailer/dealer		10.0%	90.0%
Fodder entrepreneur		14.8%	85.2%

Note: Number of observations differ due to missing values in survey responses.

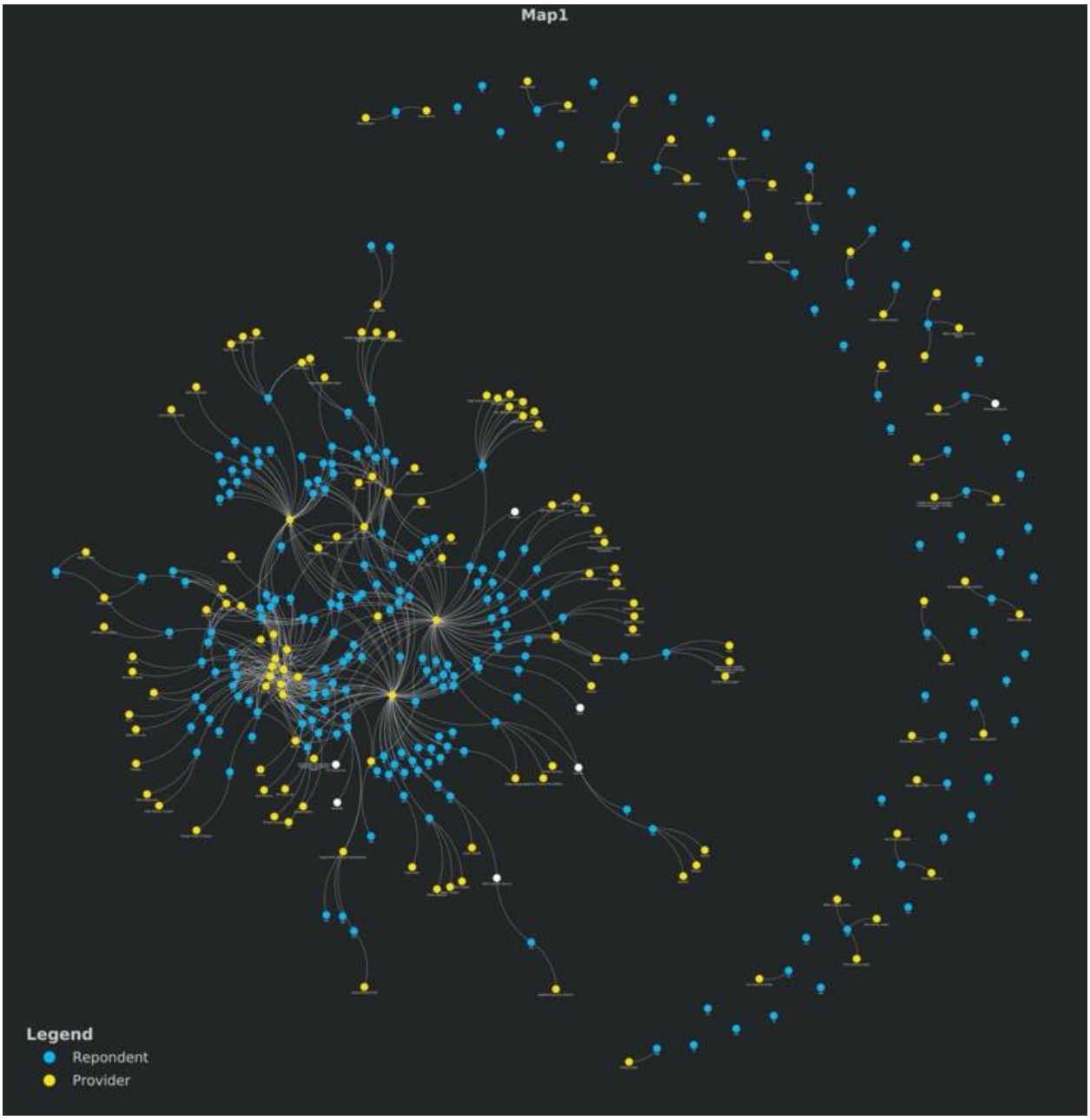
[2] The average exchange rate between March–April 2020 was 84.7 BDT=1 USD, so the estimated annual sales was equivalent to 3,151 USD during the time of data collection in 2020.

service provider firms. This also means that the average network size is 3.15. The mean value for closeness centrality, a measure of network prominence, is 0.161. Eigenvector centrality, a measure of network leadership, has a mean value of 0.004. K-2 reach, the measure of centrality of reach within two connections away in the network, has a mean of 0.115. Network isolates are LSPs that did not name a single connection.

Networks and Network Relationship to LSP Success

Analysis examined statistically significant relationships between network metrics and success indicators (sales and clients served) (Table 2). Sales presented a positive relationship with degree centrality and size ($p < .001$), but no significant relationship with closeness, eigenvector centrality, or K-2 reach. Project LSPs were found to have significantly

Figure 1. Sociogram Display of All Study LSP Networks



higher sales compared to the control group (see Table 1, $p<.10$). All selected network metrics presented a significant positive relationship with clients served ($p<.05$). Sales did not correlate with clients served. There was no significant difference in clients served noted between project and control LSPs.

There were significant differences across network metrics between the LPIN assisted and non-LPIN assisted LSPs (Table 3). However, LPIN assisted LSPs were allowed to reference ACDI/VOCA as a service provider in this study. Although not all LSPs included ACDI/VOCA in their list (since not all LSPs received the same types of assistance or services from ACDI/VOCA), most did. This contributed to project-assisted LSPs averaging one additional connection (degree centrality of 2.652) compared to the control sample (1.643) and likely influenced all measures of centrality, which were significantly higher for LPIN assisted LSPs. This also demonstrates the prominence of key nongovernmental organizations (NGOs) in providing economic and agricultural assistance to spur community development throughout Bangladesh (Das & Kabir, 2014; Farouque et al., 2024; Roborgh et al., 2024; Shamsuddoha, 2009).

What Role Did LSP Gender and Age Play in Network Results and Performance?

A significant difference was found between LPIN assisted male and female LSP owners for all network measures (Table 4). These differences were not observed for control LSPs. This demonstrates that network access is more limited among female-owned LSPs involved in the LPIN project as compared to men. This gender disparity is consistent with previous studies that demonstrate more limited social and economic network access by women entrepreneurs in the country (Afroze et al., 2014; Schuler at al., 2010; Shoma, 2019). Male LSPs were found to have significantly greater annual sales compared to female LSPs (Table 5). This disparity was also found among the project sample. No gender disparity was indicated in the number of clients that LSPs served.

When controlling for the LSP sector type, degree centrality/size ($p<.10$) and closeness ($p<.01$) among the project sample were shown to maintain significant gendered differences (male LSPs have greater measures of degree and closeness centrality) in the project sample. For the overall sample, no

Table 2. Network and Success Variables Comparison

Variable	Sales	Clients served
Degree	+***	+**
Closeness		+**
Eigenvector		+**
Reach		+**
Size		+**

Note: n=230; ** $p < .05$. *** $p < .001$

Table 3. LPIN Project Sample and Overall Sample Comparison with Network Variables

Variable	Group	Mean	Std. Err.	Std. Dev.
Degree	Control	1.643	0.0146	1.563
	Project	2.652	0.194	2.082
<*** ; ≠***	Total	2.148	0.126	1.905
Closeness	Control	0.130	0.009	0.101
	Project	0.191	0.009	0.096
<*** ; ≠***	Total	0.161	0.007	0.103
Eigenvector	Control	0.002	0.0003	0.003
	Project	0.005	0.0004	0.005
<*** ; ≠***	Total	0.004	0.0003	0.004
Reach	Control	0.075	0.007	0.072
	Project	0.155	0.010	0.103
<*** ; ≠***	Total	0.115	0.006	0.097
Size	Control	2.643	0.146	1.563
	Project	3.652	0.194	2.082
<*** ; ≠***	Total	3.148	0.126	1.905

Note: Control group n=115; Project group n=115; Total n=230; *** = $p<.001$.
Symbols key: < control is significantly smaller than project group; ≠ control is significantly different from project group; > control is significantly greater than project group.

Table 4. Gender Comparison with Network Variables

Variable	Group	Mean	Std. Err.	Std. Dev.	*n*
Degree (all)	Female	2.047	0.280	1.838	43
	Male	2.171	0.141	1.924	187
Not sig.	Total	2.148	0.126	1.905	230
(Project resp.)	Female	2.139	0.329	1.973	36
	Male	2.886	0.236	2.100	79
<*	Total	2.652	0.194	2.082	115
Closeness (all)	Female	0.154	0.018	0.115	43
	Male	0.162	0.007	0.100	187
Not sig.	Total	0.161	0.007	0.103	230
(Project resp.)	Female	0.159	0.019	0.116	36
	Male	0.206	0.009	0.083	79
<**	Total	0.191	0.009	0.096	115
Eigenvector (all)	Female	0.004	0.0007	0.004	43
	Male	0.004	0.0003	0.004	187
Not sig.	Total	0.004	0.0003	0.004	230
(Project resp.)	Female	0.004	0.001	0.005	36
	Male	0.006	0.0005	0.004	79
<*	Total	0.005	0.0004	0.005	115
Reach (all)	Female	0.125	0.017	0.110	43
	Male	0.112	0.007	0.094	187
Not sig.	Total	0.115	0.006	0.097	230
(Project resp.)	Female	0.131	0.019	0.114	36
	Male	0.166	0.011	0.096	79
<*	Total	0.155	0.010	0.103	115
Size (all)	Female	3.047	0.280	1.838	43
	Male	3.171	0.141	1.924	187
Not sig.	Total	3.148	0.126	1.905	230
(Project resp.)	Female	3.139	0.329	1.973	36
	Male	3.886	0.236	2.100	79
<*	Total	3.652	0.194	2.082	115

Note: * $p<.05$; ** $p<.01$.
Symbols key: < female is significantly smaller than male group.

measures of network centrality maintained significant gender differences. When the scope of the analysis is narrowed to individual sectors, female AH workers without an input shop were found to have greater degree centrality/size ($p<.10$), closeness ($p < .05$), eigenvector ($p<.05$), and K-2 reach ($p<.01$) compared to men. Female milk collector LSPs were shown to have lesser degree centrality/size ($p<.10$) and closeness ($p<.05$) compared to men.

Statistically significant differences were observed between youth-owned and non-youth-owned LSPs (Table 5). Youth-owned LSPs have greater degree centrality/size, closeness, eigenvector, and K-2 reach compared to non-youth-owned LSPs. Among project LSPs, youth-owned LSPs have greater degree centrality/size, eigenvector, and K-2 reach compared to non-youth-owned LSPs. Youth-owned LSPs were less likely to be network isolates. Youth ownership was not found to have a significant relationship with sales or clients served.

Differences were found in LSPs that are female youth-owned. Female youth-owned LSPs

Table 5. Bivariate Relationships: {x} by {gender; youth-ownership; female youth-ownership}

	Degree/Size	Closeness	Eigenvector	K-2 reach	Sales	Clients served
Gender (overall)	—	—	—	—	>^	—
(project)	>*	>*	>*	>*	>^	—
Youth ownership (overall)	>***	>**	>***	>**	—	—
(project)	>***	—	>***	>*	—	—
Female youth ownership (overall)	—	>^	>**	>**	—	>*
(project)	—	—	—	—	—	—

Note: ^ p<.10; * p<.05; ** p<.01; *** p<.001; — indicates no significant difference. Gender: Male reference group compared to female. Youth ownership: Youth owned referenced group compared to non-youth owned. Female youth ownership: Female youth owned referenced group compared to non-female youth owned.

have greater closeness, eigenvector, and K-2 reach compared to other LSPs. In the overall sample, female youth-owned LSPs were found to serve more clients compared to other LSPs. Female youth-owned animal healthcare workers without an input shop had greater closeness (p<.10), eigenvector (p<.01), and K-2 reach (p<.01) compared to all other LSP types. No other statistically significant female youth-owned LSP differences were found within sectors. Controlling for LSP sector, female youth ownership was found to maintain significance in the overall sample for closeness (p<.10), eigenvector (p<.05), and K-2 reach (p<.05). In the overall sample, female youth-owned LSPs were found to serve more clients compared to other LSPs. Pervasive disparities in economic empowerment and access to resources have been noted among differing sectors and demographic groups in Bangladesh (Farouque et al., 2024; Gomes et al., 2024; Hernandez et al., 2021). This provides evidence that is in conversation with our observed findings relating to differences in network characteristics, sales, and clients served between groups in the livestock sector.

LSP Characteristics Influence on Performance

There are seven different sectors in which surveyed LSPs were engaged in the livestock management field (noted previously). The statistically significant, individual network centrality measure differences that LSP sector types display, when independently examined in relation to all other sector types, can be seen in Table 6. When all LSP sector types are examined simultaneously in a one-way analysis of variance, the models for sector differences are significant for degree centrality, size, and eigenvector centrality, but not for closeness or K-2 reach centrality. There were also significant differences found between specific LSP sector types and different network metrics, suggesting one provider can play multiple network

Table 6. Measures of Network Centrality LSP Sector Relationship

	Degree/size***	Closeness	Eigenvector***	K-2 reach
AH worker with shop	+***	+**	+***	+**
Alternative fodder seller	-*			
AH worker w/o shop	+*	+*	+*	+*
AI tech	-*			
Feed retailer/dealer		+*	+*	+**
Fodder entrepreneur		+*		+*
Milk collector	-*	-***	-***	-***

Note: Top row includes ANOVA model significance; + = sector mean is significantly higher compared with all other sectors; - = sector mean is significantly lower compared with all other sectors; * p<.05; ** p<.01; *** p<.001

roles: AH workers with an input shop were shown to have the most local influence, connections, the largest ego-network, and are best positioned to be network leaders in terms of accessing these business service providers. AH workers without an input shop and feed retailers and dealers were shown to have more local influence, more connections, and larger ego-networks compared to other sectors. AH workers without an input shop and fodder entrepreneurs are better positioned to be network leaders compared to other LSP sectors. Alternative fodder sellers had the least measure of local network influence, the least connections, and the smallest ego-network. Milk collectors were shown to be worst positioned to be network leaders. Milk collectors and artificial insemination technicians were shown to have less local network influence, fewer connections, and smaller ego-networks compared to other LSP sectors. Feed retailers and dealers were shown to be poorly positioned to be network leaders compared to other LSP sectors. Feed retailers and dealers and fodder entrepreneurs were less likely to be network isolates. This suggested that feed retailers and dealers and fodder entrepreneurs operate in the livestock sector with at least one livestock sector network connection. Conversely, milk collectors were more likely to be network isolates. This demonstrates that milk collectors more frequently operated in the livestock sector in network isolation compared to LSPs in other sectors. The reasons for these differences in network measures between the LSP sectors may have been due to the nature of the role they play in the livestock sector or may also have been due to the type of business owners that are drawn to these occupations. We cannot give causal explanations for these differences beyond our hypotheses, and this presents an area for important future research.

The age of the LSP business (mean of 7.6 years) did not have any significant relationships with measures of network centrality or with LSP sales and clients served. Male-owned LSPs were found to be significantly older businesses (8.2 years) compared to female-owned LSPs, at 4.9 years ($p<.05$). It is unsurprising that non-youth-owned LSPs had older businesses (8.0 years) compared to youth-owned LSPs, at 5.2 years ($p<.10$). Businesses with more recent entrance into the livestock sector (mean of 6.1 years) are more prominent actors in the network in terms of business service provider access (greater closeness; $p<05$), more often network leaders (higher eigenvector; $p<.10$), and have more opportunities for social and market interaction (greater K-2 reach; $p<.05$) when compared to LSPs longer established in the livestock value chain. The year an LSP became active in the livestock sector did not have a significant relationship with LSP sales. More established businesses were associated with serving more clients ($p<.01$). Women-owned LSPs were shown to have entered the livestock sector more recently (4.5 years) compared to male-owned LSPs, at 6.5 years ($p<.05$). Unsurprisingly, youth-owned businesses were shown have entered the livestock sector more recently (4.7 years) compared to non-youth-owned LSPs, 6.3 years ($p<.10$).

Sector types were shown to have significant differences for sales ($p<.001$). When individual LSP sectors were compared with the full sample, feed retailers and dealers had the highest sales ($p<.001$). Alternative fodder sellers had the lowest sales ($p<.01$). Fodder entrepreneurs and AH workers without input shops had significantly lower sales compared to other sectors ($p<.01$ and $p<.05$, respectively). Sector types were shown to have significant differences for clients served ($p<.001$). AH workers with an input shop had the most clients ($p<.001$). Artificial insemination technicians also demonstrated a significantly higher number of clients ($p<.10$). Fodder entrepreneurs have the least clients served ($p<.05$). Alternative fodder sellers and milk collectors also demonstrated significantly lower clients served compared to other sectors ($p<.05$). When controlling for the sector in the overall sample, gender and female youth-ownership retained significant differences in clients served ($p<.001$). Therefore, the characteristics of a given LSP are shown to have distinct impacts on markers of social connectedness and economic success. Partially due to its central livelihood importance, the livestock sector in Bangladesh is especially sensitive to individual differences in business characteristics that impact their efficacy in the wider market (CGIAR-IAE, 2016; Jost et al., 2016; Rahman et al., 2014; Schleiss, 2001).

Identifying High- and Low-Performers Network Actors

By noting the differences between LSPs, we are able to document the actors in the networks that are potentially high- or low-performing. Three LSP types were shown to have significantly higher eigenvector centrality, meaning they are potential market bottlenecks as they are uniquely positioned as network leaders: AH workers with an input shop, AH workers without an input shop, and feed retailers and dealers. Three LSP types were also noted to be more isolated in their immediate network access: milk collectors, alternative fodder sellers, and artificial insemination technicians. Milk collectors are also more likely to be network isolates and the worst positioned sector to be a network leader in regard to business service provider access. LSPs in these sectors are in a vulnerable network position as low performers in the network. Network performers can be broken down as follows:

- High performers:
  - Sectors (in overall sample): AH workers with an input shop (degree/size and eigenvector centrality), AH workers without an input shop (degree/size and eigenvector centrality), feed retailers and dealers (eigenvector centrality and isolates), and fodder entrepreneurs (isolates).
  - Male or non-female-owned LSPs in project sample (all network measures).
  - Youth-owned LSPs in overall (all network measures) and project sample (three network measures).
  - Female youth-owned LSPs in overall sample (three network measures).
- Low performers:
  - Sectors (in overall sample): Milk collectors (three network measures), alternative fodder seller (degree/size), and artificial insemination technician (degree/size).
  - Female-owned LSPs in project sample (all network measures).
  - Non-youth LSPs in overall (all network measures) and project sample (three network measures).
  - Non-female-youth-owned LSPs in overall sample (three network measures).

Discussion and Conclusion

Our findings can be summarized with the following four key points: (1) network centrality regarding business service provider access matters to LSP success indicators (sales and clients served); (2) there are varied effects of LSP characteristics on performance; (3) sector type impacts performance; and (4) this study provides valuable lessons that can be applied in future development initiatives. Results demonstrate that increasing LSP access to business provider services, which is reflected in increased measures of centrality, enhances LSP sales and the number of LSP clients. Essentially, this information supports the value of such firm services in supporting the economic growth of LSPs, as well as the livestock sector overall. This is because, as they grow, LSPs are also reaching more producers and actors (i.e., clients). These findings recommend further implementation and potential scaling-up of activities that facilitate LSP connections to firms as an effective means of aiding performance and sector growth.

Youth-owned LSPs demonstrated higher measures of centrality in terms of access to service providers. However, there was no significant difference between adult and youth-owned firms in terms of sales or number of clients. Similarly, LSPs that more recently entered the livestock market (which tend to be female and youth-owned LSPs in the sample) are also network leaders but have significantly fewer clients than longer established livestock sector businesses. The lack of increased clients or sales for youth-owned or recently established livestock firms, despite these higher network centrality statistics, suggests confounding factors are serving as impediments to their success. In this study, youth cite lack of access to reliable service providers as a key barrier, implying that, although they are accessing services, they might not be of high quality or the ones that they need. Other contributing factors could be time, pricing models, the types of clients they serve, or a lack of access to certain equipment and capital. Future activities should try to identify and address barriers to whole-of-business success as these youth-owned or newly established LSPs demonstrate promise in terms of scaling of impacts, due to current strengths in network

centrality measures, including leadership roles in the network.

Along this same trend, female youth-owned LSPs exhibited high potential in terms of business performance, interacting more prominently with these service firms and positioning themselves as leaders, as compared to female adult-owned LSPs. This is a surprising finding and challenges previous evidence noting the limitations often faced by these populations (Afroze et al., 2014; Hossain et al., 2021; Shoma, 2019). Notably, female youth-owned LSPs had significantly more clients than adult female-owned LSPs. However, overall, female LPIN-assisted LSPs had significantly lower network access than LPIN-assisted male LSPs. The precise reasons for this are uncertain and require further examination but it is suspected there is a gap in female business owners accessing wider livestock sector networks due to cultural and economic customs. To close this gap, it is recommended that future activities note this inequality and intentionally provide additional or more targeted assistance to female LSPs in linking them to helpful firm service providers. Future development activities might choose to champion these female youth LSPs or place them as coaches of adult female LSP actors. The primary barriers female LSPs cited in accessing firm services included transportation and distance and not enough supply. More research should be done to examine these and potentially other barriers facing women-owned businesses and to identify why the age disparity exists between female-owned LSPs.

Results imply that female LSPs are charging, and thus receiving, less per services or product than male LSPs as they had lower sales, but no significant differences in the number of clients served. This also relates to the finding that sales and clients served are not significantly related to each other, meaning that neither measure is a sufficient stand-alone proxy for success. In keeping with this theme, LPIN's gender impact assessment found gender biases influenced customers' willingness to pay female LSPs for their services. Ideally, future research would examine why female LSPs are not able to charge or collect the same amount for their services and products as male LSPs and if there is a way to change or adjust this pricing model. Each LSP sector type had different strengths and weaknesses, and the influence of LSP owner sex or age on performance varied by LSP type. These results suggest that future activities tailor formative research and interventions by LSP sector type.

This analysis presents a number of areas for research. Targeted analysis is merited to examine why differences exist between sectors. Perhaps there are certain characteristics for each type of business that impact how they interact with others in the livestock sector. Alternatively, there may be something about the people that are attracted to these sectors that influence how they construct their networks and conduct their business. A more gender-centric avenue of research is also needed to examine how these business success and network measures impact potential indicators of empowerment and, ultimately, aspects of everyday livelihood like poverty and food security. Future research would also benefit from including enhanced spatial and socioeconomic status analysis to further understand the nuances in the findings and improve future service delivery.

Finally, this study documents the usefulness of practical applications of social network analysis for market systems actors in an applied development setting. The specific findings are not widely applicable across geographic or cultural contexts, but, rather, the application of the method demonstrates the relevance of this type of scientific analysis for development projects. The results effectively advocate for additional support targeting younger LSP business owners and women-owned businesses.

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References

ACDI/VOCA. (2015). USAID Livestock Production for Improved Nutrition. In *Revised Technical Application*.

Afroze, T., Alam, M. K., Akther, E., & Jui, N. S. (2014). Women entrepreneurs in Bangladesh—Challenges and determining factors. *Journal of Business and Technology (Dhaka)*, *9*(2), 27–41. https://doi.org/10.3329/jbt.v9i2.26194

Akter, S., & Farrington, J. (2011). What determines poverty transition? An investigation of women livestock farmers in Bangladesh. *Development in Practice*, *21*(2), 269–281. https://doi.org/10.1080/09614524.2011.543274

Breiger, R. L. (1974). The duality of persons and groups. *Social Forces*, *53*(2), 181–190. https://doi.org/10.2307/2576011

Burt, R. S. (1993). The social structure of competition. In R. Swedberg (Ed.), *Explorations in economic sociology* (pp. 65–103). Russell Sage Foundation.

CGIAR-IEA. (2016). *Evaluation of CGIAR research program on Livestock and Fish (L&F)*. Independent Evaluation Arrangement (IEA) of CGIAR.

Das, S., & Kabir, W. (2014). Rural innovations in agricultural information service delivery in Bangladesh. *Asia-Pacific Journal of Rural Development*, *24*(1), 55–66. https://doi.org/10.1177/1018529120140105

Duxbury, S. W. (2020). Identifying key players in bipartite networks. *Network Science*, *8*(1), 42–61. https://doi.org/10.1017/nws.2019.62

Farouque, M. G., Kabir, K. H., Roy, D., Rana, M. M., & Donalson, J. L. (2024). An assessment of capacity building activities for common interest farmer groups in Bangladesh. *Development in Practice*, *34*(4), 491–511. https://doi.org/10.1080/09614524.2024.2325415

Gani, O. A., & Hossain, E. (2015). Market participation decision of smallholder farmers and its determinants in Bangladesh. *Economics of Agriculture*, *62*(1), 163–179. https://doi.org/10.5937/ekopolj1501163g

Gerhart, J. A., & Howard, P. H. (2023). Assessing the profitability of scaling up for retail access: Lessons from local salad mix in Southeast Michigan. *Journal of Agriculture, Food Systems, and Community Development*, *12*(4), 85–102. https://doi.org/10.5304/jafscd.2023.124.003

Gomes, M., Jahan, N., Shatil, T., Tahsin, N., Das, N., & Matin, I. (2024). Economic recovery of the new poor created by COVID-19: Evidence from Bangladesh. *Development in Practice*, *34*(2), 221–237. https://doi.org/10.1080/09614524.2023.2267795

Graddy-Lovelace, G., & Roman-Alcalá, A. (2024). Agroecology beyond the statist quo? Transforming U.S. imperial agricultural policy. *Journal of Agriculture, Food Systems, and Community Development*, *13*(3), 99–105. https://doi.org/10.5304/jafscd.2024.133.008

Haythornthwaite, C. (1996). Social network analysis: An approach and technique for the study of information exchange. *Library & Information Science Research*, *18*(4), 323–342. https://doi.org/10.1016/S0740-8188(96)90003-1

Head, S. K., Yount, K. M., Hennink, M. M., & Sterk, C. E. (2015). Customary and contemporary resources for women's empowerment in Bangladesh. *Development in Practice*, *25*(3), 360–374. https://doi.org/10.1080/09614524.2015.1019338

Hernandez, R., Belton, B., Reardon, T., Hu, C., Zhang, X., & Ahmed, A. (2021). The "quiet revolution" in the aquaculture value chain in Bangladesh. In A. U. Ahmed, N. Islam, & M. K. Mujeri (Eds.), *Securing food for all in Bangladesh* (pp. 413–452). University Press Unlimited. https://doi.org/10.2499/9789845063715_12

Hossain, S. M., Akbar, A., Tehseen, S., Poulova, P., Haider, S. A., Sheraz, F., & Yasmin, F. (2021). Evaluation of entrepreneurs success: A special reference to women entrepreneurs in Bangladesh. *Academy of Entrepreneurship Journal*, *27*(5S), 1–13. https://www.abacademies.org/articles/evaluation-of-entrepreneurs-success-a-special-reference-to-women-entrepreneurs-in-bangladesh-12790.html

Hossain, N., & Matin, I. (2007). Engaging elite support for the poorest? BRAC's Targeted Ultra Poor programme for rural women in Bangladesh. *Development in Practice*, *17*(3), 380–392. https://doi.org/10.1080/09614520701336923

Jost, C., Kyazze, F., Naab, J., Neelormi, S., Kinyangi, J., Zougmore, R., Aggarwal, P., Bhatta, G., Chaudhury, M., Tapio-Bistrom, M.-L., Nelson, S., & Kristjanson, P. (2016). Understanding gender dimensions of agriculture and climate change in smallholder farming communities. *Climate and Development*, *8*(2), 133–144. https://doi.org/10.1080/17565529.2015.1050978

Kobo Toolbox. (2020). *Kobo Collect*.

Krebs, V., & Holley, J. (2002). *Building smart communities through network weaving*. Retrieved from the Community-Wealth.org website: http://staging.community-wealth.org/content/building-smart-communities-through-network-weaving

Kumu Inc. (2021). *Kumu*. https://kumu.io

Kydd, J., & Dorward, A. (2004). Implications of market and coordination failures for rural development in least developed countries. *Journal of International Development*, *16*(7), 951–970. https://doi.org/10.1002/jid.1157

Larremore, D. B., Clauset, A., & Jacobs, A. Z. (2014). Efficiently inferring community structure in bipartite networks. *Physical Review E*, *90*, Article 012805. https://doi.org/10.1103/PhysRevE.90.012805

Little, M., Horn, T., & Sit, M. (2024). Food democracy as food security strategy: The case of a Costa Rican tourism town. *Journal of Agriculture, Food Systems, and Community Development*, *13*(3), 199–216. https://doi.org/10.5304/jafscd.2024.133.019

Mailfert, K. (2007). New farmers and networks: How beginning farmers build social connections in France. *Tijdschrift voor economische en sociale geografie*, *98*(1), 21–31. https://doi.org/10.1111/j.1467-9663.2007.00373.x

Marsden, P. V. (2002). Egocentric and sociocentric measures of network centrality. *Social Networks*, *24*(4), 407–422. https://doi.org/10.1016/S0378-8733(02)00016-3

Mostari, M. P., Sadrul, S. B., Rahman, M. H., & Islam, M. S. (2021). Women empowerment and livestock development in Bangladesh: A review. *Bangladesh Journal of Livestock Research*, *28*(1–2), 1–15. https://doi.org/10.3329/bjlr.v28i1.72014

Mujjabi, C., Bohn, M. O., Wander, M. M., & Ugarte, C. M. (2024). Participatory breeding in organic systems: Experiences from maize case studies in the United States. *Journal of Agriculture, Food Systems, and Community Development*, *13*(2), 23–36. https://doi.org/10.5304/jafscd.2024.132.008

Nath, T. D., Rahman, M. S., Biswas, A., & Juice, R. A. (2024). Livestock farming and women empowerment in rural Bangladesh: A mixed method approach. *CABI Agriculture and Bioscience*, *5*(1), Article 86. https://doi.org/10.1186/s43170-024-00294-3

Newman, M. E. J. (2006). Finding community structure in networks using the eigenvectors of matrices. *Physical Review E*, *74*(3), Article 036104. https://doi.org/10.1103/PhysRevE.74.036104

Palmer, K., Strong, R., Patterson, M., & Elbert, C. (2023). Improving positive food waste behaviors: An egocentric network analysis evaluation of leading women in agriculture's advice networks. *Advancements in Agricultural Development*, *4*(2), 48–59. https://doi.org/10.37433/aad.v4i2.307

Rahman, M. S., & Chandra Das, G. (2021). Effect of COVID-19 on the livestock sector in Bangladesh and recommendations. *Journal of Agriculture and Food Research*, *4*, Article 100128. https://doi.org/10.1016/j.jafr.2021.100128

Rahman, S., Begum, I. A., & Alam, M. J. (2014). Livestock in Bangladesh: Distribution, growth, performance and potential. *Livestock Research for Rural Development*, *26*(10), Article 173. http://www.lrrd.org/lrrd26/10/rahm26173.html

Rahut, D. B., Castellanos, I. V., & Sahoo, P. (2010). *Commercialization of agriculture in the Himalayas* (IDE Discussion Paper No. 265). Institute of Developing Economies. https://ir.ide.go.jp/record/37907/files/IDP000265_001.pdf

Reardon, T., Chen, K., Minten, B., & Adriano, L. (2012). *The quiet revolution in staple food value chains in Asia: Enter the dragon, the elephant, and the tiger*. ADB and IFPRI.

Roborgh, S., Banks, N., Islam, M. A., Morshed, K. A. M., & Oberreit, J. (2024). BRAC in Bangladesh and beyond: Bridging the humanitarian-development nexus through localisation. *Development in Practice*, *34*(2), 238–252. https://doi.org/10.1080/09614524.2023.2273756

Rocker, S., Kropczynski, J., & Hinrichs, C. (2022). Using social network analysis to understand and enhance local and regional food systems. In C. Peters & D. B. T. Thilmany (Eds.), *Food systems modelling* (pp. 231–256). Academic Press. https://doi.org/10.1016/B978-0-12-822112-9.00015-1

Schleiss, K. (2001). The Smallholder Livestock Development Project, Bangladesh. In R. G. Alders & P. B. Spradbrow (Eds.), *ACIAR Proceedings No. 103* (pp. 140–142). Australian Centre for International Agricultural Research (ACIAR). https://www.cabidigitallibrary.org/doi/full/10.5555/20013086403

Schuler, S. R., Islam, F., & Rottach, E. (2010). Women's empowerment revisited: A case study from Bangladesh. *Development in Practice*, *20*(7), 840–854. https://doi.org/10.1080/09614524.2010.508108

Scott, C. K., & Richardson, R. B. (2021). Farmer social connectedness and market access: A case study of personal networks among emerging farmers. *Journal of Agriculture, Food Systems, and Community Development*, *10*(2), 431–453. https://doi.org/10.5304/jafscd.2021.102.024

Shamsuddoha, M. (2009). Development of livestock sector through leading NGO in Bangladesh. *The Annals of the "Stefan Cel Mare" University of Suceava*, *9*(1), 36–44. https://scholar.archive.org/work/25gwiscptbbftkz3kfk673hd24/access/wayback/http://seap.usv.ro:80/annals/ojs/index.php/annals/article/viewFile/145/197

Shoma, C. D. (2019). Financing female entrepreneurs in cottage, micro, small, and medium enterprises: Evidence from the financial sector in Bangladesh 2010–2018. *Asia and the Pacific Policy Studies*, *6*(3), 397–416. https://doi.org/10.1002/app5.286

Sraboni, E., Malapit, H. J., Quisumbing, A. R., & Ahmed, A. U. (2014). Women's empowerment in agriculture: What role for food security in Bangladesh? *World Development*, *61*, 11–52. https://doi.org/10.1016/j.worlddev.2014.03.025

Stofer, K. A., Fulton, J., Nesbitt, H., Prizzia, A., Garrett, K. A., & Rosario, J. J. (2022). Initial social network analysis of producers working towards sustainability suggests weak ties and potential fragmentation. *Advancements in Agricultural Development*, *3*(1), 4–18. https://doi.org/10.37433/aad.v3i1.141

U.S. Agency for International Development [USAID]. (2021). *USAID/Bangladesh Feed the Future Bangladesh Livestock Production for Improved Nutrition Activity final performance evaluation*. Retrieved from https://web.archive.org/web/20221006171333/https://pdf.usaid.gov/pdf_docs/PA00XRQQ.pdf

Uzzi, B. (1997). Social structure and competition in interfirm networks: The paradox of embeddedness. *Administrative Science Quarterly*, *42*(1), 35–67. https://doi.org/10.2307/2393808

Vaughan, R. (2017). Oversampling in health surveys: Why, when, and how? *American Journal of Public Health*, *107*, 1214–1215. https://doi.org/10.2105/AJPH.2017.303895

Wahyono, N. D., Hasanah, N., Parmawati, R., & Wong, W.-K. (2023). Improving economic welfare through capital development: Case study of smallholder dairy farmers in Pujon District. *Sustainability*, *15*(11), Article 8453. https://doi.org/10.3390/su15118453

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Adapting to climate change on the farm: Experiences of small-scale ecological farmers in two regions of China

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Abstract

While ecological practices are widely recognized as effective strategies for addressing climate change, their adoption among smallholders is significantly influenced by the experiences of early adopters such as small-scale ecological farmers. Despite this important factor in adoption, few empirical studies have examined how small-scale ecological farmers experience climate change and evaluate the effectiveness of their ecological approaches. Drawing on data from in-depth interviews, farm visits and surveys with 28 ecological farmers in China, we develop an integrative analytical framework that uses farmers' own narratives to examine how they perceive, are impacted by, and respond to climate change at the farm level. We found that beyond direct impacts on crop yield and quality, ecological farm productivity was undermined as climate shocks disrupt agroecosystems, damage farm facilities, and pose health risks to farm workers. In response, farmers apply diverse ecological practices alongside socio-economic measures to build resilience. While the paper demonstrates the adaptive

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value of ecological practices, it also reveals that their broader and successful adoption among smallholders is contingent upon overcoming substantial economic, social and institutional barriers. The study highlights the potential of bottom-up, farmer-led initiatives and advocates for targeted policies and services tailored specifically to the needs of ecological farmers.

Keywords
climate change, adaptation, smallholders, ecological farmers, China

> *Neither flood nor drought can stop a good peasant from farming.*
>
> —Hsun Tze (c. 313-238 BCE)

Introduction

Climate change poses increasing challenges to agriculture, with small-scale producers among the most vulnerable (Cohn et al., 2017; Morton, 2007; Pörter et al., 2022; Touch et al., 2024). Smallholders have been directly impacted in multiple ways, including reduced crop yields, damaged infrastructure, heightened harm from pests and disease, water scarcity, diminished income and threats to food security (Harvey et al., 2018; Ricart et al., 2023; Tofu et al., 2022). China, where the average annual surface temperature has risen at nearly twice the global average since 1951 due to its geographic conditions and land use changes (Stanway, 2022), is particularly at risk. The large number of smallholders that dominate the agricultural sector in China makes the country more vulnerable to climate change due to their reliance on natural ecosystems and limited adaptive capacity caused by constrained economic resources, inadequate infrastructure, and limited access to information and climate awareness (Morton, 2007; Xu et al., 2020). Despite their vulnerability, to cope with climate change smallholders develop adaptive strategies, ranging from crop diversification to altered planting schedules (Khanal et al., 2020; Moore & Lobell, 2014).

As most Chinese farmers are smallholders, their response to climate change shapes their livelihoods and China's overall agricultural productivity. Organic farming and agroecology, which share similar ecological principles, are considered by many scholars promising strategies to help farmers build climate resilient agroecosystems (Altieri et al., 2015; Dittmer et al., 2023; Migliorini & Wezel, 2017; Scialabba & Müller-Lindenlauf, 2010). Because of China's agricultural conditions, adopting an ecological approach offers significant benefits. Unfortunately, China's policies on climate change adaptation tend to favor large-scale technical solutions targeted at crop productivity (Rogers, 2016), although the excessive use of chemical inputs in conventional farming has depleted resources, degraded the environment (S. Li et al., 2019; Norse & Ju, 2015), and exacerbated climate change through increased greenhouse gas emissions due to chemical inputs (J. Chen et al., 2022).

Despite the increasing research on climate change and on smallholders in China and beyond, empirical studies on small-scale ecological farmer experiences and coping strategies remain scarce. This gap is particularly noticeable with the rise of small-scale ecological farms in the past two decades, driven by the growing middle- and upper-class consumers seeking risk-free food and distrusting organic labels (Scott et al., 2014, 2018). China had 6,308 certified organic producers in 2019 (Willer et al., 2021, p. 213); by 2023, the total area of certified organic farmland exceeded four million acres, ranking China fourth globally (Xiao, 2024). Lacking third-party certification, many organic farms remain invisible in official statistics so that it is difficult to estimate the number of small ecological farms. Zhong et al. (2022) estimates that there are over 1,000 small-scale organic and community-supported farms in China, operating on a model in which consumers share both the risks and benefits of food production by subscribing directly to farm produce.

Although the number of small-scale ecological farmers is limited, investigating this distinctive group offers several valuable insights into how their farming practices are adapting to climate change and how such approaches might be scaled across the broader smallholder population. First, ecological farmers operate without synthetic chemicals, demonstrating the efficacy of ecological practices. Second, unlike subsistence farmers, they are entrepreneurial, proactively employing ecological measures to balance ecological and economic via-

bility under the pressures of climate change. Understanding their experiences can inform policies to enhance smallholder sustainability and support a broader transition toward resilient agriculture. Overall, this research aims to deepen the understanding of whether and how ecological farming can be a sustainable and economically viable pathway for smallholders in China and beyond when facing climatic challenges. China's vast smallholder base and its heighted exposure to climate change impacts make it a critical case. Insights from China are relevant to other countries with similar agrarian structures facing growing climate risks.

The following sections of this paper are structured as follows: we first review relevant literature about climate change and small farms. We then present our research methods, followed by an analysis of respondent profiles, climate impacts, and adaptive practices. We compare ecological farms to conventional farms, and offer recommendations for future research and policy to promote the broader adoption of ecological farming in China.

Farmers' Perceptions of Climate Change, Adaptation, and Barriers

To understand farmers' adoption of adaptation measures, studies on climate change perception and adaptation often apply the Protection Motivation Theory, which asserts that perceptions of severity, ability to withstand the impacts, and internal barriers significantly correlate with adaptation intentions (Ghanian et al., 2020; Keshavarz & Karami, 2016). Across diverse geographies, many studies on climate change adaptation in agriculture identify perception as a crucial factor, often considered the initial step in the adaptation process (Bohensky et al., 2013; Maddison, 2007). However, farmers' awareness of climate change varies significantly in developing countries (Harmer & Rahman, 2014). Smallholders commonly perceive climate change through increased temperatures, unpredictable monsoons, and its impacts on yields, pests, food security, and their livelihoods (Funk et al., 2020; Harvey et al., 2018; Kom et al., 2020). Recent studies have demonstrated that Chinese smallholders are acutely aware of climate change and its adverse impacts (Gao et al., 2022; Pickson & He, 2021), providing a valuable opportunity for studying climate adaptation. Little is known, however, about how ecological farmers perceive these changes.

Adaptation to climate change, like perception, has also been widely studied. Adaptation means adjustments made in processes, practices, or structures within ecological, social, and economic systems in response to climate change (McCarthy et al., 2001). Recognizing that the agricultural system is an artificial construct that incorporates elements of both natural and social systems (McConnell & Dillon, 1997), farmers' adaptation to climate change can be categorized into two types. The first involves adaptations targeting the natural elements within the agroecosystem, such as soil, water resources, crops, and livestock, and aiming to address the direct or anticipated impacts of climate change on agricultural production. The second focuses on the broader social-economic dimensions of agriculture, such as access to extension services, income diversification, and the adoption of insurance schemes, which aim to build resilience against wider systemic challenges.

Farmers are adapting to climate change by adjusting both natural agroecosystem elements and broader socio-economic factors. Strategies include crop diversification, climate-resilient varieties, altered planting dates, and improved soil and water management (Magesa et al., 2023). Livestock and fish farming adaptations, such as improved breeding and water harvesting, are also prominent (Onyeneke et al., 2019). However, current strategies may fall short in more extreme future climate scenarios, indicating the need for transformative measures like improved infrastructure, crop insurance, and livelihood diversification (Magesa et al., 2023).

For the smallholder population in general, studies in Pakistan, Ethiopia, Nepal and Kenya have shown adaptive strategies to cope with climate change, despite limited resources in those regions. These include adjusting fertilizer use, crop types and varieties, planting schedules, and irrigation practices (Abid et al., 2015; Belay et al., 2017; Karki et al., 2020; Khan et al., 2020; Ogola & Ouko, 2021). Ecological approaches, such as intercropping, crop rotation, soil amendment practices, water conservation, and agroforestry, are also com-

mon in Malawi, the Andes, Ethiopia, Bolivia, and Kenya (Ballesteros & Isaza, 2021; Bezner Kerr et al., 2019; Gebrehiwot & Van Der Veen, 2013; Jacobi et al., 2015; Muriithi et al., 2021; Ricart et al., 2023; Sedebo et al., 2021). Besides these major adaptations, smallholders in Nepal are also resorting to supplementary strategies such as the use of greenhouses, diversification of income, and migration (Karki et al., 2020).

Similarly, Chinese farmers employ a range of adaptation methods that span conventional farming to ecological practices, such as crop diversifying, increasing chemical inputs, adjusting planting and harvesting dates, changing crop varieties, and enhancing irrigation infrastructure (H. Chen et al., 2014; C. Li et al., 2013). More sustainable approaches, such as soil and water conservation and agroforestry, have been adopted in tropical agriculture in Hainan (Gao et al., 2022) and across the Loess Plateau of China (Alhassan et al., 2021), while conservation tillage and intercropping are prevalent in Fujian Province (Sattar et al., 2023). Local governments support smallholders with extension services, financial subsidies, and production inputs to combat climate challenges (H. Chen et al., 2014).

Beyond documenting various adaptation measures, researchers have identified institutional barriers and other challenges that hinder adaptation to climate change. Demographic, socio-economic, technological, cultural, and psychological factors influence farmers' adaptation choices (Dang et al., 2019). In response, researchers have determined that strengthening institutional capacity, including both formal and informal institutions, is more effective than solely focusing on agricultural technology (Aryal et al., 2020; Islam & Nursey-Bray, 2017), as institutional and policy challenges, including limited capacity for adaptation planning and implementation, further impede farmers' efforts to respond effectively to climate change (Alie et al., 2024). Farmers often struggle to access critical institutional support such as markets, climate information, agricultural inputs, and credit facilities (Mu et al., 2020). Failure to adequately understand the effectiveness of such measures and the absence of a supportive and integrative agricultural adaptation program are two additional barriers (Vignola et al., 2015). Cultural and psychological factors, such as traditional attitudes resistant to change, also hinder adaptation efforts (Alie et al., 2024).

Despite growing scholarly interests in climate change and agriculture, several critical gaps remain. First, while studies emphasize farmer awareness of climate change, they often fail to provide a holistic perspective on how farmers perceive the significance of climate-related stressors relative to other pressing challenges, such as labor shortage, labor cost, market dynamics, sales, and land tenure issues. This study addresses this gap by examining the relative significance of climate change among the myriad challenges faced by farmers. Second, most studies on climate impacts in China have generalized the direct effects on crop yield losses and food security, particularly for staple crops, including rice (Saud et al., 2022; Xiong et al., 2009), wheat and maize (Song et al., 2022; Zhang et al., 2022), and potatoes (Huang et al., 2022). In contrast, our study broadens the scope to include indirect impacts on agroecosystems, farm infrastructure, and farmers' health, emphasizing the multifaceted nature of climate stressors beyond immediate yield losses.

Furthermore, China's governmental climate strategies are centered on agricultural infrastructure, technology, and insurance (Wang et al., 2014), but these policies are often one-size-fits-all, disregarding the nuanced realities and diverse needs of smallholders. In addition, adaptation studies (H. Chen et al., 2014; Jin et al., 2020; C. Li et al., 2013) rarely distinguish between conventional farmers and ecological farmers. This is understandable, because the very small number of ecological farmers in China makes them less prominent in large-scale regional surveys. Systemic review of Chinese farmers' adaptation practices show that increased chemical inputs are among the most adopted practices (J. Chen et al., 2022), which leaves the adaptation experiences of ecological farmers largely underexplored. This disconnect not only limits the effectiveness of adaptation measures but also risks marginalizing small-scale ecological farmers by failing to incorporate their local knowledge, context-specific practices, and adaptive strategies into policy frameworks. By shifting the focus toward this particular farmer group—small-scale ecological

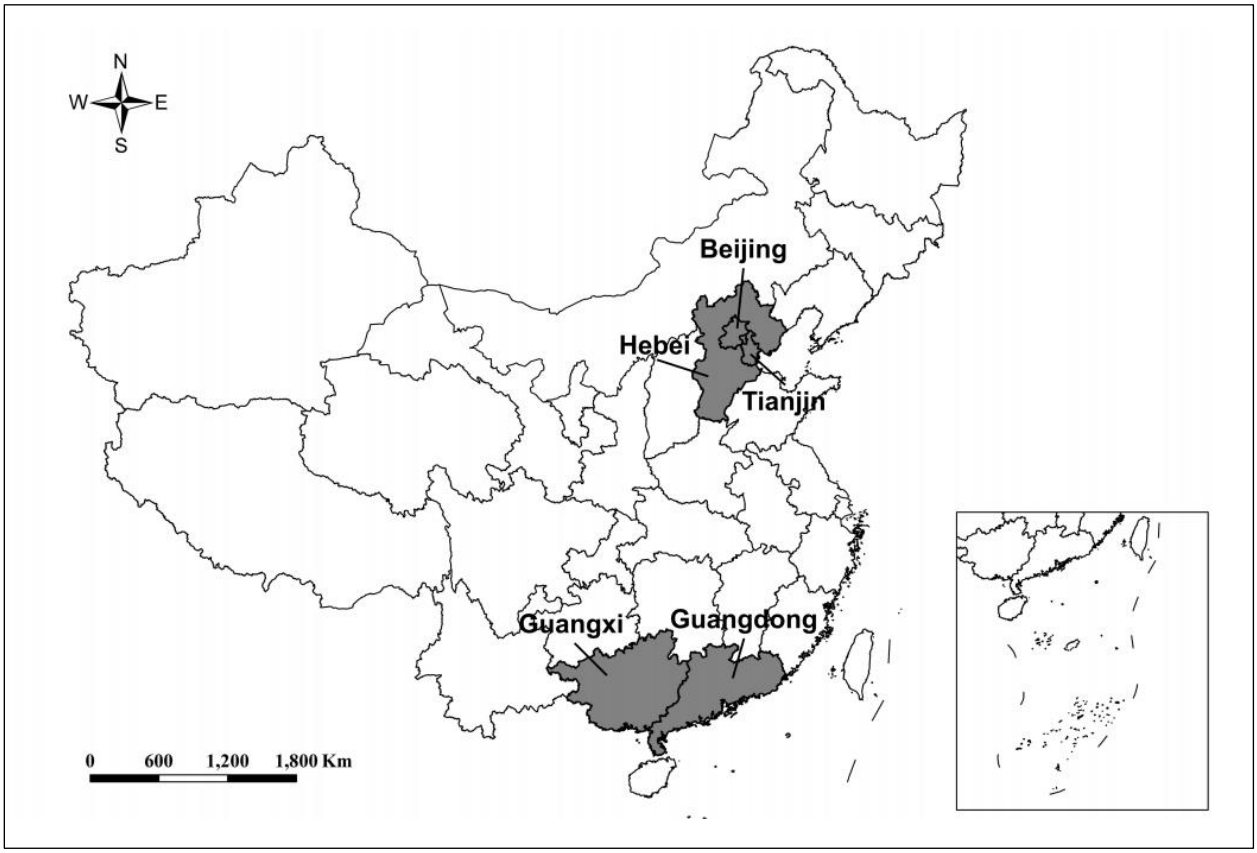
farmers—the study provides nuanced empirical evidence of how they navigate the complex interplay of ecological, economic, and social factors in climate change adaptation, offering valuable insights into the broader dynamics of agrarian changes.

Research Methods

To effectively illustrate the diverse impacts of climate change on ecological farmers and their adaptation practices, we selected Guangxi Zhuang Autonomous Region and Guangdong Province to represent southern China, and the Beijing-Tianjin-Hebei region for northern China (Figure 1). Both regions experienced significant climate variability in recent years: heavy precipitation in North China (2021), extended drought in South China (2021 and 2022), and unprecedented rainfall in the Pearl River Delta (May–June 2022). These events ranked among China's top ten extreme weather and climate events for 2021 and 2022 (China Meteorological Administration, 2021, 2023). The proximity of these regions to major economic hubs—the Beijing-Tianjin-Hebei Region and the Pearl River Delta—further supports their selection. Urban consumers' purchasing power, diverse diets, heightened food safety awareness, and environmental concerns drive the prosperity of the ecological agricultural sector (Scott et al., 2018; Shi et al., 2011).

In early May 2022, a recruitment letter was disseminated through local environmental organizations, inviting ecological farmers in the two regions to participate. The research targeted farmers practicing ecological or organic production methods for crop planting or livestock raising, without using synthetic chemicals such as fertilizers, pesticides, growth hormones, and herbicides. In terms of farm size, we considered the Food and Agriculture Organization of the United Nations' (FAO) definition of small-scale or smallholders as those managing from less than one to ten hectares (2013), as

Figure 1. Locations of the Two Study Sites in China (Shaded Areas)



well as the benchmarks established in China's Third Agriculture Census. Accordingly, we defined small-scale farms in this study as those with a cultivated acreage not exceeding 200 mu (~13.3 hectares), with exceptions for agroforestry or orchards. Despite their relatively small size, most of these farms are not subsistence-based but are market-oriented. In addition, we solicited recommendations from non-government organizations operating in the study areas to extend outreach, resulting in a sample of 28 farms. As the objective of the study is to gain in-depth insights rather than to achieve statistical generalizability, the sample is not intended to be fully representative of all small-scale ecological farmers in China.

Beginning in early May 2022, the lead researcher conducted in-depth interviews (online and in person), farm visits, structured surveys, and follow-up conversations via WeChat, the most popular communication and social media app in China, or phone calls to collect data. Ethics approval for this study was obtained from the Office of Research Ethics at the University of Waterloo in Canada (No. 41206). Consent was obtained through WeChat messages. Semi-structured interviews collected both biophysical and socioeconomic data. As much as domestic COVID-19 prevention and control policies permitted, we visited most respondent farms. After interviews and field trips, we distributed questionnaires to the 28 respondents, addressing key issues identified during the interviews and site visits, as well as new issues that emerged during the aggregation of interview data. Supplementary questionnaires explored emerging issues in greater depth, and follow-up communications helped enrich the findings. A total of 28 ecological farms were studied: Beijing (5), Tianjin (1), Hebei (5), Guangxi (8), and Guangdong (9), with 20 visited on-site by June 2023. While achieving absolute saturation is ideal, in qualitative research saturation may not always be fully attainable in studies involving hard-to-reach or specialized populations, such as this newly emerged group of Chinese small-scale ecological farmers. As we strived to achieve in this study, focusing rather on the depth and richness of the data can provide meaningful insights, even in the absence of complete saturation.

The primary scale of analysis in this study is the farm-level. Detailed notes were taken during all interviews. For online interviews conducted via Tencent Meeting, recordings were used to verify the notes. Interviews were then transcribed in Chinese. Relevant information and raw data were then extracted from the transcripts, categorized, and analyzed using an inductive approach to explore awareness and perception of climate change, its impacts on production and livelihoods, and current adaptation measures. As conventional smallholders were not included in the study, comparison between small-scale ecological and conventional farmers was conducted by using the narratives from participants and information drawn from existing literature. The following sections review the key findings.

Profiles and Heterogeneity of the Ecological Farmers and Farms

Compared to the general farmer population profiled in China's Third National Agricultural Census (National Bureau of Statistics, 2017), the ecological farmers in this study are younger and better educated (Table 1). About 53.6% (15 of 28) of respondents held an associate degree or higher, in stark contrast to the national average of 1.2%. This aligns with findings by Burton (2014) that more

Table 1. Demographics of Respondents in Comparison with Data from China's Third National Agricultural Census (Released in 2017)

	In this Study	Third National Census
Gender		
Male	71.4% (20/28)	52.5%
Female	28.6% (8/28)	47.5%
Age		
<35	21.4% (6/28)	19.2%
36–54	71.4% (20/28)	47.3%
55>	7.1% (2/28)	33.6%
Education		
No schooling	0	6.4%
Primary school	3.6% (1/28)	37.0%
Junior middle school	25.0% (7/28)	48.4%
Senior middle school	17.9% (5/28)	7.1%
Associate degree and above	46.4% (13/28)	1.2%

educated farmers tend to have a better understanding of ecological systems and are more likely to adopt sustainable practices. Notably, five respondents majored in agriculture or related fields. Ages ranged from 26 to 56, with an average of 42, significantly younger than the 58.6-year average for farmers recorded in a 2013 Jiangsu Province survey (Zou, 2013). Eight respondents were female, half of whom worked collaboratively with their husbands on the farm.

Although all farms are ecological, there is considerable variation in farm size, land tenure, terrain features, crops and livestock variety, and their business scope. Farm size ranges 0.4 mu (~0.027 hectare)–300 mu (20 hectare). Nine farms are on plains, and others are in terrains that include hills, mountains, basins and coastal land. Of the 28 farmers, 18 operate entirely open-air fields, with greenhouses or cold frames areas typically less than one-third of the total farm space. Sixteen farms can be simply classified as "family farms," relying primarily on family labor. Eight farms have diversified into activities such as hosting nature education programs, bed-and-breakfast services, and fruit-picking.

Awareness and Perception of Climate Change Impacts

Interviews and surveys show that small-scale ecological farmers generally perceived climate change as having significant impacts (Table 2). Over two-thirds of survey respondents rated the impact over the last five years as "major" or "significant," with none reporting "minor" or "no impact." These ratings, while subjective, reflect a high level of awareness which could contribute to farmers' proactive approach to adaptation (Jin et al., 2020).

In addition to climate risks, farmers faced various socio-economic challenges. To assess the relative significance of these issues, farmers were asked to rank their top three concerns from a list we compiled through interviews and site visits (Table 3). Climate change and extreme weather topped the list of concerns for 15 farmers, with an additional eight ranking it among their top three. Rising labor costs followed, noted by 16 farmers, while market sales were a priority for 15. Other concerns included worker availability, consumer attitudes towards eco-food, land tenure stability and rising land rents. Notably, six farmers held household contracting rights[1] to their land, which may explain

Table 2. Farmer Perceptions of the Impacts of Climate Change in the Last Five Years

Different Levels of Perceived Impact	Number of Farmers Selected	%
No Impact	0	0%
Minor Impact	0	0%
Moderate Impact	9	32%
Major Impact	14	50%
Significant Impact	5	18%
Total	28	100%

Table 3. Top Three Concerns of Climate Change Relative to Social-Economic Stressors

Concerns	1st Choice	2nd Choice	3rd Choice	Total Mentions
Climate Change/Extreme Weather	15	5	3	23
Rising Labor cost	3	5	8	16
Market Sales	5	5	5	15
Availability of Workers	3	4	4	11
Consumer Awareness of Eco-food	1	5	3	9
Land Tenure Stability	1	3	1	5
Rising Rents for Land	0	1	4	5

[1] In China, all agricultural land is owned by the state or rural collectives, while farmers have "contracting rights" which allow them to access land through contracts with the rural collective. If a farmer wishes to cultivate land for which they do not hold a contract, they must lease it from other farmers or the rural collectives.

the low ranking of "land tenure stability" and "rising rents." Furthermore, these concerns were often interconnected. For instance, we discovered that extreme summer heat made it difficult to find labor in aging rural communities, as aged people avoid outdoor work to prevent heatstroke. A farmer in Guangdong stated:

> I am the only '90s-born person farming in the nearby villages. From mid-June to mid-August, even if I offered 120 yuan a day, I couldn't find extra help in nearby villages. They said it was too hot. Even a few people said they were willing to work, but their grown-up children wouldn't allow them to work in such hot weather.

When asked about the potential impact of climate change over the next five years, 15 respondents anticipated greater damage, while 13 expressed uncertainties. During the interviews, some farmers perceived extreme or abnormal weather events as isolated incidents rather than indicators of a broader trend, which may partly explain their uncertainty in predicting future impacts. A female farmer in Guangdong Province explained:

> We didn't think of it as climate change. Locals just consider it a natural disaster. For example, this year, it rained continuously for a month, or even two months. I don't know whether these events are isolated or part of a larger change. We just feel helpless and out of options.

Climate Change Impacts

The most significant and widespread climate change impact perceived over the past five years was yield loss, followed by disrupted farming schedules, damage to farm facilities, and impacts on farmers' health (Table 4). These impacts are consistent with findings from other studies globally. In-depth interviews provide detailed insights into specific instances of production loss, as well as broader effects on farmers and the agroecosystem.

Of the 28 farmers, 26 reported losses in crop or livestock production with 12 reporting over 50% losses of a single crop; three even suffered total crop failures. Extreme temperatures during critical growth or maturity stages of crops were a major cause. For instance, one farmer encountered continuous rainfall during the ripening period of rice, which prevented harvesting and caused the mature rice to germinate on the ears. Some extreme weather events, while not reducing yield, impaired the commercial value of farm produce. One farmer described how apples bruised by hail became unsellable.

The respondents also revealed that changes in temperatures and precipitation, and the increasing frequency and intensity of extreme weather events significantly disrupted farm ecosystems. Several farmers cited that unprecedentedly prolonged rainfall has harmed pollinators and triggered pest and pathogen outbreaks. A month-long rain in Guangxi in May 2022 almost halved the bee population of a local farmer who was also a beekeeper. Another farmer in Beijing observed that drought-inflicted dry soil led to rampant pests such as aphids and red spiders. Several farmers mentioned sea water intrusions in the Pearl River Delta region due to prolonged droughts in 2022. The elevated salinity level hindered crop growth and required extra irrigation to reduce soil salinity. Farmers also reported proliferations of invasive species in recent years. In Conghua, Guangdong Province, increasing number

Table 4. Climate Change Impacts Experienced by Farmers Over the Last Five Years

Impacts on Farming Operations	Number of Farmers Reporting
Crop/Livestock Loss	26
Disrupted Farming Schedules	16
Single Crop Loss > 50%	12
Flooding of the Farm	7
Damage to Farm Facilities	6
Pollination Issues	5
Health Issues	5
Total Crop Failure of a Single Item	3
Disrupted Transportation	2
Soil Salinization	2
Damage to Farm Roads	2
Water Access Issues	1
Power Outages on the Farm	0

of needle bees (fruit flies) attacked local fruits such as citrus and guavas and vegetables such as pumpkins and loofah unless the young fruits and vegetables are protected with plastic or paper bags.

A less commonly discussed dimension of climate change is its impact on farmer health, particularly pertinent to ecological farmers as they rely more heavily on manual labor (e.g., for weeding, pest control, harvesting). While outdoor workers in the agricultural sector are among the most vulnerable to heightened risks of heat stress under global warming (Kjellstrom et al., 2019), there is little research connecting climate change and farm labor productivity (De Lima et al., 2021). We found that many farmers were forced to shift working hours to avoid excessive heat on hot summer days. Five respondents experienced heatstroke, with older workers—commonly employed by ecological farms—particularly vulnerable due to both the intense physical demands of the work and the heightened risk of heat-related illness. A farm operating manager reported a labor shortage in July 2022:

> Our farm has hired aunties who are between 60 and 70 years old. Due to fear of heatstroke, many of them finished work and left for home by 3 P.M. Several others took breaks during this hot month.

Another pressing concern found in our fieldwork is the increasing intersection between farm ecosystem change and farmer health, both exacerbated by climate change. In recent years, farmers in Guangzhou have noticed the disturbing presence of invasive red fire ants on their farms, damaging crops and posing health risks through painful stings, potentially causing severe allergic reactions. Scholars attribute the proliferation of this intrusive species to climate change and global trade, predicting that suitable habitats for these ants will expand into higher latitudes under future climatic conditions (D. Li et al., 2023). This threat has made labor recruitment more difficult, with some farmers resorting to machinery as a substitute.

Adaptation Measures

Our study categorizes farmers' approaches to mitigating the impacts of climate change into two main dimensions: farm-level ecosystem-based adaptations and socio-economic activities. The first dimension focuses on management practices that leverage biodiversity, ecosystem services, and ecological processes to bolster the resilience of crops and livestock to climate variability (Vignola et al., 2015). The second broadens the scope of adaptation to encompass a wide range of socio-economic interventions, including infrastructure enhancement, insurance for risk sharing, and strategies of income diversification and continued learning ways to strengthen adaptive capacity.

Farm-level Ecosystem-based Adaptation Measures

Nearly all farmers emphasized that adding organic matter to the soil is the primary and most important step in improving soil fertility and structure. Composting was the most commonly adopted measure, as more than two-thirds of the farmers made natural organic fertilizers through composting. While some farmers purchased commercial microorganisms to improve soil, one farmer in Guangxi adopted a more locally embedded economical approach. He collected soil containing beneficial microorganisms in nearby bamboo forests and made his own liquid bacterial culture. He then sprayed it on soil to balance the bacterial flora and prevent the growth of pathogens. The farmer explained:

> If I buy commercial products, I don't know what ingredients they use or how they are produced. But I know I collect microorganisms and cultivate them in a very ecological, pollution-free environment. So, I think the microorganisms I produce are safer, and using local microorganisms in local farms makes them more effective.

Another major strategy to improving soil quality is integrating livestock-crop production systems. Fifteen growers also raised various animals, including cattle, pigs, chickens, ducks, fish, and even earthworms, and used their manure as natural fertilizer to boost soil fertility. Diversified cropping increases the temporal and spatial diversity of agricultural systems through practices such as intercropping, crop rotation, and the use of cover

crops, important to boost the resilience of the agroecosystem against climate change (Kremen & Miles, 2012; Lin, 2011).

All respondents practiced polyculture, with six cultivating over 50 kinds of grain, vegetables and fruits all year round. In addition, a number of farmers grew legume plants as companion crops or green manure, while some left strips of natural vegetation in the fields. The benefits they described include lowering ground temperature, retaining soil moisture, reducing soil erosion, and providing habitats for pollinators and natural pest predators. A mandarin orange grower in Guangxi reported that a few years after applying a range of ecological practices without chemical pesticides, as the agroecosystem in her farm became more resilient the damage caused by the outbreak of fruit flies in 2022 was negligible. A farmer who grows clementines kept grass in the fields as a living mulch and constantly added organic matter to improve the soil quality. During the driest season, in 2022, he was envied by a neighboring conventional farmer who had to water the farm twice as often. In addition, a rice farmer in terraced fields noted that wild grass growing along the ridge sides helps stabilize the terraces, preventing collapses during heavy rainstorms.

Some farmers carefully chose their site by considering weather conditions and the surrounding environment. A farmer in Guangdong Province spent eight months evaluating potential sites. After spotting fireflies at a prospective site, an indicator of clean water and unpolluted soil, he reviewed 15 years of local meteorological data and spent two months living in the village to observe the area during typhoons before making the final decision to lease the land.

Farmers actively select types and varieties of crops and livestock breeds that are well-suited to their local landscape and climate conditions, thereby optimizing productivity and sustainability. On a farm in Guangzhou, fields prone to flooding were converted to rice paddies and fishponds, making full use of the natural water flow and retaining the run-off nutrients. Landraces, also known as "old seeds" or "family heirloom," are selected generation after generation by farmers due to their proven suitability for the local environment. A farmer in Guangxi found that local rice varieties have better drought resistance than mainstream commercial seeds in the market. A farmer growing shaddock in Guangxi said that the white Shatian shaddock his family has been growing since 1987 has always maintained a stable yield even without intensive management.

In summary, small-scale ecological farmers integrate local knowledge, sustainable practices, and innovative transformations to address climate change. By focusing on soil health, biodiversity, and tailored adaptations to environmental conditions, they showcase the holistic approach to resilience advocated by agroecology, presenting a stark contrast to the practices typically employed by conventional farmers. By leveraging locally available resources, integrating livestock-crop systems, and selecting traditional landraces, these farmers optimize productivity while maintaining sustainability. Their transformations of landscapes, such as converting flood-prone fields into productive systems, highlight the potential of ecological farming to address climate and economic challenges.

Adaptation Measures at Social-economic Levels

Adaptation to climate change has limits, especially when confronting extreme weather events (Aryal et al., 2020). Ecological farmers in South China indicated the need for new investments in crop cultivation facilities to counter the rare extreme cold of winter and extended droughts in recent years. Conversely, in Hebei province, where annual precipitation is only half of that in the Guangdong and Guangxi Region, farmers are adapting to abnormally heavy and concentrated precipitation in the summer. Although it was challenging to quantify the overall cost involved, several cases in our study revealed a wide range of expenses, from less than US$300 to more than US$41,000. Larger farms, with better access to bank loans and subsidies, demonstrated a greater financial capacity to invest in climate-resilient infrastructure such as greenhouses, cold storage, and machinery. Notably, two farms that constructed greenhouses or cold storage received government support covering up to 40% of the costs. Small-scale investments such as repairing roads damaged by heavy rains, building rainwater harvesting pools, and excavating wider trenches

for better drainage were typically self-funded. A farmer who owns chicken houses uphill had to repair roads after heavy rains several times in the summer of 2022:

> Because only I use the mountain roads to feed the chickens daily, I had to pay out of my pocket to rent an excavator and hire people to repair the road; otherwise when the rain stops and the muddy road dried, it would become very dangerous to drive a three-wheeler along the path.

Such constant investments in farm infrastructure to adapt to climate change offer valuable insights into the operational resilience of these ecological farms. Of the 28 farmers who had an average of seven years in the business (duration of operation ranging 3–19 years), only nine have recouped their initial investments and are currently operating at a profit. Eight are self-sustaining, with annual revenues covering all expenses but without generating profit. The remaining 11 still need to rely on personal financial contributions to make ends meet.

As Magesa et al. (2023) have discussed, future extreme climate scenarios necessitate more transformative measures like improved infrastructure, crop insurance, and livelihood diversification. We found that ecological farmers' diversification strategies in livelihood and business serve as an effective adaptation approach to reducing climate change risks, although climate change might not be the sole motivator for these changes. For example, a farmer in Guangxi is currently working temporarily to renovate downtown flats to cover operational costs of his farm and his family's living expenses. Besides off-farm jobs, agritourism and other on-farm services such as fruit-picking, homestay, and nature education courses were offered on eight farms to bolster their economic viability. A farm in Guangdong province organized firefly-themed nature education activities every July and August, that generated sufficient revenue to cover the operational costs of the farm for an entire year.

Although insurance is often proposed as an effective approach to cope with the impacts of climate change (Falco et al., 2014), only four of the 28 farmers had purchased agricultural insurance and only one of them received compensation after purchasing the weather index insurance. We found that ecological farmers are less willing to purchase government-subsidized insurance compared to conventional farmers, due primarily to uncertainty about coverage eligibility for vegetables, difficulties in assessing the size of certain crops due to diversified cropping and intercropping practices, and concerns that the time and effort required for the application and claims process may outweigh the expected compensation, which is calculated based on the costs and prices of conventional farm produce. Sometimes small farm size even made them ineligible for insurance. A farmer wanted to buy insurance for the pigs she raised from a local insurance company but found that such insurance is only available for farms with over 30 pigs: "Although I only raised a few, that number could be all that a small farmer has. Insurance should be accessible for farmers equally."

The two sets of adaptive measures highlighted above are not exhaustive; rather, they represent crucial insights derived from our findings. To gauge the relevance of these measures, in the supplementary questionnaire farmers were asked to select the top five adaptive measures they considered most effective (Table 5). Responses indicated a strong preference for ecosystem-based measures, such as diversified cropping and soil improvement. Their preference for soil improvement aligns with the findings of Lal et al. (2011), which emphasized the importance of increasing soil organic matter and improving aggregate structure to bolster small farm resilience against climate change. While ecosystem-based measures dominate the list, reflecting farmer confidence in ecological practices, several measures regarding infrastructure enhancement were also recognized as viable strategies by a significant number of farmers, suggesting the pragmatic approach of ecological farmers in adopting diverse measures to mitigate risks.

Discussion

This section examines ecological farmers' approaches to climate change and the lessons they offer for broader agricultural adaptation. Central topics include ecosystem-based practices, the use

of local knowledge, and the challenges of limited institutional support. We also discuss the complexities of balancing farm size with adaptation strategies, and identify insights that can inform more sustainable and inclusive policies, particularly for smallholders. The findings on climate change impacts and adaptation strategies are contextualized through comparative analysis with existing literature.

Table 5. Measures Considered Effective by Farmers to Mitigate Climate Risks and Impacts (Multiple Choice)

Measures	Category	Number of Farmers Selected
Diversified Cropping	Ecosystem-based	20
Soil Improvement	Ecosystem-based	19
Farmland Planning	Ecosystem-based	14
Strengthen the Drainage System	Socio-economic	11
Water Harvest/Irrigation Systems	Socio-economic	10
Integration of Planting and Breeding	Ecosystem-based	9
Cover Crops	Ecosystem-based	8
Intercropping/Rotation	Ecosystem-based	8
Greenhouse Enhancement	Socio-economic	7
Choose Landraces	Ecosystem-based	7
Choose Stress Resistant Varieties	Ecosystem-based	6
Biological Pest Control	Ecosystem-based	5
Nutrient Management	Ecosystem-based	4
Attending Training for Knowledge and Skills	Socio-economic	4

Adaptation Capability in Comparison with Conventional Farmers

A primary goal of the study is to understand how ecological farmers cope with climate change compared to conventional farmers, with the aim of identifying innovative strategies to inform broader agricultural adaptation. This section presents the key differences between the two groups. Jin et al. (2020) found that conventional farmers primarily adopt three critical adaptation strategies: switching to drought-resistant crop varieties, adjusting pesticide use, and modifying fertilizer application practices. J. Chen et al. (2022) showed that major adaptive strategies employed by conventional farmers in China are crop variety adjustment, changing farming schedules, increasing chemical inputs, and enhancing irrigation.

While selecting crop varieties, adjusting farming schedules, and enhancing irrigation are common practices for both conventional and ecological farmers, they differ in agricultural inputs. Conventional farmers resort to chemical inputs as a coping strategy, which may bring immediate effects but can lead to pesticide resistance and soil degradation in the long term (Afsar & Sadavarte, 2024). Furthermore, a study by Quan et al. (2019) of small conventional wheat farmers' adaptation strategies in Henan identified frequent misapplication and overuse of chemical inputs, resulting in significant yield losses. In contrast, practices employed by ecological farmers such as adding organic matter to the soil by composting, relying on labor inputs, and sticky traps and organic sprays for pest control might not prevent immediate yield losses but would boost the overall resilience of crops and enhance the farm ecosystem in the long run (Ekström & Ekbom, 2011). This distinction underscores the potential for ecological farming to inform broader agricultural adaptation strategies, promoting more sustainable and knowledge-intensive solutions to climate challenges.

Another key difference lies in how knowledge and technological support are obtained. Ecological farming is a knowledge-intensive practice that emphasizes processes over inputs (Tittonell, 2013). While conventional smallholders typically receive support from local extension (H. Chen et al., 2014; Sattar et al., 2023), only one ecological farmer in our study reported having such support. Two-thirds have relied on self-study, and slightly less than half have attended training classes. Farmers tend to place greater trust in their neighbors and local model farmers than in agricultural extension staff. This lack of supportive and credible institutional support highlights the need for more inclusive policies and programs that integrate ecological farming practices into institutional frameworks.

In addition, while taking extra off-farm jobs may be a common livelihood adaptation strategy for both conventional and ecological farmers, ecological farms offer unique value as serene pastoral retreats for urban dwellers and ideal venues for nature-based education. Several farms have successfully diversified into agritourism and educational programs, generating extra revenue beyond from farm produce. Such initiatives demonstrate that diversified and creative usage of ecological spaces would enhance the economic viability of small ecological farms.

Promising Practices Yet Persistent Challenges

This study provides evidence on the efficacy of ecological farming in mitigating the impacts of climate change through enhanced pest resistance, improved water conservation, and increased yield. Despite some successes, significant gaps remain. We found that the complex dynamics of the agroecosystem induced by climate change are beyond the knowledge and control of individual farmers. Many farmers who tended their farms with great care, and in some cases hold college degrees in agriculture, have observed but struggled to fully understand the dynamic interactions among pests, natural enemies, and plants under varying climate shocks. A clementine farmer, perplexed by climate patterns in the past three years, noted that the prevailing pests on the farm changed each year. Other issues such as invasive species also prove difficult for individual farmers to handle alone. These observations call for more farm-level monitoring and participatory research to investigate the micro-situations of agroecosystem dynamics under various climate scenarios.

Farm Size and Tailored Policies to Boost Adaptation Capacity

While it sounds like an obvious finding, our study affirms the positive correlation between farm size and the cost of climate adaptation measures. Smaller farms mainly use low-cost agronomic practices such as making compost and enzymes for soil enhancement, and better conserving of water. Relatively larger farms spanning several hectares seem to have more financial resources to enhance adaptive capacity, enabling investments in infrastructure such as greenhouses and cold storage facilities. Additionally, it is more economical for large farms to purchase crop insurance, since the time and effort to apply and claim compensation are less cost-effective for smaller farms. With global warming and more frequent extreme weather events, current policies could place the smallest farms with limited access to financial subsidies and insurance coverage in a particularly vulnerable position.

However, not all economic realities are working in bigger farms' favor. Government subsidies oriented to larger farms might incentivize bigger investments, but ecological farming's inherently labor-intensive nature and the associated high costs can pose substantial challenges to large farms. According to respondents, labor costs constitute a big chunk of their annual operational expenses. With an aging rural population, bigger ecological farms find it even more difficult and costly to hire labor. With up-scaled production capacity, bigger farms will face more pressure to market and sell the produce compared to smaller ones. In contrast, smaller farms that primarily rely on family labor and direct sales to consumers might enjoy greater flexibility in adjusting their operations. These dynamics align with Stringer et al.'s observation that different types of farms following different pathways require tailored support for their adaptation and development (2019).

As China's agricultural sector is dominated by over 200 million smallholders, the ecological adaptation strategies developed by small-scale ecological farmers, along with their practical experiences, hold immense value for advancing the sustainability transition of Chinese agriculture. Small-scale ecological farmers operate with limited resources and face significant climate stressors, making their strategies highly relevant for other smallholders who need cost-effective and sustainable solutions. The smallholder nature of China's agricultural sector aligns closely with the principles of agroecology, which advocates small-scale, resource-efficient, and ecologically sound practices. Agroecology thus offers a viable pathway toward long-term sustainable development, as it leverages the strengths of smallholder farming systems demonstrated in our study, such as localized knowledge, diversified production, and close integration with natural ecosystems.

Conclusion

With a sample consisting of 28 small ecological farms in Beijing-Tianjin-Hebei area and Guangxi and Guangdong area, we investigated their perceptions of climate change and the impacts they have experienced. This study contributes to the existing literature by providing a holistic perspective on how climate stressors are perceived by farmers relative to other pressing challenges. Despite diversity among the farms in size and landscape, two-thirds of the farmers believed that the impacts brought by climate change were substantial. The reported impacts such as yield loss, disrupted schedules, pest outbreaks, and health risks, reflect patterns seen across sub-Saharan Africa and South Asia, where erratic weather and pests threaten smallholder productivity (Aryal et al., 2020; Morton, 2007). These findings likely explain why the majority ranked climate change/extreme weather as their top concern compared to other market-, labor- and land tenure–related factors. Nevertheless, some farmers still perceived the abnormal weather events in recent years as isolated incidents rather than indicators of a long-term trend. Such a perception might explain the uncertainty among 12 of the respondents about whether more severe impacts would take place in the coming years. This underestimation of future climate challenges demonstrates the need to further raise farmer awareness of climate change in the long run.

This study broadens the scope of existing research on climate change impacts on Chinese farmers, which often focuses on the direct impacts, by incorporating an analysis of indirect effects across multiple dimensions, including agroecosystems, farm infrastructure, and health. Beyond direct impacts on yield and quality, disturbed ecosystems manifested pollination failure, pest and pathogen outbreaks, and invasive species and sea water intrusion which also exacerbate farmer hardship. Moreover, extreme weather such as heat waves affects farmers' health and brings more health risks to aged workers in particular, a topic underexplored in China despite global recognition of heat stress risks in agriculture (Kjellstrom et al., 2019). These findings highlight the pressing need to mitigate the multifaceted impacts of climate change in China, especially with the vulnerabilities of its rapidly aging agricultural workforce.

This study contributes to the field of climate change research by offering a nuanced analysis of the lived experiences and adaptive strategies of a specific subgroup of farmers—small-scale ecological farmers. It shows the potential of ecological adaptation approaches to cope with climate change without applying agrochemicals, thus also contributing to a more sustainable agricultural system. Adaptation strategies like soil improvement, diversified cropping, livestock integration, and the use of landraces mirror agroecological approaches promoted internationally (Altieri et al., 2015; Kremen & Miles, 2012). Moreover, use of locally sourced microorganisms and site selection based on ecological indicators (e.g., the presence of fireflies) reflects a deeper application of local knowledge than is typically documented in adaptation literature, supporting insights from Bhatta et al. (2017) on the value of local knowledge in climate adaptation. As we found that farmers trust their neighbors and model farmers much more than extension service staff (Fan et al., 2022), there is an opportunity to leverage model farms as knowledge hubs, through a farmer-to-farmer extension model, for spreading ecological farming knowledge and sustainable adaptive practices to a broader but local audience. This could also help address the gap in existing agricultural extension systems, which often lack sufficient information about sustainable agricultural practices.

The necessity to adapt to extreme weather in recent years has also compelled many farmers to construct new infrastructure or improve existing facilities such as greenhouses, rainwater collection, irrigation, and drainage systems. In addition to pursuing part-time jobs as a livelihood diversification strategy, ecological farmers can enhance their economic viability by utilizing the ecological space of their farms in creative ways. These socio-economic responses, ranging from infrastructure upgrades to agritourism and off-farm employment, align with broader resilience strategies (Bryan et al., 2009; Mertz et al., 2009), though many farmers face high costs and delayed returns. Moreover, challenges with insurance uptake are typical of global findings, as smallholders are deterred by eligibility gaps and complex claims processes (Surminski et al., 2016).

With small ecological farms also facing more institutional barriers to obtain government subsidies, there is need for government policies tailored to different farm sizes and effectively boosting their adaptive capacity. This is consistent with Hou and Wang's (2025) call for establishing a multi-level agricultural insurance system that provides basic and additional insurance and extends coverage to more cash crops.

The study presents a nuanced and multifaceted picture of the research objective: to deepen our understanding of whether and how ecological farming can be a sustainable and economically viable pathway for smallholders in China and beyond. On the environmental front, the evidence strongly supports the sustainability of small-scale ecological farms. They tend to use fewer synthetic inputs, foster biodiversity, improve soil health, and reduce pollution, demonstrating clear ecological benefits that align with global sustainability goals. On the economic front, despite innovative uses of farm space such as agritourism and nature-based education proven effective in generating additional income, the economic viability of these farms is often precarious. This multifaceted picture underscores that ecological farming holds promise as an environmentally sustainable model, but its broader and successful adoption among smallholders is contingent upon overcoming substantial economic, social and institutional barriers. For other countries or regions where smallholders dominate agricultural production, this suggests that transitioning to ecological farming must be coupled with targeted interventions, such as capacity building, institutional support, market development, and inclusive policies, to create enabling conditions for success. The experiments of small-scale ecological farms in China also suggests that policies should recognize and support bottom-up, farmer-driven innovations in ecological practices, while avoiding prescriptive top-down directives.

Despite these many observations, the response and interaction mechanisms among plants, animals, and microorganisms on the farm when exposed to climate stressors remain unclear. We hope this study will open the door to more quantitative and participatory research to identify, develop and evaluate cost-effective and accessible ecological practices dealing with climate change. This will not only assist ecological farmers but could also pave the way for scaling up ecological practices among the much broader population of smallholders across China, enhancing their adaptive capacity and promoting sustainable agriculture. Due to the small sample in this study, larger-scale studies that cover more diverse samples of small-scale ecological farmers are necessary. While our findings are not fully generalizable to all smallholders across China, they nonetheless offer important insights that can inform broader discussions on sustainable adaptation. Further research is necessary to explore the unique factors, such as environmental values, educational backgrounds, and local socioeconomic conditions, that shape the adaptation decision-making processes of ecological farms. By drawing on the experiences of small-scale ecological farmers, China's agricultural sector could demonstrate how smallholder agriculture can lead a sustainable response to climate change and other global challenges.

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References

Abid, M., Scheffran, J., Schneider, U. A., & Ashfaq, M. (2015). Farmers' perceptions of and adaptation strategies to climate change and their determinants: The case of Punjab province, Pakistan. *Earth System Dynamics, 6*(1), 225–243. https://doi.org/10.5194/esd-6-225-2015

Afsar, A. N., & Sadavarte, P. S. (2024). Chemical farming, emerging issues of chemical farming. *International Journal of Innovative Science and Research Technology*. *9*(3), 2502–2508. https://doi.org/10.38124/ijisrt/IJISRT24MAR2197

Alhassan, A.-R. M., Yang, C., Ma, W., & Li, G. (2021). Influence of conservation tillage on greenhouse gas fluxes and crop productivity in spring-wheat agroecosystems on the Loess Plateau of China. *PeerJ: Life & Environment, 9*, Article e11064. https://doi.org/10.7717/peerj.11064

Alie, M. E. K., Yateh, M., Bavumiragira, J. P., & Liao, Z. (2024). Identifying challenging barriers to farmer's adaptation to climate change in Bo district, Sierra Leone: A review. *Journal of Water and Climate Change*, *15*(7), 2992–3014. https://doi.org/10.2166/wcc.2024.634

Altieri, M. A., Nicholls, C. I., Henao, A., & Marcos, M. A. (2015). Agroecology and the design of climate change-resilient farming systems. *Agronomy for Sustainable Development, 35*, 869–890. https://doi.org/10.1007/s13593-015-0285-2

Aryal, J. P., Sapkota, T. B., Khurana, R., Khatri-Chhetri, A., Rahut, D. B., & Jat, M. L. (2020). Climate change and agriculture in South Asia: Adaptation options in smallholder production systems. *Environment, Development and Sustainability, 22*(6), 5045–5075. https://doi.org/10.1007/s10668-019-00414-4

Ballesteros, J., & Isaza, C. (2021). Adaptation measures to climate change as perceived by smallholder farmers in the Andes. *Journal of Ethnobiology, 41*(3), 428–446. https://doi.org/10.2993/0278-0771-41.3.428

Belay, A., Recha, J. W., Woldeamanuel, T., & Morton, J. F. (2017). Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia. *Agriculture & Food Security, 6*(1), Article 24. https://doi.org/10.1186/s40066-017-0100-1

Bezner Kerr, R., Kangmennaang, J., Dakishoni, L., Nyantakyi-Frimpong, H., Lupafya, E., Shumba, L., Msachi, R., Boateng, G. O., Snapp, S. S., Chitaya, A., Maona, E., Gondwe, T., Nkhonjera, P., & Luginaah, I. (2019). Participatory agroecological research on climate change adaptation improves smallholder farmer household food security and dietary diversity in Malawi. *Agriculture, Ecosystems & Environment, 279*, 109–121. https://doi.org/10.1016/j.agee.2019.04.004

Bhatta, G. D., Ojha, H. R., Aggarwal, P. K. Sulaiman, V. R., Sultana, P., Thapa, D., Mittal, N., Dahal, K., Thomson, P., & Ghimire, L. (2017). Agricultural innovation and adaptation to climate change: Empirical evidence from diverse agro-ecologies in South Asia. *Environment, Development and Sustainability, 19*, 497–525. https://doi.org/10.1007/s10668-015-9743-x

Bohensky, E. L., Smajgl, A. & Brewer, T. (2013). Patterns in household-level engagement with climate change in Indonesia. *Nature Climate Change, 3,* 348–351. https://doi.org/10.1038/nclimate1762

Bryan, E., Deressa, T. T., Gbetibouo, G. A., & Ringler, C. (2009). Adaptation to climate change in Ethiopia and South Africa: Options and constraints. *Environmental Science & Policy*, *12*(4), 413–426. https://doi.org/10.1016/j.envsci.2008.11.002

Burton, R. J. F. (2014). The influence of farmer demographic characteristics on environmental behaviour: A review. *Journal of Environmental Management, 135*, 19–26. https://doi.org/10.1016/j.jenvman.2013.12.005

Chen, H., Wang, J., & Huang, J. (2014). Policy support, social capital, and farmers' adaptation to drought in China. *Global Environmental Change, 24*, 193–202. https://doi.org/10.1016/j.gloenvcha.2013.11.010

Chen, J., Zhong, F., & Sun, D. (2022). Lessons from farmers' adaptive practices to climate change in China: A systematic literature review. *Environmental Science and Pollution Research, 29*(54), 81183–81197. https://doi.org/10.1007/s11356-022-23449-z

China Meteorological News Agency. (2021, December 29). *Top 10 domestic and international climatic events in 2021* (In Chinese). https://www.cma.gov.cn/2011xwzx/2011xqxxw/2011xqxyw/202112/t20211229_589812.html

China Meteorological News Agency. (2023, January 9). *Top 10 domestic and international climatic events in 2022* (In Chinese). https://www.cma.gov.cn/2011xwzx/2011xqxxw/2011xqxyw/202301/t20230109_5247477.html

Cohn, A. S., Newton, P., Gil, J. D. B., Kuhl, L., Samberg, L., Ricciardi, V., Manly, J. R., & Northrop, S. (2017). Smallholder agriculture and climate change. *Annual Review of Environment and Resources, 42*, 347–375. https://doi.org/10.1146/annurev-environ-102016-060946

Dang, H. L., Li, E., Nuberg, I., & Bruwer, J. (2019). Factors influencing the adaptation of farmers in response to climate change: A review. *Climate and Development*, *11*(9), 765–774. https://doi.org/10.1080/17565529.2018.1562866

De Lima, C. Z., Buzan, J. R., Moore, F. C., Baldos, U. L. C., Huber, M., & Hertel, T. W. (2021). Heat stress on agricultural workers exacerbates crop impacts of climate change. *Environmental Research Letters, 16*(4), Article 044020. https://doi.org/10.1088/1748-9326/abeb9f

Dittmer, K. M., Rose, S., Snapp, S. S., Kebede, Y., Brickman, S., Shelton, S., Egler, C., Stier, M., & Wollenberg, E. (2023). Agroecology can promote climate change adaptation outcomes without compromising yield in smallholder systems. *Environmental Management 72*(2), 333–342. https://doi.org/10.1007/s00267-023-01816-x

Ekström, G., & Ekbom, B. (2011). Pest control in agro-ecosystems: An ecological approach. *Critical Reviews in Plant Sciences*, *30*(1–2), 74–94. https://doi.org/10.1080/07352689.2011.554354

Fan, L., Ge, Y., & Niu, H. (2022). Effects of agricultural extension system on promoting conservation agriculture in Shaanxi Plain, China. *Journal of Cleaner Production, 380, Part 1*, Article 134896. https://doi.org/10.1016/j.jclepro.2022.134896.

Falco, S. D., Adinolfi, F., Bozzola, M., & Capitanio, F. (2014). Crop insurance as a strategy for adapting to climate change. *Journal of Agricultural Economics, 65*(2), 485–504. https://doi.org/10.1111/1477-9552.12053

Food and Agriculture Organization of the United Nations (FAO). (2013). *Factsheet: Smallholders and family farmers.* https://openknowledge.fao.org/handle/20.500.14283/ar588e

Funk, C., Sathyan, A. R., Winker, P., & Breuer, L. (2020). Changing climate—changing livelihood: Smallholder's perceptions and adaption strategies. *Journal of Environmental Management*, *259*, Article 109702. https://doi.org/10.1016/j.jenvman.2019.109702

Gao, J., Shahid, R., Ji, X., & Li, S. (2022). Climate change resilience and sustainable tropical agriculture: Farmers' perceptions, reactive adaptations and determinants of reactive adaptations in Hainan, China. *Atmosphere, 13*(6), Article 955. https://doi.org/10.3390/atmos13060955

Gebrehiwot, T., & Van Der Veen, A. (2013). Farm level adaptation to climate change: The case of farmer's [*sic*]in the Ethiopian Highlands. *Environmental Management, 52*(1), 29–44. https://doi.org/10.1007/s00267-013-0039-3

Ghanian, M., Ghoochani, O. M., Dehghanpour, M., Taqipour, M., Taheri, F., & Cotton, M. (2020). Understanding farmers' climate adaptation intention in Iran: A protection-motivation extended model. *Land Use Policy*, *94*, Article 104553. https://doi.org/10.1016/j.landusepol.2020.104553

Harmer, N., & Rahman, S. (2014). Climate change response at the farm level: A review of farmers' awareness and adaptation strategies in developing countries. *Geography Compass, 8*(11), 808–822. https://doi.org/10.1111/gec3.12180

Harvey, C. A., Saborio-Rodríguez, M., Martinez-Rodríguez, M. R., Viguera, B., Chain-Guadarrama, A., Vignola, R., & Alpizar, F. (2018). Climate change impacts and adaptation among smallholder farmers in Central America. *Agriculture & Food Security, 7*, Article 57. https://doi.org/10.1186/s40066-018-0209-x

Hou, D., & Wang, X. (2025). How agricultural insurance influences the scale of grain planting: The mediating role of farmers' income. *Frontiers in Sustainable Food Systems, 9*, Article 1524874. https://doi.org/10.3389/fsufs.2025.1524874

Huang, N., Wang, J., Song, Y., Pan, Y., Han, G., Zhang, Z., Ma, S., Sun, G., Liu, C., & Pan, Z. (2022). The adaptation mechanism based on an integrated vulnerability assessment of potato production to climate change in Inner Mongolia, China. *Mitigation and Adaptation Strategies for Global Change, 27*(3), Article 24. https://doi.org/10.1007/s11027-022-10000-1

Islam, M. T., & Nursey-Bray, M. (2017). Adaptation to climate change in agriculture in Bangladesh: The role of formal institutions. *Journal of Environmental Management*, *200*, 347–358. https://doi.org/10.1016/j.jenvman.2017.05.092

Jacobi, J., Schneider, M., Bottazzi, P., Pillco, M., Calizaya, P., & Rist, S. (2015). Agroecosystem resilience and farmers' perceptions of climate change impacts on cocoa farms in Alto Beni, Bolivia. *Renewable Agriculture and Food Systems, 30*(2), 170–183. https://doi.org/10.1017/S174217051300029X

Jin, J., Kuang, F., Wan, X., He, R., & Ning, J. (2020). Exploring the effects of sociocognitive factors on the adaptation behavior of farmers in rural Southwest China. *Climate and Development, 13*(2), 164–172. https://doi.org/10.1080/17565529.2020.1740078

Karki, S., Burton, P., & Mackey, B. (2020). Climate change adaptation by subsistence and smallholder farmers: Insights from three agro-ecological regions of Nepal. *Cogent Social Sciences, 6*(1), Article 1720555. https://doi.org/10.1080/23311886.2020.1720555

Keshavarz, M., & Karami, E. (2016). Farmers' pro-environmental behavior under drought: Application of protection motivation theory. *Journal of Arid Environments*, *127*, 128–136. https://doi.org/10.1016/j.jaridenv.2015.11.010

Khan, I., Lei, H., Shah, I. A., Ali, I., Khan, I., Muhammad, I., Huo, X., & Javed, T. (2020). Farm households' risk perception, attitude and adaptation strategies in dealing with climate change: Promise and perils from rural Pakistan. *Land Use Policy, 91*, Article 104395. https://doi.org/10.1016/j.landusepol.2019.104395

Khanal, U., Wilson, C., Rahman, S., Lee, B. L., & Hoang, V. (2020). Smallholder farmers' adaptation to climate change and its potential contribution to UN's sustainable development goals of zero hunger and no poverty. *Journal of Cleaner Production, 281*, Article 124999. https://doi.org/10.1016/j.jclepro.2020.124999

Kjellstrom, T., Maître, N., Segat, C., Matthias, O., & Karinova, T. (2019). *Working on a warmer planet: The impact of heat stress on labor productivity and decent work*. Work Income and Equity Unit, International Labour Organization Research Department. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_711919.pdf/

Kom, Z., Nethengwe, N. S., Mpandeli, S., & Chikoore, H. (2020). Climate change grounded on empirical evidence as compared with the perceptions of smallholder farmers in Vhembe District, South Africa. *Journal of Asian and African Studies*, 55(5), 683–698. https://doi.org/10.1177/0021909619891757

Kremen, C., & Miles, A. (2012). Ecosystem services in biologically diversified versus conventional farming systems: Benefits, externalities, and trade-offs. *Ecology and Society, 17*(4), Article 40. https://doi.org/10.5751/ES-05035-170440

Lal, R., Delgado, J. A., Groffman, P. M., Millar, N., Dell, C., & Rotz, A. (2011). Management to mitigate and adapt to climate change. *Journal of Soil and Water Conservation, 66*(4), 276–285. https://doi.org/10.2489/jswc.66.4.276

Li, C., Tang, Y., Luo, H., Di, B., & Zhang, L. (2013). Local farmers' perceptions of climate change and local adaptive strategies: A case study from the Middle Yarlung Zangbo River Valley, Tibet, China. *Environmental Management, 52*, 894–906. https://doi.org/10.1007/s00267-013-0139-0

Li, D., Li, Z., Wang, X., Wang, L., Khoso, A. G., & Liu, D. (2023). Climate change and international trade can exacerbate the invasion risk of the red imported fire ant Solenopsis invicta around the globe. *Entomologia Generalis*, *43*(2), 315–323. https://doi.org/10.1127/entomologia/2023/1686

Li, S., Lei, Y., Zhang, Y., Liu, J., Shi, X., Jia, H., Wang, C., Chen, F., & Chu, Q. (2019). Rational trade-offs between yield increase and fertilizer inputs are essential for sustainable intensification: A case study in wheat-maize cropping systems in China. *The Science of the Total Environment, 679*, 328–336. https://doi.org/10.1016/j.scitotenv.2019.05.085

Lin, B. B. (2011). Resilience in agriculture through crop diversification: Adaptive management for environmental change. *BioScience, 61*(3), 183–193. https://doi.org/10.1525/bio.2011.61.3.4

Maddison, D. (2007). *The perception of and adaptation to climate change in Africa* (Policy Research Working Paper No. 4308). World Bank. https://doi.org/10.1596/1813-9450-4308

Magesa, B. A., Mohan, G., Matsuda, H., Melts, I., Kefi, M., & Fukushi, K. (2023). Understanding the farmers' choices and adoption of adaptation strategies, and plans to climate change impact in Africa: A systematic review. *Climate Services*, *30*, Article 100362. https://doi.org/10.1016/j.cliser.2023.100362

McCarthy, J. J., Canziani, O. F., Leary, N. A., Dokken, D. J., & White, K. S. (Eds.) (2001). *Climate change 2001: Impacts, adaptation, and vulnerability*. *Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/2018/03/WGII_TAR_full_report-2.pdf

McConnell, D. J., & Dillon, J. L. (1997). *Farm management for Asia: A systems approach* (FAO Farm Systems Management Series No. 13*)*. Food & Agriculture Organization of the United Nations. Retrieved from https://www.fao.org/3/w7365e/w7365e00.htm#Contents/

Mertz, O., Mbow, C., Reenberg, A., & Diouf, A. (2009). Farmers' perceptions of climate change and agricultural adaptation strategies in rural Sahel. *Environmental Management*, 43(5), 804–816. https://doi.org/10.1007/s00267-008-9197-0

Migliorini, P., & Wezel, A. (2017). Converging and diverging principles and practices of organic agriculture regulations and agroecology. A review. *Agronomy for Sustainable Development, 37*, Article 63. https://doi.org/10.1007/s13593-017-0472-4

Moore, F., & Lobell, D. (2014). Adaptation potential of European agriculture in response to climate change [Letter]. *Nature Climate Change, 4*(7), 610–614. https://doi.org/10.1038/nclimate2228

Morton, J. F. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences, 104*(50), 19680–19685. https://doi.org/10.1073/pnas.0701855104

Mu, L., Fang, L., Liu, Y., & Wang, C. (2020). Identifying barriers and enablers for climate change adaptation of farmers in semi-arid North-Western China. *Sustainability*, *12*(18), Article 7494. https://doi.org/10.3390/su12187494

Muriithi, L. N., Onyari, C. N., Mogaka, H. R., Gichimu, B. M., Gatumo, G. N., & Kwena, K. (2021). Adoption determinants of adapted climate smart agriculture technologies among smallholder farmers in Machakos, Makueni, and Kitui Counties of Kenya. *Journal of Agricultural Extension, 25*(2), 75–85. https://doi.org/10.4314/jae.v25i2.7

National Bureau of Statistics. (2017). *China's Third National Agricultural Census (Communique 5)* (in Chinese). https://www.stats.gov.cn/sj/tjgb/nypcgb/qgnypcgb/202302/t20230206_1902105.html/

Norse, D., & Ju, X. (2015). Environmental costs of China's food security. *Agriculture, Ecosystems & Environment, 209*, 5–14. https://doi.org/10.1016/j.agee.2015.02.014

Ogola, R. J., & Ouko, K. O. (2021). Synergies and trade-offs of selected climate smart agriculture practices in Irish potato farming, Kenya. *Cogent Food & Agriculture, 7*(1), Article 1948257. https://doi.org/10.1080/23311932.2021.1948257

Onyeneke, R. U., Nwajiuba, C. A., Emenekwe, C. C., Nwajiuba, A., Onyeneke, C. J., Ohalete, P., & Uwazie, U. I. (2019). Climate change adaptation in Nigerian agricultural sector: A systematic review and resilience check of adaptation measures. *AIMS Agriculture and Food*, *4*(4), 967–1006. https://doi.org/10.3934/agrfood.2019.4.967

Pickson, R. B., & He, G. (2021). Smallholder farmers' perceptions, adaptation constraints, and determinants of adaptive capacity to climate change in Chengdu. *Sage Open, 11*(3), 1-16. https://doi.org/10.1177/21582440211032638

Pörter, H.-A., Roberts, D. C., Tignor, M. M. B., Poloczanska, E., Mintenbeck, K., Alegria, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., Okem, A., & Rama, B. (Eds.) (2022). Summary for policymakers. In *Climate change 2022: Impacts, adaptation and vulnerability*. *Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 3–33). Cambridge University Press.

Quan, S., Li, Y., Song, J., Zhang, T., & Wang, M. (2019). Adaptation to climate change and its impacts on wheat yield: Perspective of farmers in Henan of China. *Sustainability, 11*(7), Article 1928. https://doi.org/10.3390/su11071928

Ricart, S., Gandolfi, C., & Castelletti, A. (2023). Climate change awareness, perceived impacts, and adaptation from farmers' experience and behavior: A triple-loop review. *Regional Environmental Change, 23,* Article 82. https://doi.org/10.1007/s10113-023-02078-3

Rogers, S. (2016). Adaptation science and policy in China's agricultural sector. *Wiley Interdisciplinary Reviews: Climate Change, 7*(5), 693–706. https://doi.org/10.1002/wcc.414

Sattar, R. S., Mehmood, M. S., Raza, M. H., Wijeratne, V. P. I. S., & Shahbaz, B. (2023). Evaluating adoption of climate smart agricultural practices among farmers in the Fujian Province, China. *Environmental Science and Pollution Research, 30*(15), 45331–45341. https://doi.org/10.1007/s11356-023-25480-0

Saud, S., Wang, D., Fahad, S., Alharby, H. F., Bamagoos, A. A., Mjrashi, A., Alabdallah, N. M., AlZahrani, S. S., AbdElgawad, H., Adnan, M., Sayyed, R. Z., Ali, S., & Hassan, S. (2022). Comprehensive impacts of climate change on rice production and adaptive strategies in China. *Frontiers in Microbiology, 13*, Article 926059. https://doi.org/10.3389/fmicb.2022.926059

Scialabba, N. E.-H., & Müller-Lindenlauf, M. (2010). Organic agriculture and climate change. *Renewable Agriculture and Food Systems, 25*(2), 158–169. https://doi.org/10.1017/S1742170510000116

Scott, S., Si, Z., Schumilas, T., & Chen, A. (2014). Contradictions in state-and civil society-driven developments in China's ecological agriculture sector. *Food Policy, 45*, 158–166. https://doi.org/10.1016/j.foodpol.2013.08.002

Scott, S., Si, Z., Schumilas, T., & Chen, A. (2018). *Organic food and farming in China: Top-down and bottom-up ecological initiatives*. Routledge. https://doi.org/10.4324/9780203701706

Sedebo, D. A., Li, G.-C., Abebe, K. A., Etea, B. G., Ahiakpa, J. K., Ouattara, N'B., Olounlade, A., & Frimpong, S. (2021). Smallholder farmers' climate change adaptation practices contribute to crop production efficiency in southern Ethiopia. *Agronomy Journal, 113*(6), 4627–4638. https://doi.org/10.1002/agj2.20900

Shi, Y., Cheng, C., Lei, P., Wen, T., & Merrifield, C. (2011). Safe food, green food, good food: Chinese Community Supported Agriculture and the rising middle class. *International Journal of Agricultural Sustainability*, *9*(4), 551–558. https://doi.org/10.1080/14735903.2011.619327

Song, C., Huang, X., Les, O., Ma, H., & Liu, R. (2022). The economic impact of climate change on wheat and maize yields in the north China plain. *International Journal of Environmental Research and Public Health, 19*(9), Article 5707. https://doi.org/10.3390/ijerph19095707

Stanway, D. (2022, August 4). China warns that its temperatures are rising faster than global average. *Reuters*. https://news.yahoo.com/china-warns-temperatures-rising-faster-045514345.html

Stringer, L. C., Fraser, E. D. G., Harris, D., Lyon, C., Pereira, L., Ward, C. F. M., & Simelton, E. (2019). Adaptation and development pathways for different types of farmers. *Environmental Science & Policy, 104,* 174–189. https://doi.org/10.1016/j.envsci.2019.10.007

Surminski, S., Bouwer, L. M., & Linnerooth-Bayer, J. (2016). How insurance can support climate resilience. *Nature Climate Change*, *6*(4), 333–334. https://doi.org/10.1038/nclimate2979

Tittonell, P. A. (2013, May 16). *Farming systems ecology: Towards ecological intensification of world agriculture* (Inaugural lecture upon taking the position of Chair in Farming Systems Ecology at Wageningen University, Wageningen, Netherlands). https://scispace.com/pdf/farming-systems-ecology-towards-ecological-intensification-3liv0j004p.pdf

Tofu, D., Woldeamanuel, T., & Haile, F. (2022). Smallholder farmers' vulnerability and adaptation to climate change induced shocks: The case of Northern Ethiopia highlands. *Journal of Agriculture and Food Research, 8*, Article 100312. https://doi.org/10.1016/j.jafr.2022.100312

Touch, V., Tan, D. K. Y., Cook, B. R., Liu, L., Cross, R., Tran, T. A., Utomo, A., Yous, S., Grunbuhel, C., & Cowie, A. (2024). Smallholder farmers' challenges and opportunities: Implications for agricultural production, environment and food security. *Journal of Environmental Management, 370*, Article 122536. https://doi.org/10.1016/j.jenvman.2024.122536

Vignola, R., Harvey, C. A., Bautista-Solis, P., Avelino, J., Rapidel, B., Donatti, C., & Martinez, R. (2015). Ecosystem-based adaptation for smallholder farmers: Definitions, opportunities and constraints. *Agriculture, Ecosystems & Environment, 211*, 126–132. https://doi.org/10.1016/j.agee.2015.05.013

Wang, J., Huang, J., & Yang, J. (2014). Overview of impacts of climate change and adaptation in China's agriculture. *Journal of Integrative Agriculture, 13*(1), 1–17. https://doi.org/10.1016/S2095-3119(13)60588-2.

Willer, H., Trávníček, J., Meier, C., & Schlatter, B. (Eds.). (2021). *The world of organic agriculture: Statistics and emerging trends 2021*. Research Institute of Organic Agriculture FiBL, IFOAM Organics International. https://www.fibl.org/fileadmin/documents/shop/1150-organic-world-2021.pdf

Xiao, T. (2024, November 27). Capitalizing on China's organic boom: Certification, trends, and opportunities. *China Briefing*. https://www.china-briefing.com/news/china-organic-product-certification-trends-sustainability/#:~:text=China's%20organic%20production%20sector%20is,around%2030%2C000%20organic%20product%20certifications

Xiong, W., Conway, D., Lin, E., & Holman, I. (2009). Potential impacts of climate change and climate variability on China's rice yield and production. *Climate Research, 40*, 23–35. https://doi.org/10.3354/cr00802

Xu, X., Wang, L., Sun, M., Fu, C., Bai, Y., Li, C., & Zhang, L. (2020). Climate change vulnerability assessment for smallholder farmers in China: An extended framework. *Journal of Environmental Management*, 276, Article 111315. https://doi.org/10.1016/j.jenvman.2020.111315

Zhang, Z., Wei, J., Li, J., Jia, Y., Wang, W., Li, J., Lei, Z., & Gao, M. (2022). The impact of climate change on maize production: Empirical findings and implications for sustainable agricultural development. *Frontiers in Environmental Science, 10*, Article 954940. https://doi.org/10.3389/fenvs.2022.954940

Zhong, S., Hughes, A., Crang, M., Zeng, G., & Hocknell, S. (2022). Fragmentary embeddedness: Challenges for alternative food networks in Guangzhou, China. *Journal of Rural Studies, 95,* 382–390. https://doi.org/10.1016/j.jrurstud.2022.09.008

Zou, J. (2013, March 7). With farmers' average age at 58.6 in Jiangsu, the aging problem of farm labor needs to be addressed (In Chinese). *China News*. https://www.chinanews.com/sh/2013/03-07/4624407.shtml

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Strategic mix priorities as drivers of agripreneurial performance: Evidence from smallholder organic vegetable farmers in Tamil Nadu State of India

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Abstract

The adoption of organic farming practices by smallholder vegetable farmers is gaining wide importance in emerging economies such as India. Though information is available on the adoption practices, attitudes, and other characteristics of farmers, a detailed analysis of the various elements of the strategic mix, as drivers of the performance of smallholder organic vegetable farmers is lacking. This study aims to address the issue by collecting primary data from 271 organic vegetable growers, covering 16 districts in Tamil Nadu, India. The effects of four important strategic priorities—cost reduction, networking, quality differentiation, and supply chain management—in driving farm performance were investigated. The results revealed that quality differentiation, supply chain management, and networking are significant and have a positive impact, whereas cost reduction as a strategy does not have any significant effect on the performance of smallholder organic vegetable

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farmers. Additional analysis also unravels insights about the relative importance of each of the strategic items. The findings from this study have significance for stakeholders such as agricultural extension workers, NGOs and farmer producer organizations (FPOs), and other policymakers who are involved in promoting supportive policies and for popularizing organic farming practices. The results also enrich the existing literature on the successful adoption of organic farming practices in economies like India, where organic farming is growing but has yet to reach its full potential.

Keywords
agripreneurship, organic farming, PLS-SEM, IPMA, strategic management, smallholder farmers, quality differentiation, supply chain management

Introduction

Agripreneurship, or agriculture-related entrepreneurial activity (Bairwa et al., 2014), is valued as a growth-propelling engine, primarily in generating employment and improving economic growth and development. Agripreneurship is not solely confined to farm and rural enterprise; it covers all the activities that are related to agriculture and are a part of the agri-value chain (Sharma et al., 2019). The concept of agripreneurship is well suited for farmers who adopt organic farming practices, since agripreneurship may involve switching over from a completely chemical-oriented farming system to environment-friendly natural and sustainable cultivation practices but also comprises the adoption of newer technologies and sustainable cultivation practices according to market opportunities (Wiklund & Shepherd, 2005). Organic farming is a natural, sustainable, and traditional farming system that does not involve any chemical fertilizers or chemical pesticides during the entire crop cycle or cropping period (Sadati et al., 2010).

In India, due to the demand for fresh, chemical-free, high-nutritive-value vegetables, the area used for certified organic farming practices is increasing (Agricultural and Processed Food Products Export Development Authority [APEDA], 2024). Organic vegetable growers, mostly on rural farmsteads with small holdings, form the bulk of the vegetable producers in India (Dev, 2012). According to the report from the Centre for Science and Environment (CSE, 2020), as of February 2020, 1.49 million farmers have adopted organic farming, covering an area of 0.59 million ha (1.46 million acres).

Among the different states in India, Tamil Nadu is ranked 15th in terms of area under organic cultivation, having around 42,758 hectares under organic cultivation (APEDA, 2024). The adoption rate of organic farming in Tamil Nadu is very low compared with the opportunities available for organic vegetable cultivation, in spite of the various initiatives taken by the government of India in launching the National Program for Organic Production (NPOP) as well as awareness campaigns from the State Department of Agriculture (Paramasivam et al., 2022). Low adoption practices of organic farming have been attributed to poor awareness, depletion of soil nutritional status, improper pest and disease management practices, lower crop yields, inadequate marketing facilities, poor technical expertise, economic and financial concerns, and lack of proper skills to manage the farms (Das et al., 2020). Just like any other business, farming also requires strategic decisions to be taken for making the farming profitable and sustainable. Business literature defines "strategic mix" as a combination of different business strategies such as marketing, finance, operations, human resources, and the innovations integrated into a business to attain its long-term goals and stand out from competitors (Wheelen & Hunger, 2012). Likewise, production strategy mix is about choices regarding resources, such as capacity of production, technology, and quality systems to help a firm to meet its goals for cost, quality, flexibility, and delivery (Slack et al., 2010). Marketing strategy mix primarily consists of the tactical components of the marketing strategy, blending product, price, promotion, and place decisions to create value for customers and achieve competitive advantage in the target market (Kotler & Keller, 2016). In the context of organic farming, the strategic mix primarily consists of elements related to production and marketing, as farmers as entrepreneurs are themselves the major financial and human resource.

In our present model, we have incorporated four important strategies of *cost reduction*, *quality dif-*

ferentiation, *networking*, and *supply chain management* as part of the overall strategic mix that affects the business performance of smallholder organic vegetable farmers, as per literature. Cost reduction and product differentiation based on features or quality are two major elements of business strategy applicable to all kinds of businesses (Magretta, 2012; Porter, 2011), including organic farming. Networking among peers has also been found to play a significant role in the success of organic farms, especially for small farmers (Cardoso et al., 2020). Another major aspect of strategic importance in organic farming is the strategic management of logistics, as the ability to manage supply chains effectively leads to an increase in the volume of output being produced and marketed (Sylvander et al., 2006). Therefore, these four elements can be considered to form the core of the organic farming strategic mix.

Though several reports are available on the socioeconomic characteristics as well as the attitude of smallholder farmers in adopting organic farming practices, information on the effect of elements of the strategic mix in improving organic farms' overall performance is lacking. The present study aims to fill the research gap by analyzing the impact of the various elements of the strategic mix responsible for the performance of smallholder organic vegetable growers in the state of Tamil Nadu in India.

Theoretical Framework and Hypotheses

Our hypothetical model includes the major elements of the strategic mix identified from agricultural literature that are impacting and driving the overall performance of smallholder organic vegetable farmers in Tamil Nadu. Helping traditional farmers to adopt organic farming practices can lead to social and economic acceptance of organic farming, thereby promoting natural cultivation practices. Strategic decision-making involves performing activities differently from those of other farmers in the market or performing activities similar to those being performed by other farmers but doing them in a different way (Porter, 2011). For instance, an entrepreneurial-oriented farmer develops a willingness to innovate a profitable agribusiness in an uncertain environment by continuously adopting newer farming techniques, growing value-added crops that are different from other farmers' crops, and exploring and exploiting new market opportunities (Lumpkin & Dess, 2001; Rosairo & Potts, 2016; Verhees et al., 2012). On the contrary, a market-oriented farmer focuses on growing quality crops and proactively adopts new marketing strategies, different from those of other competitors (Wiklund & Shepherd, 2005).

The role of strategic management in the performance of smallholder organic vegetable farmers is still not clear. For instance, due to constant adaptation to market opportunities, small farmers may lack rational, sequential, and formal strategic planning (O'Dwyer et al., 2009). Adopting organic farming practices is a high-cost activity requiring farmers to plan carefully. Factors such as market conditions, benefits and costs, and community support have been found to affect the adoption of organic farming practices by smallholder vegetable and fruit farmers (Nandi et al., 2015; Panneerselvam et al., 2012). Previous research has shown that while entrepreneurial-oriented farmers show a bigger preference for increasing the overall farm performance and reducing cultivation costs, market-oriented farmers focus on diversifying crop technologies and engaging with customers to improve their network (Verhees et al., 2012). There is a lack of studies that focus on an integrated framework combining various strategies in organic farming. It is important to research how the trade-offs between these strategies affect outcomes in this context.

The performance of farmers denotes the total income generated or profitability from the cultivation of vegetables (Verhees et al., 2012). Studies indicate that partnership, networking, and formal contracts as well as forward and backward linkages (Nain et al., 2019) for maximizing farm productivity and profitability for vegetable farmers are often either missing or less developed in the agricultural value chain. Likewise, product or quality diversification is a strategy that consists of growing different value-added crops, developing value-added products, or entering new market segments. Other studies have indicated that diversified farms achieve better profitability by catering to niche markets and reducing dependency on traditional

crops (Gurr et al., 2016; Kittur et al., 2023). Crop product diversification is expected to create a positive influence on income stability and market expansion.

Based on the above discussion, we framed the following hypotheses to examine the effects of the elements of strategic mix in driving farm performance:

H1: A positive significant relationship exists between Strategic Cost-Reduction (SCR) and Performance (PERF).

H2: A positive significant relationship exists between Strategic Quality Differentiation (SQD) and Performance (PERF).

H3: A positive significant relationship exists between Strategic Networking with Farmers (SNW) and Performance (PERF).

H4: A positive significant relationship exists between Supply Chain Management (SCM) and Performance (PERF).

Research Methodology

The sampling method, measurement instrument used for data collection, and techniques of data analysis applied for the study are discussed in the following subsections.

Sampling

The survey data was collected from 16 districts of Tamil Nadu between June 2023 and August 2024, to include all three major cultivation seasons (April–May, July–August, and November–December). For calculating the required sample size, power analysis was conducted, which "is a method for determining the probability that a statistical test will detect effects of a specified size" (Cohen, 1988, p. 3). Power analysis is used to determine the minimum sample size required for a study based on the desired level of statistical power, the assumed significance level, the expected effect size, and the type of statistical test being conducted. Power analysis helps to ensure that the study is capable of detecting a true effect if one exists, thereby minimizing the risk of Type II errors and maximizing the power of the test. G*Power (Faul et al., 2009) software was used to conduct the power analysis, which suggested a minimum sample size of 262 respondents for achieving 95% power at 5% level of significance even if the effect size was as small as 0.05. Using purposive sampling, a total of 271 smallholder organic farmers were selected. The selected farmers followed sustainable farming practices and grew diverse vegetable crops during the cropping season. The sample consisted of 59% male and 41% female farmers. Approximately 70% of farmers had been educated up to the primary school level, 25% up to the secondary school level, and the other 5% were uneducated. In terms of land area, more than 80% owned land up to 2 acres (0.8 ha), and only 20% had larger land area for organic cultivation. Most of the farmers were in the age group of 30–50 years, with only 16% above 50 and 3% below 30 years of age.

Measurement Instrument

The instrument used to measure the variables in this study was developed as a formative index for the four strategic elements constructs and these were validated following the procedure outlined by Diamantopoulos and Winklhofer (2001). The formative index suits the context of this study, as there are various subaspects of each strategic element that may be focused upon differently by the farmers, and these substrategies may or may not be correlated to each other. Thus, it is imperative for the broad strategic element to be measured as a formative construct with items relating to different substrategies that form the overall strategic element (Diamantopoulos et al., 2008). The items for SCR, SQD, SNW, and SCM were framed based on the different ways in which the strategies of cost reduction, differentiation, networking, and supply chain management are carried out (King et al., 2010; Teece, 2010; Verhees et al., 2012).

Performance has been measured as a reflective construct by adapting items from previous studies (Love et al., 2015; Peel et al., 2015; Verhees et al., 2011). All the items of the instrument are presented in Table 1. The variables included in the study were measured using a 5-point Likert scale (1=*strongly disagree* to 5=*strongly agree*), with only PERF4 and PERF5 having different anchors, as mentioned in Table 1 (Love et al., 2015; Peel et al., 2015).

Table 1. Measurement Instrument

Construct	Items
SCR	I look for possibilities to reduce the production costs of organic vegetables and fruits for arriving at competitive selling prices.
	I grow other non-organic crops along with organic crops to reduce my overall average cost
	I track the direct costs of skilled laborers involved in organic cultivation practices.
	I track the Indirect costs involved in grading, packing, and certification of organic crops.
SQD	I believe in growing quality organic vegetables and fruits
	I believe in adopting the cultivation practices of other farmers for growing quality organic vegetables and fruits.
	I believe a high-quality product differentiation is needed to cater to the growing needs of "organic niche markets."
SNW	I closely coordinate with other fellow organic growers.
	I try and find out details of new varieties of organic crops grown by other farmers in the region.
	Focusing on my own expertise is more important than following the practices of other farmers.*
SCM	I believe studying the dynamics of the marketing channel model of organically grown crops is important.
	I work out the cost structure at each channel point.
	I analyze the time taken to move the product from farm to market or to end customers.
	I network well with all channel partners to deliver value to the customers.
PERF	Organic farming has been my primary source of income in the past 12 months.
	My organic farming business has been profitable in the past 12 months.
	I have a good profit margin on organic farming produce.
	What has been the overall position of your organic farming business? (1=*Huge Loss* to 5=*Highly Profitable*)
	How sustainable do you believe your organic business will be in the long run? (1=*Highly Unsustainable* to 5=*Highly Sustainable*)

* = Reverse coded

Analysis Method

The data collected was analyzed employing a partial least squares structural equation modeling (PLS-SEM) approach. Structural equation modeling (SEM) is a powerful technique for analyzing the relationships between latent variables measured through multiple observed variables (Hox & Bechger, 1999). There are two approaches of SEM: covariance-based SEM (CB-SEM) and variance-based SEM, or PLS-SEM. PLS-SEM is suited for the analysis of data that deviates from multivariate normality assumption, as in our study, with a significant Mardia's coefficient of skewness and kurtosis. Further, PLS-SEM has the capability for assessing formatively measured constructs, which makes this technique suitable for this study (Hair et al., 2011). Further, PLS-SEM is known for its high predictive relevance (Hair et al., 2017), which makes it a preferred technique for predicting the performance of organic farmers with the strategic mix elements as the predictors. SmartPLS4 was used to estimate the model results.

Results and Discussion

The model of the study was analyzed in two phases, as required in SEM. The first step was the assessment of the measurement model for examining the reliability and validity of constructs. The second step was to assess the structural model for the significant path relationships between the exogenous and endogenous constructs.

Measurement Model Results

The construct PERF, being reflective, was tested for reliability by checking the Cronbach's Alpha, Rho A, and Rho C values followed by convergent

Table 2. Reflective Construct Measurement Model Results

Reflective Construct	Item	Loading	Cronbach's Alpha	Rho A	Rho C	AVE
PERF	PERF1	0.679	0.809	0.815	0.867	0.567
	PERF2	0.769				
	PERF3	0.790				
	PERF4	0.739				
	PERF5	0.781				

validity through average variance extracted (AVE). Discriminant validity was not a concern in the model because all other constructs except PERF were formative, and therefore correlation-based discriminant validity measures like Heterotrait-Monotrait ratio of correlations (HTMT) were not relevant here (Sarstedt et al., 2021). It was found that all reliability measures for PERF were above the threshold of 0.7, and the AVE of the construct was above 0.5; hence, all the items were retained (Hair et al., 2022). Table 2 presents the results of the measurement model assessment of the reflective construct of performance (PERF).

The formative measurement model was assessed for validity using redundancy analysis by estimating the correlation of the construct measured through the formative items with a global single item representing that construct (Cheah et al., 2018). SCR, SQD, SNW, and SCM all exhibited this correlation with their global single item to be above 0.8, which satisfied the recommended threshold of 0.7 or above (Diamantopoulos et al., 2008; Hair et al., 2019). Further, the items were assessed for multicollinearity issues by checking the outer VIF values, and all values were found to be below 3, eliminating the possibility of collinearity issues (Diamantopoulos & Winklhofer, 2001). As the next step, item weights were checked for significance. Item weights refer to the relative contribution of each item in forming the construct (Hair et al., 2022). All weights were found to be significant except that of SCR1. However, the item loading (which refers to the absolute contribution of this item to the overall construct) of SCR1 was found to be above 0.5 and hence was retained (Hair et al., 2022). Table 3 presents the results of the formative constructs' measurement model assessment:

Table 3. Formative Constructs Measurement Model Results

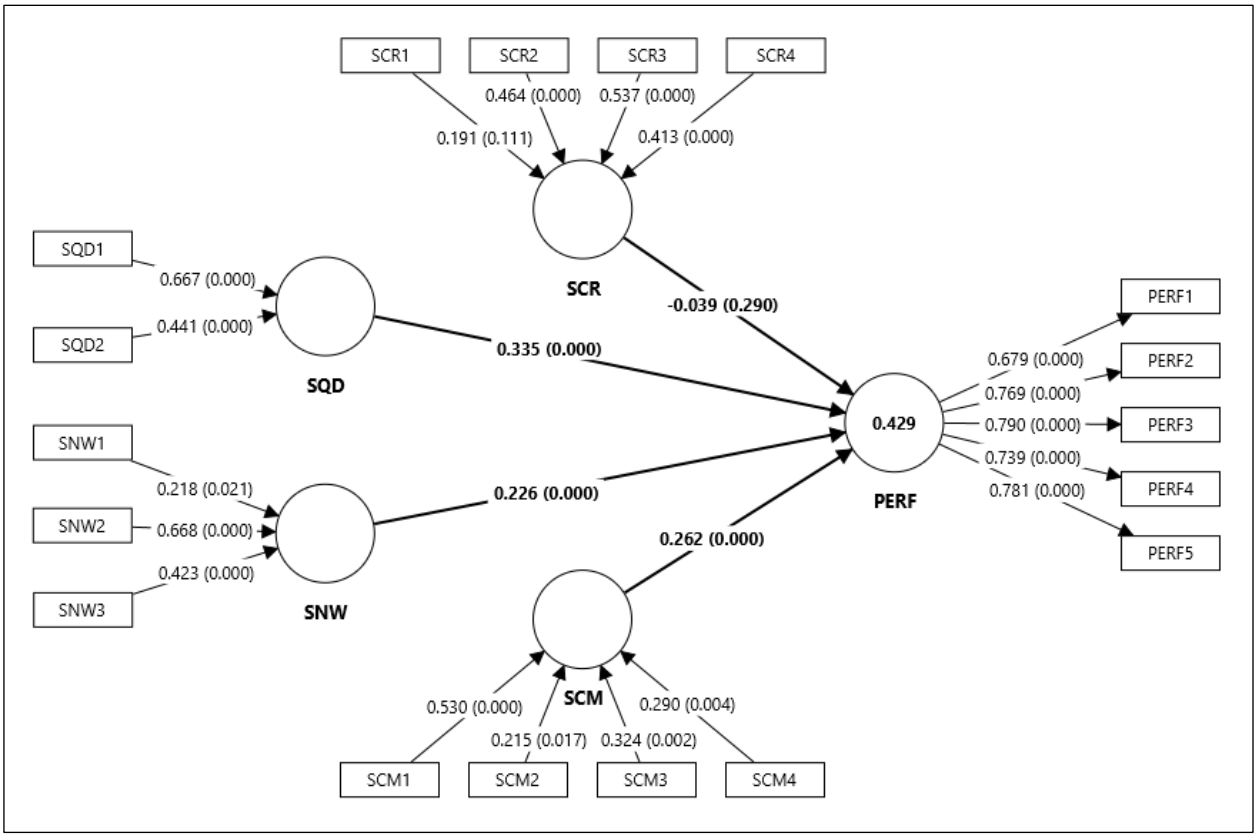
Formative Construct	Redundancy Coefficient	Item	Outer VIF	Outer Weight	Weight sig. (*p* value)	Outer loading
SCR	0.843	SCR1	1.144	0.191	0.111	0.506
		SCR2	1.108	0.464	0.000	0.552
		SCR3	1.148	0.537	0.000	0.768
		SCR4	1.162	0.413	0.000	0.569
SQD	0.866	SQD1	1.600	0.667	0.000	0.937
		SQD2	1.600	0.441	0.000	0.849
SNW	0.854	SNW1	1.716	0.218	0.021	0.760
		SNW2	1.557	0.668	0.000	0.866
		SNW3	1.135	0.423	0.000	0.604
SCM	0.867	SCM1	1.276	0.530	0.000	0.820
		SCM2	1.399	0.215	0.017	0.665
		SCM3	1.462	0.324	0.002	0.741
		SCM4	1.223	0.290	0.004	0.630

Structural Model Results

Structural model assessment begins with the examination of multicollinearity between the predictor constructs, as collinearity must be ruled out to ascertain that regression results are not biased (Hair et al., 2018). Inner VIF values were checked for the same, and no value was found to be above 3, ruling out any collinearity problem.

The path coefficients and their significance were then examined to interpret the effect of each of the strategic mix

Figure 1. Bootstrapping Results



elements on the performance of the organic farmers by running the bootstrapping procedure with 5,000 subsamples. The results of bootstrapping are depicted in Figure 1. Further, the explanatory power and predictive relevance of the model were assessed through the coefficient of determination R^2 (Hair et al., 2022) and PLSpredict-based Q^2 (Shmueli et al., 2019). Table 4 demonstrates the results of path relationships, and Table 5 gives the explanatory power, model fit, and predictive power of the structural model.

It can be seen from the results that all the hypotheses except H1 stand supported. Results show that the strategic elements of quality differentiation, networking with peers, and supply chain management have a significant positive effect on performance, but cost reduction as a strategic element does not affect the performance in any significant manner. This is an interesting finding that highlights the relatively insignificant role of cost

Table 4. Path Coefficients & Significance

Path	Inner VIF	Path Coefficient	*T* Statistic	*p*-value	Confidence Interval (Bias Corrected)		Hypothesis Test Inference
					5%	95%	
SCR → PERF	2.064	−0.039	0.553	0.290	−0.178	0.055	H1 not supported
SQD → PERF	1.743	0.335*	5.989	0.000	0.246	0.432	H2 supported
SNW → PERF	1.997	0.226*	3.843	0.000	0.128	0.322	H3 supported
SCM → PERF	1.608	0.262*	4.527	0.000	0.163	0.354	H4 supported

Note: * shows significant at 5%

Table 5. Explanatory Power, Model Fit & Predictive Power

Explanatory Power			Predictive Power	
Endogenous Variable	*R*-Square	*R*-Squared Adjusted	Q^2 (PLSpredict)	
Performance	0.429	0.422	Latent Variable Q^2	0.404
			Measured Variables Q^2	
			PERF1	0.233
			PERF2	0.199
			PERF3	0.178
			PERF4	0.166
			PERF5	0.331
Model Fit (SRMR): 0.08				

reduction in organic farming and shows that more emphasis must be given to innovative approaches for quality differentiation and supply chain management for creating value and enhancing performance. The role of peer networking is also significant for learning from other organic farmers and using their experience in making one's own performance better.

Table 5 exhibits the satisfactory explanatory and predictive power of the model, with the model explaining more than 40% of the variance in the dependent construct and all Q^2 values above zero (Shmueli et al., 2016). The model has an acceptable fit, exhibited through the SRMR value of 0.08, which is below the acceptable threshold of 0.1 (Hu & Bentler, 1999; Kock, 2020).

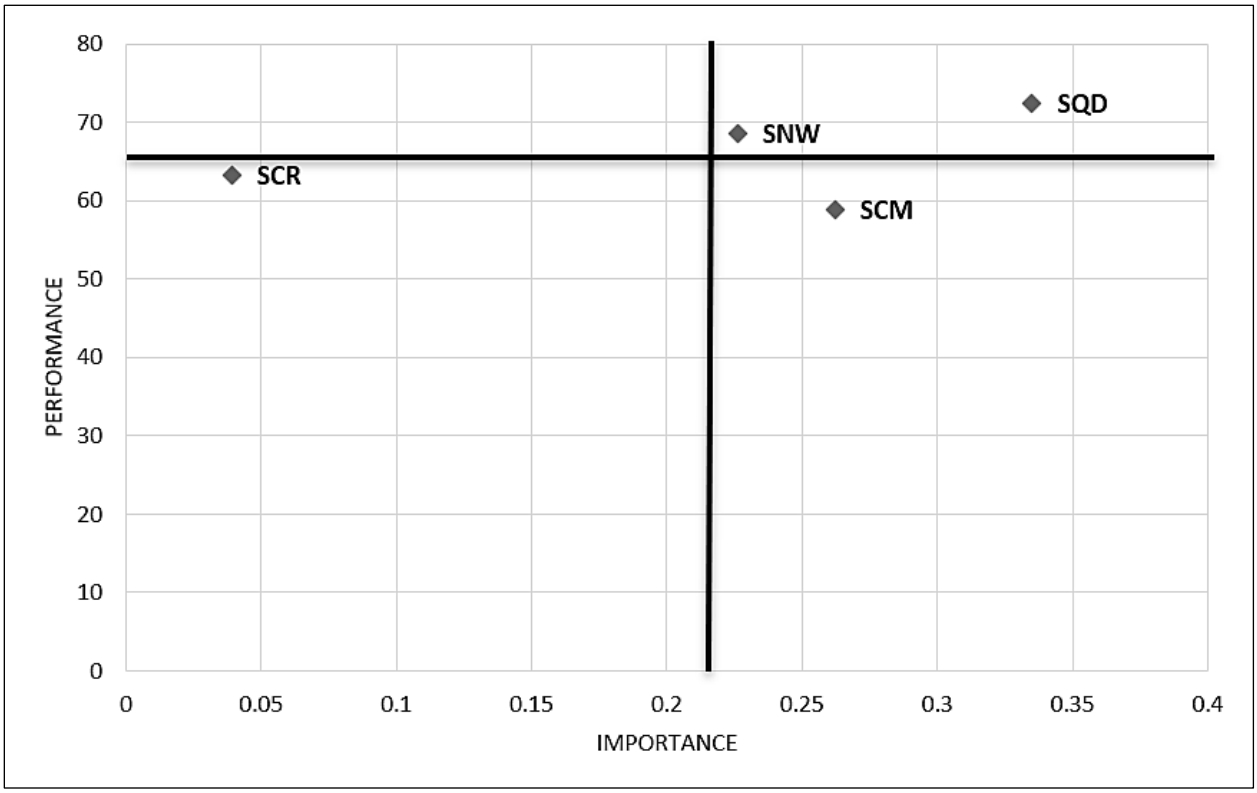
IPMA Results

Importance-performance map analysis (IPMA) provided deeper insights into the results and gave actionable insights for decisionmakers to take action on the priority areas. IPMA works by combining the total effect of a predictor on the dependent variable and its relative performance vis-á-vis other predictors (Ringle & Sarstedt, 2016). Figure 2 shows the IPMA result in four quadrants in graphical form, with the quadrants divided based on the average total effect and the average performance of the different predictor constructs on the dependent variable of Performance. It can be seen from the graph that the construct SQD has the maximum effect on performance and is also performing well, which implies that the organic farmers are focusing on quality-based differentiation to create a niche for themselves and expand their markets. However, SCM emerges from the IPMA results as a major area of concern, as it is the second most significant predictor, with a high total effect on performance but below-average performance. Therefore, SCM must be a priority area for organic farmers to improve and create more value in the chain, which has the potential to boost performance. SNW is above average in importance as well as performance and hence not a construct to be prioritized at present by the organic farmers, despite being significant. It is already performing well, with farmers networking with each other and learning from each other as a community. SCR lies in the lower left quadrant showing, that it is low in importance as well as performance. This shows that cost reduction as a strategy may not work well in improving performance in the context of organic farming. This may be because organic farming is more focused on delivering quality products to the customers for building trust and enhancing the reach in the market.

Conclusion and Implications

The present study utilized the PLS-SEM to explore the impact of the four important elements of the strategic mix namely, cost reduction, networking, quality differentiation, and supply chain management, as drivers of the performance of the smallholder organic vegetable growers, of Tamil Nadu, India. The analysis of the model based on the research hypotheses indicated that while three strategic elements, that is, networking, quality differentiation, and supply chain management, had a sign-

Figure 2. Importance–Performance Map Analysis



ificant positive effect, cost reduction as a strategic element did not show any significant effect on performance. This demonstrates that smallholder organic farmers should concentrate more on improving their quality of produce with crop diversification for better value addition as well as improve their networking and supply chain logistics with all stakeholders for sustainable development. The IPMA results also revealed that the construct of quality differentiation had the strongest effect on performance, followed by supply chain management. Networking with channel partners was found to be satisfactory. However, cost-reduction as a construct exhibited a lower priority, thereby indicating that farmers need to focus more on crop diversification and delivery of quality produce to meet the market and customer demands. The findings from the present study not only bridge the gaps in research on the effect of elements of strategic mix on the performance of smallholder organic vegetable farmers. This research is also useful for the policymakers and stakeholders who are actively involved in promoting organic cultivation of vegetables and helping farmers to practically implement effective strategies to do so. Policymakers, NGOs, and village-level agri-extension workers need to be involved in communicating the significance of product quality and differentiation over cost considerations to enhance the farmers' decision-making regarding adoption of organic farming.

The study carried out was based on a robust model with sound theoretical background; nonetheless, the results need to be interpreted with caution as there are some potential limitations. The conclusions in this study are based on the samples drawn from smallholder organic vegetable growers from only 16 districts of the state of Tamil Nadu. Thus, future researchers should extend the study to other regions so that the results can be generalized to larger sections. Secondly, future research should include more organically cultivated crops like cotton, paddy, wheat, maize, oilseeds, soybean, and plantains in the study so that the results can be generalized to a broader variety of crops. Despite these limitations, this study has significantly contributed to understanding the impact of strategic

elements on decision-making, performance, and agripreneurial development among smallholder organic vegetable farmers in India.

Recommendations for Research, Policy, and Practice

The findings from this study have important implications for the adoption of organic farming practices by smallholder vegetable farmers in India and other emerging economies. To enhance the adoption of the cultivation of organic vegetables by smallholder farmers, the policymakers as well as agricultural extension officers, NGOs, and the link should consider the following actionable recommendations.

Training Program on Organic Farming Practices

Regular training programs on the organic cultivation of vegetable crops must be conducted for agricultural extension as well as NGOs to keep them updated on the latest agricultural practices, which they can disseminate to farmers. Through these regular programs, new training modules should introduce the need for organic crop diversification as well as the delivery of quality produce, rather than focusing merely on cost-reduction strategies.

Organic Certification and Accreditation

Adoption of organic certification and accreditation is still lacking as far as farming in India is concerned. This is evident from the low rates of adoption of organic farming practices compared to the total area under cultivation in India (Ramesh et al., 2010). The Department of Agriculture and Farmers Welfare under the Ministry of Agriculture should make policy decisions to recruit extension workers and agricultural officers to these certification programs for enhancing the awareness and reach of these programs. Some of the initiatives such as (a) group certifications via Farmer Producer Organization (FPO) and self-help groups, (b) digitalized registration of farmers through a single-window system, (c) financial support in the form of subsidies for certifications and renewals for those adopting eco-friendly practices, and (d) effective coordination among various departments such as the National Horticulture Board, the Directorate of Agricultural Marketing, and the organic certification body to implement the Tamil Nadu Organic Farming Policy (Agriculture-Farmers Welfare Department, 2023), will enable more smallholder farmers to obtain certification and produce value-added crops, both for domestic and export of fresh organic vegetables.

Adoption of Digital Technology

To improve supply chain and logistics in organic farming and expand the network between farmers and agricultural extension workers, policymakers should focus on developing and actively promoting digital platforms, mobile applications, and remote-sensing technologies. These tools can help extension workers and NGOs connect more easily with smallholder farmers and support them in making strategic decisions about organic cultivation when needed. Some of the suggested measures include (a) building trust and awareness through field-level demonstrations and showcasing success stories, (b)improving accessibility through distribution of free smartphones with internet connectivity along with user-friendly customized apps, (c) incentivizing adopting technologies such as soil-based sensors, GPS, and drones, and (d) popularizing the prime minister's Kisan (PM-KISAN) and AgriStack schemes, for collecting real-time crop-specific data and monitoring of pests, diseases, and climate changes. Providing such low-cost technologies will not only enhance awareness on the benefits of adopting organic farming practices but also help smallholder producers to market their produce in distant markets, through e-commerce platforms such as Uzhavu Organic and Chennai Angadi for marketing certified organic fresh fruits and vegetables.

Support Farmer Producer Organizations (FPOs)

As the findings suggest, supply chain management is an important factor in influencing farm performance, but this factor has not been performing well because of organic farmers' lesser focus on this aspect. The Government of India has initiated the National Programme for Organic Production (NPOP), National Mission for Sustainable Agriculture (NMSA), and Paramparagat Krishi Vikas Yojana (PKVY) for promoting nationwide cultivation of organic farming. In addition, the state of

Tamil Nadu has launched intensive programs such as Sustainable Agricultural Practices (SAP) with the purpose of driving organic production practices. These governmental agencies should partner with FPOs at the grassroot level to strengthen the promotion of organic farming practices as well as extend logistic supports for procurement and marketing of fresh organic produce in order to improve value in supply chain.

Promotion Through Self-help Groups (SHG)

Social networking among farmers has been found to be effective in improving organic farm performance. The Government of India recently launched the Atmanirbhar Bharat (Self-reliant India), and is promoting women's self-help groups (SHG). These women's SHG should be targeted to promote the concept of organic farming practices. Such a community movement will help to sustainably build peer-to-peer knowledge, dissemination networks for advice, and for organic cultivation practices.

Focus on Organic Crop-Based Research

Findings suggest that quality differentiation plays a crucial role in making organic farms perform well. Therefore, central as well as state agricultural universities in India should give more attention to research on the cultivation of organic products and effective farming practices under their ongoing schemes, such as precision farming, and extend their research to include more varieties of value-added crops such as cotton, soybean, oilseeds, and fruit crops, where the use of chemical pesticides is alarming, leading to residual problems.

References

Agricultural and Processed Food Products Export Development Authority [APEDA]. (2024). *Study of Indian organic market and export promotion strategy*. https://organic.apeda.gov.in/sites/default/files/2025-01/Final_Report_Indian_Organic_Market_Export_Promotion_Strategy_CRISIL291124.pdf

Agriculture-Farmers Welfare Department. (2023). *Tamil Nadu Organic Farming Policy 2023*. Government of Tamil Nadu. https://agritech.tnau.ac.in/pdf/66617733-Tamil-Nadu-Organic-Farming-Policy-2023_230315_093042.pdf

Bairwa, S. L., Lakra, K., Kushwaha, S., Meena, L. K., & Kumar, P. (2014). Agripreneurship development as a tool to upliftment of agriculture. *International Journal of Scientific and Research Publications*, *4*(3), 1-4. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=489a58671771ee78648946f63d08a4edf44e482e

Centre for Science and Environment [CSE]. (2020). *State of organic and natural farming in India: Challenges and possibilities*. https://www.cseindia.org/state-of-organic-and-natural-farming-in-india-10346

Cardoso, J. D. F., Casarotto Filho, N., & Marcon, C. (2020). Small business networks in the field of organic farming: Strategies and management tools. *Gestão & Produção*, *27*(4), Article e4730. https://doi.org/10.1590/0104-530X4730-20

Cheah, J.-H., Sarstedt, M., Ringle, C. M., Ramayah, T., & Ting, H. (2018). Convergent validity assessment of formatively measured constructs in PLS-SEM: On using single-item versus multi-item measures in redundancy analyses. *International Journal of Contemporary Hospitality Management*, *30*(11), 3192–3210. https://doi.org/10.1108/IJCHM-10-2017-0649

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge.

Das, S., Chatterjee, A., & Pal, T. K. (2020). Organic farming in India: a vision towards a healthy nation. *Food Quality and Safety*, *4*(2), 69–76. https://doi.org/10.1093/fqsafe/fyaa018

Dev, S. M. (2012). *Small farmers in India: Challenges and opportunities* [IGIDR Working Paper] (WP-2012-014), Indira Gandhi Institute of Development Research. http://www.igidr.ac.in/pdf/publication/WP-2012-014.pdf

Diamantopoulos, A., Riefler, P., & Roth, K. P. (2008). Advancing formative measurement models. *Journal of Business Research*, *61*(12), 1203–1218. https://doi.org/10.1016/j.jbusres.2008.01.009

Diamantopoulos, A., & Winklhofer, H. M. (2001). Index construction with formative indicators: An alternative to scale development. *Journal of Marketing Research*, *38*(2), 269–277. https://doi.org/10.1509/jmkr.38.2.269.18845

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149–1160. https://doi.org/10.3758/BRM.41.4.1149

Gurr, G. M., Lu, Z., Zheng, X., Xu, H., Zhu, P., Chen, G., Yao, X., Cheng, J., Zhu, Z., Catindig, J. L., Villareal, S., Van Chien, H., Cuong, L. Q., Channoo, C., Chengwattana, N., Lan, L. P., Hai, L. H., Chaiwong, J., Nicol, H. I., … Heong, K. L. (2016). Multi-country evidence that crop diversification promotes ecological intensification of agriculture. *Nature Plants*, *2*(3), Article 16014. https://doi.org/10.1038/nplants.2016.14

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2018). *Multivariate data analysis* (8th ed.). Cengage Learning EMEA.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *A primer on partial least squares structural equation modeling* (3rd ed.). Sage Publications.

Hair, J. F., Matthews, L. M., Matthews, R. L., & Sarstedt, M. (2017). PLS-SEM or CB-SEM: Updated guidelines on which method to use. *International Journal of Multivariate Data Analysis*, *1*(2), 107–123. https://doi.org/10.1504/IJMDA.2017.087624

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice*, *19*(2), 139–152. https://doi.org/10.2753/MTP1069-6679190202

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Hox, J. J., & Bechger, T. M. (1999). An introduction to structural equation modeling. *Family Science Review*, *11*, 354–373. https://www.researchgate.net/publication/27706391

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

King, R. P., Boehlje, M., Cook, M. L., & Sonka, S. T. (2010). Agribusiness economics and management. *American Journal of Agricultural Economics*, *92*(2), 554–570. https://doi.org/10.1093/ajae/aaq009

Kittur, B. H., Upadhyay, A. P., Jhariya, M. K., Raj, A., & Banerjee, A. (2023). Agroforestry for resource diversification and sustainable development. In M. K. Jhariya, R. S. Meena, & A. Raj (Eds.), *Agroforestry for Carbon and Ecosystem Management* (pp. 19–32). Elsevier. https://doi.org/10.1016/B978-0-323-95393-1.00028-2

Kock, N. (2020). Using indicator correlation fit indices in PLS-SEM: Selecting the algorithm with the best fit. *Data Analysis Perspectives Journal*, *1*(4), 1–4. https://scriptwarp.com/dapj/2020_DAPJ_1_4/Kock_2020_DAPJ_1_4_XsCorrMatrixIndices.pdf

Kotler, P., & Keller, K. L. (2016). *Marketing management* (15th ed.). Pearson Education.

Love, D. C., Fry, J. P., Li, X., Hill, E. S., Genello, L., Semmens, K., & Thompson, R. E. (2015). Commercial aquaponics production and profitability: Findings from an international survey. *Aquaculture*, *435*, 67–74. https://doi.org/10.1016/j.aquaculture.2014.09.023

Lumpkin, G. T., & Dess, G. G. (2001). Linking two dimensions of entrepreneurial orientation to firm performance: The moderating role of environment and industry life cycle. *Journal of Business Venturing*, *16*(5), 429–451. https://doi.org/10.1016/S0883-9026(00)00048-3

Magretta, J. (2012). *Understanding Michael Porter: The essential guide to competition and strategy*. Harvard Business Press.

Nain, M. S., Singh, R., Mishra J R, Sharma, J. P., Singh, A. K., Kumar, A., Gills, R., & Suman, R. S. (2019). Maximising farm profitability through entrepreneurship development and farmers' innovations: Feasibility analysis and action interventions. *Indian Journal of Agricultural Sciences*, *89*(6), 1044–1049. http://dx.doi.org/10.56093/ijas.v89i6.90833

Nandi, R., Bokelmanna, W., Nithya, V. G., & Dias, G. (2015). Smallholder organic farmer's attitudes, objectives and barriers towards production of organic fruits and vegetables in India: A multivariate analysis. *Emirates Journal of Food & Agriculture*, *27*(5), 396–406. https://doi.org/10.9755/ejfa.2015.04.038

O'Dwyer, M., Gilmore, A., & Carson, D. (2009). Innovative marketing in SMEs. *European Journal of Marketing*, *43*(1), 46–61. https://doi.org/10.1108/03090560910923238

Panneerselvam, P., Halberg, N., Vaarst, M., & Hermansen, J. E. (2012). Indian farmers' experience with and perceptions of organic farming. *Renewable Agriculture and Food Systems*, *27*(2), 157–169. https://doi.org/10.1017/S1742170511000238

Paramasivam, S., Henry, P., Seethapathy, P., & Rajamohan, T. (2022). A strategic model for empowering farmers by improving livelihood security through organic farming practices in Tamil Nadu, India. *Journal of Agricultural Sciences – Sri Lanka*, *17*(3), 471–483. https://doi.org/10.4038/jas.v17i3.9926

Peel, D., Berry, H. L., & Schirmer, J. (2015). Perceived profitability and well-being in Australian dryland farmers and irrigators. *Australian Journal of Rural Health*, *23*(4), 207–214. https://doi.org/10.1111/ajr.12176

Porter, M. E. (1996). What is strategy? *Harvard Business Review*. https://hbr.org/1996/11/what-is-strategy

Ramesh, P., Panwar, N. R., Singh, A. B., Ramana, S., Yadav, S. K., Shrivastava, R., & Subba Rao, A. (2010). Status of organic farming in India. *Current Science*, *98*(9), 1190–1194. https://www.jstor.org/stable/24110148

Ringle, C. M., & Sarstedt, M. (2016). Gain more insight from your PLS-SEM results: The importance-performance map analysis. *Industrial Management and Data Systems*, *116*(9), 1865–1886. https://doi.org/10.1108/IMDS-10-2015-0449

Rosairo, H. S. R., & Potts, D. J. (2016). A study on entrepreneurial attitudes of upcountry vegetable farmers in Sri Lanka. *Journal of Agribusiness in Developing and Emerging Economies*, *6*(1), 39–58. https://doi.org/10.1108/JADEE-07-2014-0024

Sadati, S. A., Fami, H. S., Kalantari, K., Mohamadi, Y., & Asakere, A. (2010). Investigating effective factors on attitude of paddy growers towards organic farming: A case study in Babol County in Iran. *Research Journal of Applied Sciences, Engineering and Technology*, *2*(4), 362–367. https://maxwellsci.com/print/rjaset/v2-362-367.pdf

Sarstedt, M., Ringle, C. M., & Hair, J. F. (2021). Partial least squares structural equation modeling. In C. Homburg, M. Klarmann, & A. Vomberg (Eds.), *Handbook of market research* (pp. 1–47). Springer International Publishing. https://doi.org/10.1007/978-3-319-05542-8_15-2

Sharma, A., Bhooshan, N., Singh, A., Deshmukh, S. S., & Patra, S. P. (2019). Portrait of an agripreneur of India: An acceleration study. *The Indian Journal of Agricultural Sciences*, *89*(11). https://doi.org/10.56093/ijas.v89i11.95316

Shmueli, G., Ray, S., Velasquez Estrada, J. M., & Chatla, S. B. (2016). The elephant in the room: Predictive performance of PLS models. *Journal of Business Research*, *69*(10), 4552–4564. https://doi.org/10.1016/j.jbusres.2016.03.049

Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J.-H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: Guidelines for using PLSpredict. *European Journal of Marketing*, *53*(11), 2322–2347. https://doi.org/10.1108/EJM-02-2019-0189

Slack, N., Chambers, S., & Johnston, R. (2010). *Operations management* (6th ed.). Pearson Education.

Sylvander, B., & Schieb-Bienfait, N. (2006). The strategic turn of organic farming in Europe: From a resource based to an entrepreneurial approach of organic marketing initiatives. In T. Marsden & J. Murdoch (Eds.), *Research in rural sociology and development: Vol. 12. Between the local and the global* (pp. 323–358). Emerald Group Publishing Limited. https://doi.org/10.1016/S1057-1922(06)12013-2

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, *43*(2–3), 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

Verhees, F. J. H. M., Lans, T., & Verstegen, J. A. A. M. (2011, September 2). *Entrepreneurial proclivity, market orientation and performance of Dutch farmers and horticultural growers*. EAAE 2011 Congress: Change and Uncertainty, Zurich, Switzerland. https://www.researchgate.net/publication/239805215

Verhees, F. J. H. M., Lans, T., & Verstegen, J. A. A. M. (2012). The influence of market and entrepreneurial orientation on strategic marketing choices: The cases of Dutch farmers and horticultural growers. *Journal on Chain and Network Science*, *12*(2), 167–180. https://doi.org/10.3920/JCNS2012.x011

Wheelen, T. L., & Hunger, J. D. (2012). *Strategic management and business policy: Toward global sustainability* (13th ed.). Pearson.

Wiklund, J., & Shepherd, D. (2005). Entrepreneurial orientation and small business performance: A configurational approach. *Journal of Business Venturing*, *20*(1), 71–91. https://doi.org/10.1016/j.jbusvent.2004.01.001

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Family farmers' environmental perception of ecosystem services in the Brazilian semi-arid region

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Abstract

Rural populations, whose economies are based on agriculture and livestock, depend on ecosystem services. The aim of this study was to assess family farmers' environmental perception of ecosystem services and their importance. The study was conducted in two communities in the semi-arid region of Piauí, Northeastern Brazil. Data were collected through nonparticipant observation and semi-structured interviews and analyzed using word clouds, Likert scales, and semantic networks. Farmers have a broad perception of ecosystem service categories, recognizing and valuing provisioning and cultural services above all. Nature is seen as playing a fundamental role in the activities of these communities, which depend on natural resources for their livelihoods and leisure.

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Keywords
semi-arid region, family farming, Caatinga biome, provisioning services, cultural services

Introduction

Rural populations with agriculture- and livestock-based economies depend on ecosystem services: their activities are often related to and dependent on the surrounding landscapes (Fagerholm et al., 2012). Ecosystem services (ES) represent the benefits that people obtain from ecosystems, both directly and indirectly, and are classified into four categories: support, which includes soil formation processes, nutrient cycling, and water cycling; regulation, which involves maintaining air quality, climate, and water regulation; provision, which covers food, fiber, fuel, and fresh water; and culture, which concerns cultural diversity, ecotourism, recreation, and aesthetic values (Millennium Ecosystem Assessment [MA], 2005). ES are fundamental to supporting human well-being and are considered an important component of sustainability (Summers & Smith, 2014; Wang et al., 2017).

Agriculture, for example, benefits directly from ES such as pollination, biological pest control, shade, and shelter (Stallman, 2011; Zhang et al., 2007). However, the loss of natural habitats damages ecosystem processes and their functioning, reducing nature's ability to provide ES (Díaz et al., 2019). Extensive agriculture and agricultural intensification are the main drivers of biodiversity loss and biotic homogenization worldwide (Kehoe et al., 2017). They not only jeopardize global conservation goals but also undermine the provision of many ES on which farming communities, especially family farms, and society in general depend (Bommarco et al., 2013). Furthermore, this rapid conversion of natural systems into agricultural land results in a significant loss of ES, including loss of biodiversity, increase in CO_2 emissions, soil erosion, air pollution, water pollution, and climate change (Fang et al., 2024).

This reality is particularly worrying in the Brazilian semi-arid region, already one of the most vulnerable regions in the world due to a combination of factors that include irregular rainfall, rising temperatures, soil degradation, and desertification (Marengo et al., 2017). These conditions mainly affect farmers, who depend on rainfall for rainfed crops (Marengo et al., 2011).

Landscapes composed of agricultural and forest lands are essential for providing a complete ES package for a population (Martín-López et al., 2012). However, the management of these landscapes should be focused on agriculture that establishes lower-impact management practices, such as polyculture and the cultivation of species in association that can increase the diversity of an agroecosystem (Gliessman, 2001). Studies carried out in the Caatinga, a seasonally dry tropical forest in Brazil, concluded that it is necessary to include ES in ecological restoration areas, taking into account the vulnerable human population in dry regions and their demand for natural resources (Costa et al., 2021).

Despite a growing base of studies related to ES, there is a lack of understanding of farmers' perceptions of ES and how this is associated with natural environment management (Teixeira et al., 2018). Awareness of these perceptions contributes to drawing up sustainable development strategies (Giansanti, 1998) and formulating public policies (Dominati et al., 2010).

For example, studies carried out in Colombia highlight the need to consider local perceptions when assessing which perceptions ES farmers value, in order to guide policy decisions with concrete data (Leroy & Barrasa García, 2021). These perceptions can vary widely depending on the context and environmental conditions, as evidenced by research in Indonesia (Muhamad et al., 2014), Germany (Küchen et al., 2023), Kenya (Miller et al., 2021), and Brazil (Osório de Sousa et al., 2024a). These differences are based on cognitive aspects of the perception of visual stimuli and people's experiences of nature and the surrounding environment (Arias-Arévalo et al., 2018), as well as social factors such as educational level (Maas et al., 2021). For example, living in a semi-arid region can influence farmers' perceptions, as observed in farmers in Nigeria and Ghana, where food production is highly dependent on rainwater (Aniah et al., 2024a).

This study aimed to analyze how family farmers in two communities in the Brazilian

semi-arid region perceive ES. We hypothesized that the family farmers in our sample would prioritize provisioning ES, especially those associated with the use of rainwater, due to their relevance to agricultural production in this semi-arid region.

Methodology

The study was conducted in the communities of Fornos and Pau D'Arco, located on Chapada do Mucambo, in the municipality of Picos, in the Southeast Piauí state, Northeastern Brazil. According to information obtained directly from the records of the Association of Small Rural Producers of Fornos and Pau D'Arco during field visits, these communities have a total of 212 inhabitants. The region is located 307 km (191 miles) from the state capital Teresina and has a predominantly dry and semi-arid climate, with rainfall concentrated in the months of December, January, and February (Mainar de Medeiros et al., 2012).

Our study area is part of the Caatinga, a seasonal Brazilian forest (Pennington et al., 2009) in the Northeast region with an area of 912,529 square km or 352,329 square miles (da Silva et al., 2018). It has a rich and varied biodiversity, with a high number of endemic species (Prado, 2003; Rito et al., 2017). The soils in this region come from the alteration of sandstones, siltstones, and conglomerates; they are lithic, alkalic, and dystrophic soils, with a medium texture, poorly developed, shallow to very shallow, and with a stony phase (Jacomine, 1986).

The Fornos and Pau D'Arco communities employ rainfed family farming as a source of income and food, especially corn, cassava, beans, and backyard production for human consumption (Viva o Semiarid Project, IFAD, 2020). Backyard production includes a wide diversity of food species that are grown all year round and contribute to household consumption (de Sousa et al., 2025). The community uses well water and water stored in cisterns and has no public water supply. In order to define a representative group of farmers in the region, the research was carried out with farmers from the Association of Small Rural Producers of Fornos and Pau D'Arco. Of the 35 members, 29 took part in the survey.

Sample Design and Analysis Methods

During visits to the communities, it was found that the farmers were organized into a local association made up of 35 members (N=35). For this research, 29 farmers who maintained backyard production and family-based vegetable gardens were selected, a criterion in line with the study's objective of understanding farmers' perceptions of ecosystem services. All participants were informed of the research objectives and voluntarily agreed to take part by signing an informed consent form, in accordance with the ethical principles applicable to research with communities. Our data collection combined nonparticipant observation, which allowed for a contextual understanding of local agricultural practices, and semi-structured interviews, which were used to explore in greater depth the participants' experiences, values, and perceptions in relation to provisioning, regulating, cultural, and supporting ecosystem services.

The interview form contained 42 questions focusing on the four categories of ES: provision, regulation, support, and culture. One part of the questionnaire contained open questions so that interviewees could develop their thoughts or cite examples, and another part contained questions with answers organized according to the Likert scale. This scale has rating categories, and its main objective is to obtain from interviewees how much they agree or disagree with certain statements (Allen & Seaman, 2007). In this study, the Likert scale was adapted to analyze the degree to which farmers perceived the importance of ES, with five possible answers: 1 (*very bad*), 2 (*bad*), 3 (*fair*), 4 (*good*), and 5 (*very good*).

To analyze farmers' perceptions of ES, a word cloud and a semantic network were constructed. The word cloud is an analysis that lists the most important words in a category and where the size of the words highlights their citation frequency. For a more refined qualitative analysis, we created a semantic network, an analysis that demonstrates the perceived connections between different elements. Areas that are more densely connected may indicate greater interdependence or a more significant impact between elements on farmers' perceptions. The data collected in the interviews were analyzed in the R Studio 4.2.1 program using the

following packages: quanteda, textplots, ggalluvial, ggplot, and igraph (Benoit et al., 2018; Brunson, 2020; Csárdi, 2020; Wickham, 2016).

This research was submitted to and approved by the Ethics Committee of the Federal University of Paraíba, Protocol no. 5.432.561 (CE/CCS/UFPB), through Plataforma Brasil CAAE n. 58670122.5.0000.5188.

Results

Of those interviewed, 85.7% were female and 14.3% male, with an average age of 49.5 years. With regard to participants' level of schooling, 78.3% had incomplete primary education. The farmers mentioned services in all four ES categories: provision, support, regulation, and culture. The most cited category was provisioning, accounting for 56% of the total, followed by cultural with 20%. Regulatory services received 17% of the responses, while supporting was the least cited, with 7% of mentions.

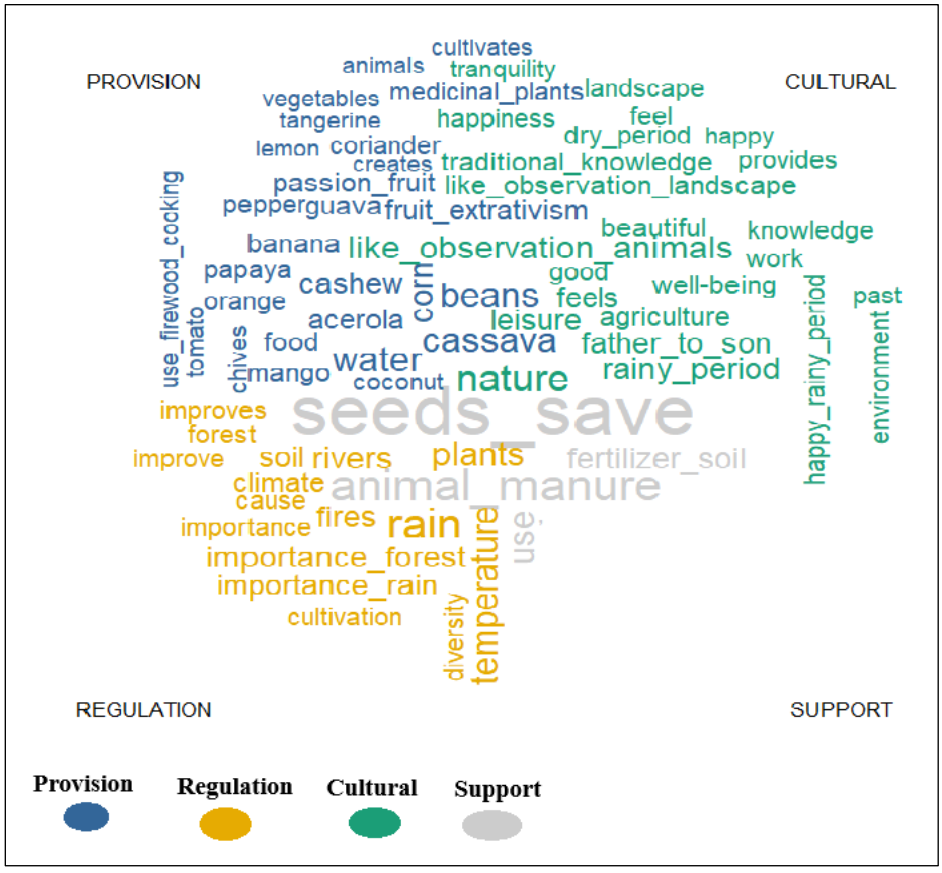
The main services cited for the provision category are directly related to agriculture, with the production of corn, beans, and cassava, and the use of water being the most visible services (Figure 1). These are the main crops planted by farmers, and water stands out due to its essential role in growing these foods.

Various services were mentioned in the cultural category; however, they all seem to have the same degree of importance since there is little difference in the size of the words, with no specific emphasis. Farmers value moments of leisure in direct contact with nature, the only word with a subtle emphasis in this cloud (Figure 1). The regulation category shows that farmers perceive the forest as regulating water maintenance in the environment and, less clearly, the soil (Figure 1). The services mentioned are more directly related to the water cycle and indicate that farmers are aware of climate change.

The support category received the fewest mentions, but the practice of saving seeds was perceived as very important. Farmers keep the best seeds from the harvest in plastic bottles. The seeds, mainly corn, beans, and pumpkin, are stored in a house set aside in the community as a "seed bank." Two other elements in the support category, soil fertilization and animal manure, also appeared with some prominence, demonstrating the significance of these practices for sustainability and agricultural productivity in the region.

In addition to perceiving provisioning and cultural services very well (Figure 1), farmers highly

Figure 1. Word Cloud of Farmers' Perceptions of Ecosystem Services in Communities in the Semi-Arid State of Piauí, Northeastern Brazil



value these services (Figure 2). These categories received the highest ratings on the Likert scale, suggesting that farmers strongly depend on nature for both resources and leisure.Soil quality and the availability of water resources, both directly related to farming, are also seen as significant services (Figure 2).

In contrast, insects and hunting received the lowest scores, reflecting a negative perception of the role of insects in agriculture and the environment as a whole. Insects were cited as synonymous with agricultural pests, disregarding their crucial roles in pollination, biological control, and other services. Additionally, responses indicated disapproval of animal hunting (Figure 2). Other ES that also proved to be important were plants, both in terms of diversity and medicinal use (Figure 2). Animal watching and interest in native animals were likewise highly rated, as were outdoor activities, fruit picking, and nature walks, thus indicating a strong interest in interacting with nature.

Semantic network analyses revealed that the three major groups of ES perceived by farmers are directly related to the term "nature," indicating that farmers consider nature to be a vital element in their daily lives (Figure 3). Provisioning ES such as cassava, beans, corn, medicinal plants, and fruit extraction are highly interconnected. Also in this category are animal services and collecting firewood for cooking. These connections indicate that farmers consider these elements significant for their livelihoods (Figure 3).

Cultural ES well-being, happiness, leisure, father-to-son, and traditional agriculture are clearly interconnected with nature, which demonstrates its importance in promoting well-being, happiness, and leisure, as well as the transmission of traditional knowledge and practices passed down from father to son (Figure 3).

Another interesting association with nature is the happy rainy period, because being a semi-arid region, farmers identify this period with happiness and increased production due to the abundance of water. The relationship between these terms sug-

Figure 2. Degree of Importance on the Likert Scale that Farmers Attribute to Some Ecosystem Services in Communities in the Semi-Arid State of Piauí, Northeastern Brazil

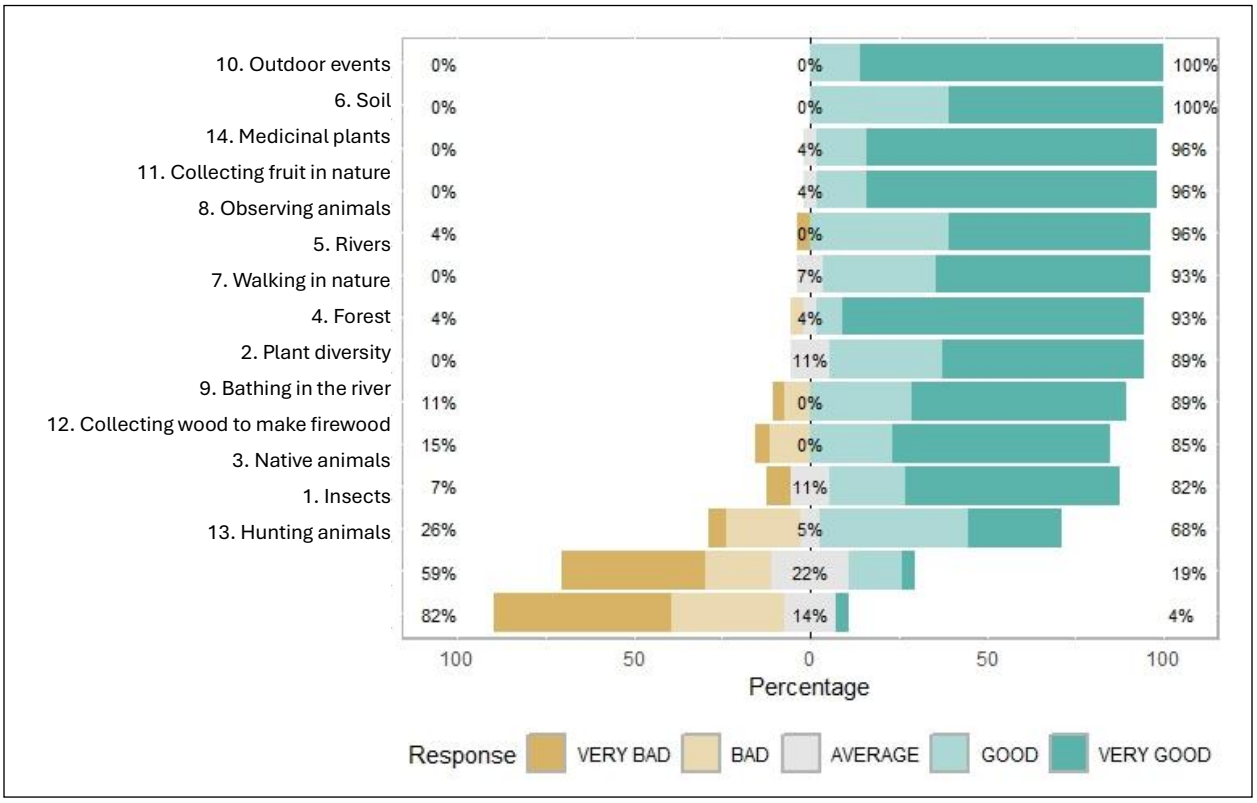
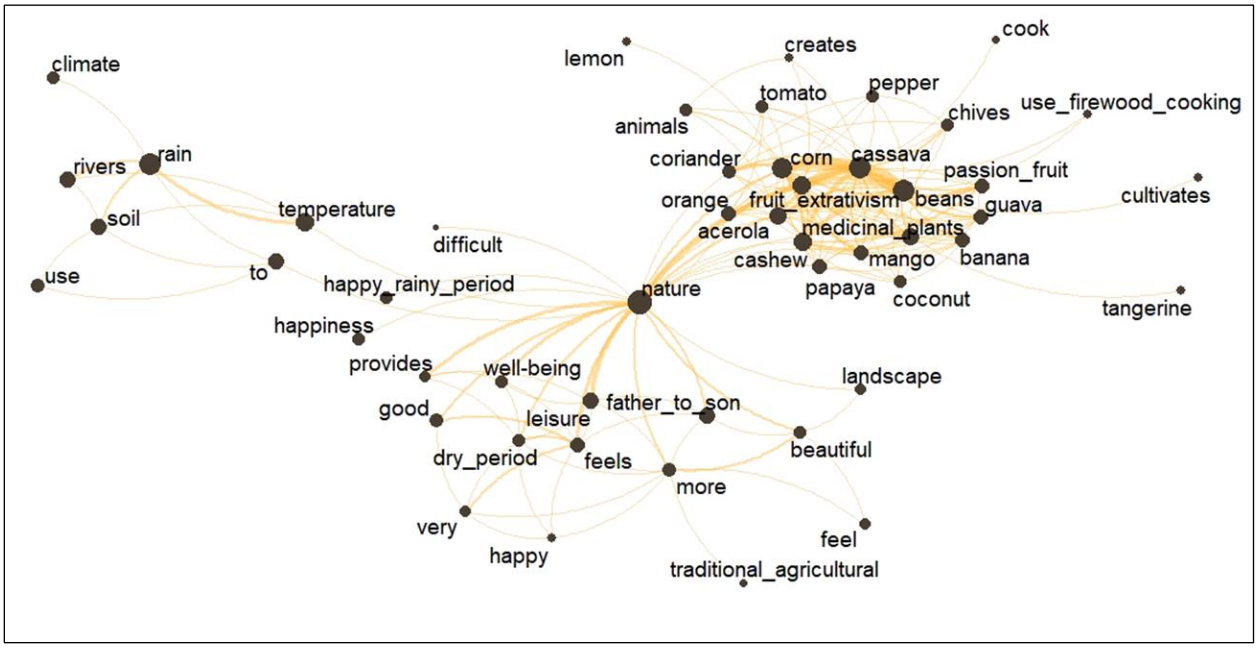


Figure 3. Semantic Network of Farmers' Perceptions of Ecosystem Services in Communities in the Semi-Arid State of Piauí, Northeastern Brazil



gests that farmers value nature not only for the resources it provides but also for its cultural and emotional benefits. Regulatory ES such as climate, rain, temperature, soil, and rivers are related to the idea of environmental regulation (Figure 3).

Discussion

Our results indicate that farmers are aware of, and can identify, the four categories of ES: provision, support, culture, and regulation. However, the most mentioned ES were provision and culture. This is consistent with studies carried out in rural Nigeria in semi-arid savannah and rainforest environments, which found that farmers are collectively aware of a wide range of ES: culture, biofuels, freshwater, species used in natural medicine, and wildlife (Zhang et al., 2016).

Similarly, in the semi-arid regions of Ghana, farmers perceive a wide range of supply and availability of provisioning ES, such as edible wild fruits and vegetables, building materials, fish, game, and medicinal plants. However, these farmers perceive that these ES have decreased significantly over the last decade. This decline in the supply and availability of ES has resulted in increased livelihood insecurity, leading to a deterioration in the well-being of the inhabitants (Aniah et al., 2024b). As in our study, the relevance of nature for food production and the provision of firewood are highly valued services. In poor communities in semi-arid regions, the seasonal variation in water availability shapes crop dynamics and influences environmental perceptions.

In addition to the ES provisioning being the most reported by farmers in the communities studied, they are also the most important. Farmers gave the highest scores to medicinal plants, water use, collecting fruit in the wild (extractivism), observing animals in the wild, and soil, the latter being directly related to food production.

Farmers along a rural gradient in the Iberian Peninsula also attributed greater relevance to provisioning services, besides attributing a higher value of importance compared to the urban population, who ranked regulating services (Martín-López et al., 2012) or cultural services (Fagerholm et al., 2019) as the most significant. This result may also be related to farmers' deep experiential knowledge, motivating them to manage these ES directly and indirectly (Teixeira et al., 2018). In addition, the provisioning services cited and most valued are part of the daily lives of farmers in the communi-

ties studied, being important sources of income and food.

In our study, cultural ES were given much greater relevance by farmers, as they were for farmers in Northeastern Pará in Brazil (Almeida et al., 2023), the Catalan Pyrenees of Northeastern Spain (Calvet-Mir et al., 2012), and the semi-arid Murcia region in Spain (Martínez-Paz et al., 2022), and for urban and rural dwellers in the state of Paraíba, Brazil (Osório de Sousa et al., 2024). Sociocultural factors, gender, level of education, and nature-based hobbies can better explain the variability in the perception of the importance of ES (Kross et al., 2018; Maas et al., 2021). In our study, income and gender seem to be key differentiators in perception of ES.

Socio-economic profile can be an influential factor in the perception of cultural services. Often, contact with nature is the only (or most affordable) leisure option for lower-income populations, as in the case of the communities in this study. Communities with low or very-low incomes tend to make more use of natural and free spaces for leisure and fun. Dryland ecosystems offer a variety of distinctive cultural ES, such as aesthetic values, recreation and tourism, knowledge and education, sense of place, and spiritual and religious values (Palacio-Prieto et al., 2016).

Attributing importance to cultural services may also be directly related to the gender of the farmers, since in our study 86% of the interviewees were women, and women tend to value provisioning services and cultural services more than men (Paudyal et al., 2018; Zoderer, 2016). This aspect is also reflected in the valuation of seeds, as illustrated in Figure 1. Women play a fundamental role in the conservation and storage of seeds, using traditional knowledge that supports food security and the preservation of agrobiodiversity (Ramirez-Santos et al., 2023). It is pertinent to note that cultural services tend to be neglected, while provisioning ES are considered priority services in decision-making by the agencies responsible for development, regulation, defining public policies, and promoting professional restoration (Milcu et al., 2013). However, cultural services should be seen as one of the fundamental services for farmers since they value activities in nature.

Farmers perceived fewer regulatory services and even fewer support services, and also attributed less significance to insects. In Northeastern Pará, Brazil, farmers also attributed little importance to insects (Almeida et al., 2023), while those in semi-arid regions and tropical forests in Nigeria were largely unaware of the beneficial services provided by insects, such as pollinators and natural enemies, due to their low level of education (Zhang et al., 2016).

Our results are likely related to the level of education. There is a lack of technical assistance for farmers in the communities, and 78% of the interviewees had not completed primary school. Studies indicate that farmers with higher education tend to attribute significantly greater importance to biodiversity and ES compared to those with only primary education (Maas et al., 2021), and 98% had not received rural technical assistance. The Brazilian Northeast is the region that most lacks technical assistance for family farmers (IBGE/SIDRA, 2019).

Generally speaking, farmers see nature as a valuable element that connects different types of ES. In interviews, the term "nature" is always connected to the services identified and was repeated a large number of times. This is in line with several studies that suggest that smallholder farmers value nature (Burgess et al., 2000; Guillem & Barnes, 2013; Harrison et al., 1998; Stupak et al., 2019).

However, studies in Europe (Estonia, Transylvania, England, Romania, Switzerland, Spain, and Portugal) also show contrasting opinions among farmers about the value of biodiversity and nature. Some view nature as a provider of ES that can be used as a tool to increase productivity and guarantee food security. Others perceive biodiversity as an inherent and universal value of nature, ecosystems, and all living species regardless of their usefulness to humans (Klebl et al., 2024).

Perceptions are varied, and influence by the local reality. In the semi-arid region described in this study, nature is seen as a significant source of resources and a place of well-being. Although farmers perceived a smaller number of regulating ES, terms such as rainfall, temperature, and soil are interconnected.

Farmers seem to identify rainfall as a factor in regulating the temperature and quality of the soil, which can be reflected in the quality of food production. Farmers practicing rainfed agriculture in semi-arid regions of India also identify rainfall as an important element in food production, since without rainfall, food production would be largely impacted by reductions in crop yields, decreased soil fertility and biodiversity, and a high frequency of drought events (Singh et al., 2023).

Farmers in the Fornos and Pau D'Arco communities in the semi-arid region of Piauí identify nature as a provider of essential services; however, they do not see nature only as a path or source for economic gain, but also as a source of well-being and leisure. Many studies state that economic interests are not the only determinants of farmers' behavior (Burton et al., 2008; Hammes et al., 2016; Schenk et al., 2007; Siebert et al., 2006). Thus, a study in Germany suggests that their understanding of nature and its protection is important at all stages of the producer's reasoning about adopting nature protection measures (Stupak et al., 2019). In this sense, knowing how farmers perceive and value services can help define management strategies and public policies for this segment.

Considerations for Community-Based Food Systems Research, Policy, and Practice

Our data showed that farmers have broad perceptions of various ES, recognizing and valuing services in all categories but with a greater emphasis on provision and culture. Understanding these perceptions is fundamental and should be reflected in public policy decisions and/or in the community's own local decision-making, underpinning immediate relief measures with long-term sustainable solutions. In order to improve farmers' understanding of their perception of ES in the region studied, we present three recommendations:

- Implement of effective public policies to improve farmers' quality of life that are based on provisioning and cultural services;
- Carry out research to understand in more detail how farmers deal with regulatory services, which they tend to know less about, and what actions they use to cope with climate change; and
- Provide environmental education on these topics to adults and children to help change perceptions and raise awareness of ES, such as the relevance of insects for agriculture or the importance of forests for climate regulation and water availability.
- Encourage public policies that recognize the conservation of creole seeds a term that refers to traditional, locally adapted seeds saved and exchanged by farmers across generations a common practice among farmers in the region, aligning it with Brazil's Nationally Determined Contributions (NDCs) to strengthen climate resilience and conserve agrobiodiversity.

Conclusion

Our results partially corroborated our hypothesis, which predicted that family farmers would perceive provisioning ES more frequently, viewing rainwater as the main water source for food production and landscape modification.

Although provisioning services were the most frequently mentioned and most important to farmers, it is worth noting the great significance farmers attached to cultural services. Nature was a central element in all food production and leisure activities, demonstrating that they were closely connected to nature. Farmers needed support and more information about the importance of biodiversity in general so that they value the role of insects more and even see other forms of sustainable management, such as the use of insects for biological control. In addition, natural areas can be better cared for and maintained so that they are more accessible leisure areas that the population can use.

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References

Allen, I. E., & Seaman, C. A. (2007). *Likert scales and data analyses*. *Quality Progress, 40*(7), 64–65. Recuperado de https://www.bayviewanalytics.com/reports/asq/likert-scales-and-data-analyses.pdf

Almeida, Á. S., Ferreira, J. N., & Coudel, E. S. (2023). Percepção de serviços ecossistêmicos por agricultores familiares no município de Irituia/PA, Amazônia oriental: subsídios para a restauração florestal [Perception of ecosystem services by family farmers in the municipality of Irituia/PA, Eastern Amazon: Subsidies for forest restoration]. *Desenvolvimento e Meio Ambiente*, *62*, 1423–1438. https://doi.org/10.5380/dma.v62i0.84539

Aniah, P., & Bawakyillenuo, S. (2024). Gender vulnerability and coping strategies to changing provisioning ecosystem services in Bongo and Kassena-Nankana West districts in the Upper East Region of Ghana. *Environment*, *29*(11), 1421–1435. https://doi.org/10.1080/13549839.2024.2391041

Arias-Arévalo, P., Gómez-Baggethun, E., Martín-López, B., & Pérez-Rincón, M. (2018). Widening the evaluative space for ecosystem services: A taxonomy of plural values and valuation methods. *Environmental Values*, *27*(1), 29–53. https://doi.org/10.3197/096327118X15144698637513

Benoit, K., Watanabe, K., Wang, H., Nulty, P., Obeng, A., Müller, S., & Matsuo, A. (2018, October 6). quanteda: An R package for the quantitative analysis of textual data. *The Journal of Open Source Software*, *3*(30), Article 774. https://doi.org/10.21105/joss.00774

Bommarco, R., Kleijn, D., & Potts, S. G. (2013). Ecological intensification: Harnessing ecosystem services for food security. *Trends in Ecology & Evolution*, *28*(4), 230–238. https://doi.org/10.1016/j.tree.2012.10.012

Brunson, J. C. (2020). ggalluvial: Layered grammar for alluvial plots. *The Journal of Open Source Software*, *5*(49), Article 2017. https://doi.org/10.21105/joss.02017

Burgess, J., Clark, J., & Harrison, C. M. (2000) Knowledges in action: An actor network analysis of a wetland agri-environment scheme. *Ecological Economics*, *35*(1), 119–132. https://doi.org/10.1016/S0921-8009(00)00172-5

Burton, R. J. F., Kuczera, C., & Schwarz, G. (2008). Exploring farmers' cultural resistance to voluntary agri-environmental schemes. *Sociologia Ruralis*, *48*(1), 16–37. https://doi.org/10.1111/j.1467-9523.2008.00452.x

Calvet-Mir, L., Gómez-Baggethun, E., & Reyes-García, V. (2012). Beyond food production: Ecosystem services provided by home gardens. A case study in Vall Fosca, Catalan Pyrenees, Northeastern Spain. *Ecological Economics*, *74*, 153–160. https://doi.org/10.1016/j.ecolecon.2011.12.011

Costa, T. L. da S. R., Mazzochini, G. G., Oliveira-Filho, A. T., Ganade, G., Carvalho, A. R., & Manhães, A. P. (2021). Priority areas for restoring ecosystem services to enhance human well-being in a dry forest. *Restoration Ecology, 29*(7), e13426. https://doi.org/10.1111/rec.13426

Csárdi, G., Nepusz, T., Müller, K., Horvát, S., Traag, V., Zanini, F., & Noom, D. (2020). igraph for R: R interface of the igraph library for graph theory and network analysis (Version 2.1.4) [Software]. *Zenodo*. https://doi.org/10.5281/zenodo.14736815

da Silva, J. M. C., Leal, I. R., & Tabarelli, M. (Eds.). (2017). *Caatinga: The largest tropical dry forest region in South America*. Springer. https://link.springer.com/book/10.1007/978-3-319-68339-3

de Sousa, M. N. B., de Sousa Júnior, J. R., de Freitas Lins Neto, E., & Monteiro, J. M. (2025). Characterization of useful plants cultivated in productive homegardens in a rural community in the semi-arid region of northeastern Brazil. *Agroforestry Systems*, *99*, Article 22. https://doi.org/10.1007/s10457-024-01122-3

Díaz, S., Settele, J., Brondízio, E. S., Ngo, H. T., Agard, J., Almut Arneth, P. B., Brauman, K. A., Butchart, S. H. M., Chan, K. M. A., Garibaldi, L. A., Ichii, K., Liu, J., Subramanian, S. M., Midgley, G. F., Miloslavich, P., Molnár, Z., Obura, D., Pfaff, A., Polasky, S., . . . Zayas, C. N. (2019). Pervasive human-driven decline of life on Earth points to the need for transformative change. *Science*, *366*(6471), Article 1327. https://doi.org/10.1126/science.aax3100

Dominati, E., Patterson, M., & Mackay, A. (2010). A framework for classifying and quantifying the natural capital and ecosystem services of soils. *Ecological Economics*, *69*(9), 1858–1868. https://doi.org/10.1016/j.ecolecon.2010.05.002

Fagerholm, N., Käyhkö, N., Ndumbaro, F., & Khamis, M. (2012). Community stakeholders' knowledge in landscape assessments—Mapping indicators for landscape services. *Ecological Indicators*, *18*, 421–433. https://doi.org/10.1016/j.ecolind.2011.12.004

Fagerholm, N., Torralba, M., Moreno, G., Girardello, M., Herzog, F., Aviron, S., Burgess, P., Crous-Durán, J., Ferreiro-Domínguez, N., Graves, A., Hartel, T., Măcicăsan, V., Kay, S., Pantera, A., Varga, A., & Plieninger, T. (2019). Cross-site analysis of perceived ecosystem service benefits in multifunctional landscapes. *Global Environmental Change*, *56*, 134–147. https://doi.org/10.1016/j.gloenvcha.2019.04.002

Fang, X., Ghazali, S., Azadi, H., Skominas, R., & Scheffran, J. (2024). Agricultural land conversion and ecosystem services loss: A meta-analysis. *Environment, Development and Sustainability*, *26*(9), 23215–23243. https://doi.org/10.1007/s10668-023-03597-z

Giansanti, R. (1998). *O desafio do desenvolvimento sustentável* [The challenge of sustainable development] (6ª ed.). Atual.

Gliessman, S. R. (2001). *Agroecologia: processos ecológicos em agricultura sustentável* [Agroecology: ecological processes in sustainable agriculture] (2ª ed.). Editora da Universidade/UFRGS.

Guillem, E. E., & Barnes, A. (2013). Farmer perceptions of bird conservation and farming management at a catchment level. *Land Use Policy*, *31*, 565–575. https://doi.org/10.1016/j.landusepol.2012.09.002

Hammes, V., Eggers, M., Isselstein, J., & Kayser, M. (2016). The attitude of grassland farmers towards nature conservation and agri-environment measures—A survey-based analysis. *Land Use Policy*, *59*, 528–535. https://doi.org/10.1016/j.landusepol.2016.09.023

Harrison, C. M., Burgess, J., & Clark, J. (1998). Discounted knowledges: Farmers' and residents' understandings of nature conservation goals and policies. *Journal of Environmental Management*, *54*(4), 305–320. https://doi.org/10.1006/jema.1998.0242

International Fund for Agricultural Development (IFAD). (2020). *Agroecological logbooks and women from the semiarid holding hands and strengthening agroecology: Results of the use of logbooks in the projects supported by IFAD in Brazil from August 2019 to February 2020*. IFAD. https://ctazm.org.br/bibliotecas/agroecological-logbooks-and-women-the-semiarid-362.pdf

IBGE. (2019). *Censo Agropecuário 2017: Resultados definitivos*. Instituto Brasileiro de Geografia e Estatística. https://sidra.ibge.gov.br/pesquisa/censo-agropecuario/censo-agropecuario-2017

Jacomine, P. K. T., Cavalcanti, A. C., Pessoa, S. C. P., Burgos, N., Mélo Filho, H. F. R., Lopes, O. F., & Medeiros, L. A. R. (1986). *Levantamento exploratório-reconhecimento de solos do Estado do Piauí* [Exploratory soil survey of the State of Piauí] (Technical report No. 36) [Open Access]. EMBRAPA-SNLCS/SUDENE-DRN. http://www.infoteca.cnptia.embrapa.br/infoteca/handle/doc/336097

Kehoe , L., Romero-Muñoz, A., Polaina, E., Estes, L., Kreft, H., & Kuemmerle, T. (2017). Biodiversity at risk under future cropland expansion and intensification. *Nature Ecology & Evolution*, *1*(8), 1129–1135. https://doi.org/10.1038/s41559-017-0234

Klebl, F., Feindt, P. H., & Piorr, A. (2024). Farmers' behavioural determinants of on-farm biodiversity management in Europe: A systematic review. *Agriculture and Human Values*, *41*, 831–861. https://doi.org/10.1007/s10460-023-10505-8

Kross, S. M., Ingram, K. P., Long, R. F., & Niles, M. T. (2018). Farmer perceptions and behaviors related to wildlife and on-farm conservation actions. *Conservation Letters*, *11*(1), Article e12364. https://doi.org/10.1111/conl.12364

Küchen, L., Schmitt, T. M., Riebl, R., Hänsel, M., Steinbauer, M. J., Fricke, U., Redlich, S., & Koellner, T. (2023). Where and why is landscape considered valuable? Societal actors' perceptions of ecosystem services across Bavaria (Germany). *Ecosystems and People*, *19*(1), Article 2192813. https://doi.org/10.1080/26395916.2023.2192813

Leroy, D., & Barrasa García, S. (2021). Which ecosystem services are truly integrated into local culture? Farmers' perceptions of the Colombian and Venezuelan Páramos. *Human Ecology*, *49*, 385–401. https://doi.org/10.1007/s10745-021-00251-y

Maas, B., Fabian, Y., Kross, S. M., & Richter, A. (2021). Divergent farmer and scientist perceptions of agricultural biodiversity, ecosystem services and decision-making. *Biological Conservation*, *256*, Article 109065. https://doi.org/10.1016/j.biocon.2021.109065

Mainar de Medeiros, R., Tavares, A. L., Kassar, C. B., da Silva, J. A. S., & da Silva, V. P. R. (2012). Metodologias de cálculo da temperatura média diária do ar: Aplicação para os municípios de Parnaíba, Picos e Gilbués, PI [Methodologies for calculating average daily air temperature: Application to the municipalities of Parnaíba, Picos and Gilbués, PI]. *Revista Brasileira de Agricultura Irrigada*, 6(4), 283–295. https://doi.org/10.7127/rbai.v6n400093

Marengo, J. A., Alves, L. M., Beserra, E. A., & Lacerda, F. F. (2011). Variability and climate change in the Brazilian semi-arid region. In R. G. Santos, & F. G. Araújo (Eds.), *Water resources in arid and semi-arid regions* (pp. 385–422). Campina Grande: National Institute for the Semi-Arid Region.

Marengo, J. A., Torres, R. R., & Alves, L. M. (2017). Drought in Northeast Brazil—Past, present, and future. *Theoretical and Applied Climatology*, *129*, 1189–1200. https://doi.org/10.1007/s00704-016-1840-8

Martín-López, B., Iniesta-Arandia, I., García-Llorente, M., Palomo, I., Casado-Arzuaga, I., Del Amo, D. G., Gómez-Baggethun, E., Oteros-Rozas, E., Palacios-Agundez, I., Willaarts, B., González, J. A., Santos-Martín, F., Onaindia, M., López-Santiago, C., & Montes, C. (2012). Uncovering ecosystem service bundles through social preferences. *PLoS ONE*, *7*(6), Article e38970. https://doi.org/10.1371/journal.pone.0038970

Martínez-Paz, J. M., Albaladejo-García, J. A., & Alcon, F. (2022). When cultural services and biodiversity matter most: Gaining a deeper insight into badlands ecosystem services preferences. *Land Degradation & Development*, *34*(2), 545–557. https://doi.org/10.1002/ldr.4478

Milcu, A. I., Hanspach, J., Abson, D., & Fischer, J. (2013). Cultural ecosystem services: A literature review and prospects for future research. *Ecology and Society*, *18*(3), Article 44. https://doi.org/10.5751/ES-05790-180344

Millennium Ecosystem Assessment [MA]. (2005). *Ecosystems and human well-being: Synthesis*. Island Press. https://www.millenniumassessment.org/documents/document.356.aspx.pdf

Miller, E. F., Doolittle, A. A., Cerutti, P. O., Naimark, J., Rufino, M. C., Ashton, M. S., & Mwangi, E. (2021). Spatial distribution and perceived drivers of provisioning service values across an East African montane forest landscape. *Landscape and Urban Planning*, *207*, Article 103995. https://doi.org/10.1016/j.landurbplan.2020.103995

Muhamad, D., Okubo, S., Harashina, K., Parikesit, Gunawan, B., & Takeuchi, K. (2014). Living close to forests enhances people's perception of ecosystem services in a forest–agricultural landscape of West Java, Indonesia. *Ecosystem Services*, *8*, 197–206. https://doi.org/10.1016/j.ecoser.2014.04.003

Osório de Sousa, L. M., Barbosa de Melo, D., Marques Rocha Ferreira, L., & Molozzi, J. (2024). The rural and urban community perceptions of ecosystem goods and services in the semi-arid reservoirs landscape. *Ethnobiology and Conservation*, *13*, Article e18. https://doi.org/10.15451/ec2024-07-13.18-1-11

Palacio-Prieto, J. L., Rosado-González, E., Ramírez-Miguel, X. (2016). Erosion, culture and geoheritage: The case of Santo Domingo Yanhuitlán, Oaxaca, México. *Geoheritage, 8*(4), 359–369. https://doi.org/10.1007/s12371-016-0175-2

Paudyal, K., Baral, H., & Keenan, R. J. (2018). Assessing social values of ecosystem services in the Phewa Lake Watershed, Nepal. *Forest Policy and Economics*, *90*, 67–81. https://doi.org/10.1016/j.forpol.2018.01.011

Pennington, R. T., Lavin, M., & Oliveira-Filho, A. (2009). Woody plant diversity, evolution, and ecology in the tropics: Perspectives from seasonally dry tropical forests. *Annual Review of Ecology, Evolution, and Systematics*, *40*, 437–457. https://doi.org/10.1146/annurev.ecolsys.110308.120327

Prado, D. E. (2003). As caatingas da América do Sul [The caatingas of South America]. In I. Leal, M. Tabarelli, & J. M. C. Silva (Eds.), *Ecologia e conservação da caatinga* [Ecology and conservation of the caatinga] (pp. 3–73). Editora Universitária da UFPE. Retrieved from https://www.researchgate.net/publication/252321916_As_caatingas_da_America_do_Sul

Ramirez-Santos, A. G., Ravera, F., Rivera-Ferre, M. G., & Calvet-Nogués, M. (2023). Gendered traditional agroecological knowledge in agri-food systems: A systematic review. *Journal of Ethnobiology and Ethnomedicine*, *19*, Article 11. https://doi.org/10.1186/s13002-023-00576-6

Rito, K. F., Arroyo-Rodríguez, V., Queiroz, R. T., Leal, I. R., & Tabarelli, M. (2017). A precipitação medeia o efeito da perturbação antrópica na vegetação da Caatinga brasileira [Precipitation mediates the effect of human disturbance on the Brazilian Caatinga vegetation]. *Journal of Ecology*, *105*(3), 828–838. https://doi.org/10.1111/1365-2745.12712

Schenk, A., Hunziker, M., & Kienast, F. (2007). Factors influencing the acceptance of nature conservation measures—A qualitative study in Switzerland. *Journal of Environmental Management*, *83*(1), 66–79. https://doi.org/10.1016/j.jenvman.2006.01.010

Siebert, R., Toogood, M., & Knierim, A. (2006). Factors affecting European farmers' participation in biodiversity policies. *Sociologia Ruralis*, *46*(4), 318–340. https://doi.org/10.1111/j.1467-9523.2006.00420.x

Singh, N. P., Ranjith, P. C., Anand, B., & Kavitha, K. (2023). Comparative assessment of farmers' perceptions on climate change: Experiences from semi-arid tropics of India. *Indian Journal of Traditional Knowledge*, *22*(4), 854–863. https://or.niscpr.res.in/index.php/IJTK/article/view/7241

Stupak, N., Sanders, J., & Heinrich, B. (2019). The role of farmers' understanding of nature in shaping their uptake of nature protection measures. *Ecological Economics*, *157*, 301–311. https://doi.org/10.1016/j.ecolecon.2018.11.022

Stallman, H. R. (2011). Ecosystem services in agriculture: Determining suitability for provision by collective management. *Ecological Economics*, *71*, 131–139. https://doi.org/10.1016/j.ecolecon.2011.08.016

Summers, J. K., & Smith, L. M. (2014). The role of social and intergenerational equity in making changes in human well-being sustainable. *Ambio: A Journal of the Human Environment*, *43*, 718–728. https://doi.org/10.1007/s13280-013-0483-6

Teixeira, H. M., Vermue, A. J., Cardoso, I. M., Peña Claros, M., & Bianchi, F. J. J. A. (2018). Farmers show complex and contrasting perceptions on ecosystem services and their management. *Ecosystem Services*, *33*(Part A), 44–58. https://doi.org/10.1016/j.ecoser.2018.08.006

Wang, B., Tang, H., & Xu, Y. (2017). Integrating ecosystem services and human well-being into management practices: Insights from a mountain-basin area, China. *Ecosystem Services*, *27*(Part A), 58–69. https://doi.org/10.1016/j.ecoser.2017.07.018

Wickham, H. (2016). *ggplot2: Elegant graphics for data analysis* (2nd ed.). Springer. https://doi.org/10.1007/978-3-319-24277-4

Zhang, W., Kato, E., Bhandary, P., Nkonya, E., Ibrahim, H. I., Agbonlahor, M., Ibrahim, H. Y., & Cox, C. (2016). Awareness and perceptions of ecosystem services in relation to land use types: Evidence from rural communities in Nigeria. *Ecosystem Services*, *22*(Part A), 150–160. https://doi.org/10.1016/j.ecoser.2016.10.011

Zhang, W., Ricketts, T. H., Kremen, C., Carney, K., & Swinton, S. M. (2007). Ecosystem services and dis-services to agriculture. *Ecological Economics*, *64*(2), 253–260. https://doi.org/10.1016/j.ecolecon.2007.02.024

Zoderer, B. M., Tasser, E., Erb, K.-H., Stanghellini, P. S. L., & Tappeiner, U. (2016). Identifying and mapping the tourists' perception of cultural ecosystem services: A case study from an Alpine region. *Land Use Policy*, *56*, 251–261. https://doi.org/10.1016/j.landusepol.2016.05.004

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Farm-to-institution in the Southwest: An evaluation of the New Mexico Grown Meat Pilot Program

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Abstract

The 2022 New Mexico legislative session introduced meat products (beef, bison, pork, and lamb/mutton) to New Mexico (NM) Grown, the state local food procurement program, and led to the development of the Meat Pilot Program (MPP). Implemented in fiscal year (FY) 2023, the MPP allowed 148 NM Grown buyers (primary and secondary [K–12] schools, early childhood and

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senior centers, and food banks) to purchase local meat products from 28 New Mexico-based suppliers (producers, processors, food hubs, and distributors) to provide to priority populations. Given the lack of research on meat-to-institution programs, a cross-sectional exploratory study was conducted to examine MPP participation, successes and barriers, and perceived impacts from the perspectives of buyers, suppliers, and stakeholders. Twenty-eight individuals representing 39 buyers (26%) and 14 meat suppliers (50%) completed a survey; 11 buyers, suppliers, and stakeholders participated in an interview or focus group. Most suppliers and buyers were satisfied with the MPP (92% and 85%, respectively) and 100% indicated they would participate again. Most buyers agreed the MPP gave ranchers and suppliers an important economic opportunity (100%) and improved recipients' diet and meal quality (89%). Qualitative data further indicated satisfaction with culturally relevant meats and yielded suggestions such as providing more supplier information to buyers, expanding marketing and outreach to engage eligible suppliers that did not participate, and organizing meetings and networking events to connect participating organizations and build community and trust. The MPP provided an important economic opportunity for New Mexico meat operations such as small-scale family farms and ranches, producer cooperatives, local food hubs, and small and midsize processors to access new local markets. The MPP was also well received by NM Grown buyers. Additional research on meat-to-institution initiatives is needed to fully understand the impacts of connecting suppliers providing culturally relevant sources of high-quality protein to priority populations.

Keywords
farm to institution, meat supply chain, meat value chain, food systems, local food, food industry, diet quality, food security, agriculture, institutional food procurement, New Mexico

Introduction

As the prevalence of food insecurity rises across the U.S., disproportionately affecting underserved population groups (Rabbitt et al., 2023; Rabbitt et al., 2024), local food systems are becoming increasingly important (Garrity et al., 2024). Integrating local food and food products into institutional foodservice, referred to as "farm-to-institution," is an important component of what is referred to as values-based procurement (Campbell, 2023; Harris et al., 2012), particularly in rural states like New Mexico, located in the Southwest region of the U.S. Local institutional procurement can potentially address population-level food and nutrition insecurity while also supporting local food producers and thus benefiting the economy (Becot et al., 2017; Harris et al., 2012). These benefits may include creating markets for small and midsize operations, shortening food supply chains, and promoting fairer prices (Jia et al., 2024).

As of 2025, all U.S. states have signed with the U.S. Department of Agriculture (USDA) Local Food Purchase Assistance Cooperative Agreements (LFPA) for food bank purchasing, and 42 states have signed Local Food for Schools Cooperative Agreements (LFS) for school purchasing (USDA Agricultural Marketing Service [USDA AMS], n.d.-a, n.d.-b). These agreements allow procurement and distribution of local foods and beverages to food banks and schools. Nationally, preschools, senior-serving institutions, food banks, and healthcare organizations also participate in farm-to-institution initiatives. This study reviews the farm-to-institution literature, focusing on "meat-to-institution," and describes New Mexico's farm-to-institution program, New Mexico Grown (NM Grown), and the results of an exploratory study of a new NM Grown meat-to-institution initiative, the Meat Pilot Program (MPP).

Literature Review

This literature review summarizes research on farm-to-institution programs in various settings in the U.S. and emphasizes the significant gap in evidence on meat-to-institution initiatives.

Farm-to-School

Research on farm-to-institution programs in the U.S. largely focuses on K–12 schools (Avuwadah & Kropp, 2022; Bontrager Yoder et al., 2014; Galloway et al., 2023; Garrity et al., 2024; Harris et al., 2012; Joshi et al., 2008; Long et al., 2021; Mishra et al., 2022; Prescott et al., 2020; Thomson

et al., 2024). A 2022 literature review found farm-to-school programs support nutrition education for children and also economically and socially benefit local communities (Mishra et al., 2022). According to the 2023 Farm to School Census, 81% of U.S. schools in the 2022–2023 school year participated in at least one farm-to-school activity, which include local food procurement, school gardens, field trips, farm tours, and cooking classes (Machata et al., 2024). Of these schools, 63% served local foods to students, spending $1.8 billion[1] on local purchasing, about 16% of total food spending. Most schools participating in farm-to-school activities report an increase in fruit and vegetable consumption in school meals (61%) and better access to higher quality foods (57%) (Machata et al., 2024). Peer-reviewed studies also suggest that farm-to-school programs increase students' food and nutrition-related knowledge and willingness to try fruits and vegetables; however, impacts on fruit and vegetable consumption, number of meals served, and student participation in meal programs are less clear (Avuwadah & Kropp, 2022; Bontrager Yoder et al., 2014; Prescott et al., 2020).

Importantly, key farm-to-school stakeholders are interested in participating in farm-to-school and note benefits, including stakeholders such as school foodservice authorities (SFA), foodservice directors and staff (Izumi, Alaimo et al., 2010; Pinard et al., 2013; Smith et al., 2013; Thomson et al., 2024), and producers (Izumi, Wynne Wright et al., 2010; Pinard et al., 2013; Thomson et al., 2022). School foodservice staff are motivated to participate by student preferences, good prices, and supporting local farmers (Izumi, Alaimo et al., 2010). Staff are also receptive to receiving training on preparing and serving local foods as part of farm-to-school programs (Smith et al., 2013). Differences in perceived benefits may vary by school size, with larger schools in the Midwest being more likely to indicate the "ability to know product sources" as a benefit than smaller schools (Smith et al., 2013, p. 154). Producers are also motivated to participate in farm-to-school, with fruit and vegetable farmers in the Mid-Atlantic region noting positive social and economic impacts and opportunities (Lehnerd et al., 2018) and farmers from the Midwest and Northeast reporting market diversification and contributing to social benefits through direct action as primary motivators (Izumi, Wynne Wright et al., 2010).

As well as benefits, however, farm-to-school can present barriers for schools and producers alike. The 2023 Farm-to-School Census found SFAs participating in farm-to-school activities report unavailability and cost of local foods as barriers (Machata et al., 2024). Throughout the literature, schools further note lack of relationships with farmers, food safety regulations, cost of labor, and storage and equipment as barriers (Pinard et al., 2013; Roche & Kolodinsky, 2011; Thomson et al., 2024), which may be more pronounced for smaller schools (Pinard et al., 2013). Producers also report as primary farm-to-school barriers lack of relationships with schools and difficulties providing product during the entire school year, providing adequate volume of products, and providing the most competitive price (Pinard et al., 2013; Thomson et al., 2022). Differences in producer and buyer approaches to food production and handling may underlie many barriers (Janssen, 2014).

Farm-to-Other Institutions

There is less research on farm-to-institution programs in non-K–12 settings. A 2012 national survey found that farm-to-preschool programs operate in at least 39 states and that the most common farm-to-preschool activities are education about locally grown foods and serving meals and snacks with local food (Hoffman et al., 2017). Less than half of the 502 preschools represented in the survey were supported through external funds, which could account for lower participation in farm-to-institution activities among early childhood centers compared to K–12 schools (Colasanti & Matts, 2013). Indeed, another study found that just over one-third (37%) of early care and education providers in Colorado participate in local food procurement (McCloskey et al., 2020).

Sociodemographic factors may play a role in farm-to-institution participation rates. A 2015 national survey of early care and education

[1] All amounts in this article are in U.S. dollars.

providers found sites serving a high proportion of low-income children were less likely to participate in farm-to-institution programs compared to those serving a low proportion, despite similar motivators and barriers (Stephens & Oberholtzer, 2020); however, low-income-serving sites spent a higher percentage of total food budgets on local foods. A report by the City University of New York (CUNY) Urban Food Policy Institute presents barriers and facilitators to local and regional food procurement at senior centers, early childhood centers, and food banks in Central Brooklyn and provides recommendations on funding, outreach, training, and evaluation (Ames et al., 2019). Otherwise, there is a lack of published research on farmto-preschool and senior-serving institutions.

Research is similarly sparse for food bank and pantry settings. A 2011 national survey of 115 food banks and similar organizations found produce obtained directly from local farmers and gardens accounts for a small proportion of total food distributed (Vitiello et al., 2015). Despite the small contribution, food bank staff are motivated to implement local agriculture programs due to perceived increases in local poverty and food insecurity and desire to provide healthier options to clients. Farmers are also motivated to participate in farm-to-food bank, citing social responsibility and financial and marketing benefits (Haynes Stein & Brinkley, 2023).

Meat-to-Institution

Across settings, farm-to-institution research focuses almost exclusively on produce and grains, leaving a significant gap in the evidence on meat products. Our literature review identified just one study, of an Alaskan "fish to school" program that significantly increased fish intake and diet quality among middle and high school students (Bersamin et al., 2019). Other meat-to-institution evidence is limited to national and state reports, which mainly present participation rates and protein purchasing data. The 2019 Farm to School Census, for example, found 24% of participating schools purchased some form of locally raised protein (meat, poultry, fish, eggs, nuts) (Bobronnikov, 2021). As of 2023, beef and poultry rank third and fourth among local items that SFAs spend the most on (Machata et al., 2024).

Two case studies on beef-to-school programs in South Dakota and Montana round out the meat-to-institution evidence base. About one-third (34%) of SFAs in South Dakota participated in a Beef to School program, spending an average of $9,577 per SFA in the 2023–2024 school year (Dunn et al., 2024). Schools that did not participate were larger operations with more locations. In Montana, of the 40% of schools participating in farm-to-school, 47% source local meat products (Byker Shanks et al., 2019). The Montana case study emphasizes the importance of starting small, addressing cost barriers, building processing facility capacity, and engaging community partnerships in meat-to-institution efforts. In summary, preliminary meat-to-institution evidence does suggest institutions, at least K–12 schools, appear to be interested in purchasing local meat, warranting additional research.

Farm-to-Institution in New Mexico

NM Grown was introduced through the New Mexico Grown Fresh Fruits and Vegetables for School Meals legislation in 2014, connecting New Mexico food producers to K–12 schools. The program has since expanded to include senior centers in 2018, early childhood education centers in 2021, and food banks in 2023. NM Grown is now the state's largest local food procurement program and has been an integral component of the governor's Food Initiative since 2022 (Office of the Governor Michelle Lujan Grisham, 2023).

NM Grown provides resources to state agencies and food banks to purchase locally produced food from New Mexican farmers and ranchers, food producers, food hubs, and distributors that meet Approved Supplier requirements (New Mexico Grown, 2024). The New Mexico Farmers' Marketing Association (NMFMA) administers the Approved Supplier program. The NMFMA also maintains a publicly available list of all Approved Suppliers and Buyers, and hosts events to connect NM Grown participants. Food purchased through NM Grown serves children in early childhood education centers, students in K–12 schools, elders at senior centers, and clients at food banks. Program

marketing materials state that "Suppliers can expect competitive prices" and "You set the price; buyers will do their best to meet your needs." NM Grown therefore rewards New Mexico farmers, ranchers, and other food producers with fair prices for products supplied. NM Grown funding has historically been provided through the state and a LFPA cooperative agreement program, the Regional Farm to Food Bank.

New Mexico's investment in local food procurement emphasizes the overall importance of agriculture and the state's traditional agriculture economy which is rooted in local and indigenous knowledge and practices, strong connection with the land, and support of ecological balance. The food and agriculture sector represented 253,529 jobs and generated $12.92 billion in total wages in 2023 (Feeding the Economy, 2025). Livestock is a large piece of the food and agriculture sector; the value of livestock production alone was $3.09 billion in 2023, a slight increase from previous years (Whitcotton et al., 2024). Small-scale livestock operations are crucial, as almost 60% of agricultural operations in New Mexico are less than 100 acres and 95% of the state's 24,700 farms and ranches are family-owned (New, 2023; USDA National Agricultural Statistics Service, 2022).

New Mexico Grown Meat Pilot Program

During the 2022 legislative session, New Mexico–based meat products were added to NM Grown, including beef, pork, bison, and lamb/mutton. The NMFMA collaborated with the New Mexico Department of Agriculture (NMDA) and other key stakeholders to develop and implement the FY23 Meat Pilot Program (MPP), which ran July 1, 2022–June 30, 2023, to officially introduce meat products to NM Grown. The MPP goal was to provide an opportunity for interested New Mexico-based meat suppliers to sell locally produced meat products to NM Grown buyers to provide locally raised sources of high-quality protein to priority recipient populations.

Meat Pilot Program approved suppliers

To recruit suppliers, the NMFMA directly emailed approximately 50 New Mexico–based producers, processors, ranchers, and food hubs; posted general MPP information to their distribution list of 1,140 recipients; and distributed information via industry groups and non-profit organizations that work with livestock producers (New Mexico Acequia Association, New Mexico Beef Council, Southwest Grassfed Livestock Alliance) and the Regional Farm to Food Bank pilot program. Interested suppliers submitted applications on a rolling basis throughout the pilot year to become Approved Suppliers of NM Grown meat products.

Twenty-eight meat suppliers met Approved Supplier requirements, outlined in Appendix A, and participated in the MPP (Table 1). Over half of participating suppliers (54%) were located in rural

Table 1. Characteristics of Approved Suppliers that Participated in the FY23 Meat Pilot Program (MPP) (*N* = 28)

	n (%)[a]	Offered beef *n* (%)	Offered lamb/ mutton *n* (%)	Offered pork *n* (%)	Offered bison *n* (%)	Disadvantaged[b] *n* (%)	Rural *n* (%)
All Suppliers	28 (100)	26 (93)	11 (39)	5 (18)	4 (14)	11 (39)	15 (54)
Producers	14 (50)	13 (93)	3 (21)	2 (14)	0 (0)	7 (50)	8 (57)
Producer collectives	2 (7)	2 (100)	0 (0)	0 (0)	0 (0)	1 (50)	1 (50)
Processors	6 (21)	5 (83)	4 (67)	1 (17)	2 (33)	3 (50)	5 (83)
Food hubs[c]	5 (18)	5 (100)	2 (40)	1 (20)	0 (0)	1 (20)	2 (40)
Distributors	3 (11)	2 (67)	3 (100)	1 (33)	2 (67)	1 (33)	1 (33)

[a] Suppliers could choose more than one option when indicating operation type.
[b] Self-identified as Socially Disadvantaged in Approved Supplier application.
[c] A food hub was defined as a centrally located facility with a business management structure facilitating the aggregation, storage, processing, distributions, and/or marketing of locally/regionally produced food products.

counties and 39% self-identified as socially disadvantaged, defined by the USDA as

> a farmer or rancher who is a member of a socially disadvantaged group. A 'Socially Disadvantaged Group' is a group whose members have been subject to discrimination on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Code of Federal Regulations Title 7, 2024, bullet [l])

In terms of product availability, most suppliers applied to sell beef (93%) while fewer applied to sell lamb/mutton (39%), pork (18%), and/or bison (14%).

Table 2 shows the geographic location of MPP Approved Suppliers. Most were in Northern (43%) or Central New Mexico (36%). No meat suppliers were in Southern New Mexico and just two were in Northwestern New Mexico.

Meat Pilot Program buyers

There were 148 NM Grown buyers in FY23 (Table 3). Most were in Central (32%) or Northern New Mexico (26%). Nearly half (46%) of buyers were in rural counties. Twenty-eight buyers were in Southern New Mexico, although there were no meat suppliers in this region of the state.

In FY23, $1.62 million was allocated for NM Grown local food purchases across three state administering agencies (K–12, early childhood, senior affairs) and one central food bank. Administering agencies distributed NM Grown funding to individual schools, early childhood education, and senior centers that could spend up to approximately 40% on meat purchases. Food banks did not have a limit on the amount eligible for meat purchases. According to data provided to the research team, senior centers spent $234,840 and food banks spent $166,528 on meat during the MPP. Meat purchasing data for K–12 schools and early childhood centers were unavailable, but an estimated amount spent by these buyers is

Table 2. Geographic Location of Approved Suppliers that Participated in the MPP (*N* = 28)

	n (%)	Central NM	Northern NM	Northwest NM	Eastern NM	Southern NM	AZ[a]
All Suppliers	28 (100)	10 (36)	12 (43)	2 (7)	3 (11)	0 (0)	1 (4)
Producers	14 (50)	4 (29)	7 (50)	1 (7)	2 (14)	0 (0)	0 (0)
Producer collectives	2 (7)	1 (50)	1 (50)	0 (0)	0 (0)	0 (0)	0 (0)
Processors	6 (21)	1 (17)	4 (67)	0 (0)	1 (17)	0 (0)	0 (0)
Food hubs	5 (18)	2 (40)	1 (20)	1 (20)	0 (0)	0 (0)	1 (20)
Distributors	3 (11)	2 (67)	1 (33)	0 (0)	0 (0)	0 (0)	0 (0)

[a] One Arizona (AZ)-based food hub met NM Grown Approved Supplier criteria and participated in the MPP

Table 3. Type and Geographic Location of FY23 NM Grown Buyers (*N* = 148)

	n (%)	Central	Northern	Northwest	Eastern	Southern	Multiple
All Buyers	148 (100)	47 (32)	39 (26)	18 (12)	14 (9)	28 (19)	2 (1)
K–12 schools	58 (39)	16 (28)	18 (31)	8 (14)	7 (12)	9 (16)	0 (0)
Early childhood centers	33 (22)	17 (52)	6 (18)	3 (9)	3 (9)	3 (9)	1 (3)
Senior centers	56 (38)	14 (25)	15 (27)	7 (13)	4 (7)	16 (29)	0 (0)
Food banks[a]	1 (0.7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (100)

[a] One food bank makes NM Grown purchases and distributes to five regional food banks.

$320,000–$380,000. Based on outreach to individual buyers, approximately 72% of NM Grown buyers purchased meat products during the MPP.

New Mexico Grown FY23 Meat Pilot Program Evaluation

Because of the gaps in knowledge of farm-to-institution programs, particularly meat-to-institution, and the motive to expand the MPP, the NMFMA and a team of researchers partnered to evaluate the FY23 MPP. This exploratory study aimed to 1) evaluate the MPP to understand successes, barriers, and impacts on recipients from the perspective of meat suppliers, buyers, and other stakeholders, and 2) contribute to the emerging meat-to-institution literature.

Applied Research Methods

An exploratory cross-sectional study was conducted in New Mexico in fall 2023, consisting of surveys, one-on-one interviews, and focus groups. The research team and the NMFMA co-designed the research and evaluation framework, data collection methods, and data collection instruments. The University of New Mexico Health Sciences Center Human Research Review Committee reviewed and approved this study as exempt research (HRRC# 23-387).

Study Participants and Recruitment

Survey participants included MPP Buyers and Approved Suppliers. Interviews and focus groups included MPP Buyers, Approved Suppliers, and stakeholders at administering and other agencies.

Survey Participants: Buyers and Suppliers

Buyers and Approved Suppliers that sold any meat products during the MPP were eligible to participate in the study survey. Individual eligibility criteria included being at least 18 years of age and involvement in their organization or operation's participation in the MPP for at least six months during FY23 (July 2022–June 2023).

The NMFMA provided information for 151 individuals representing 148 buyers and 28 suppliers for recruitment. Some individuals represented multiple buyers, primarily senior centers. Study surveys were administered through REDCap, an online survey platform approved for research. All suppliers and buyers received individual survey links and reminders via email October 23–November 17, 2023. If emails bounced back, the NMFMA provided alternative or updated contacts or contacted organizations directly. Participants first read a consent form and provided consent to participate by starting the survey. After assessing eligibility criteria, ineligible participants were redirected, and eligible participants completed the survey on behalf of their organization or operation. Participants could provide an email address at the end of the survey to enter to win one of two $50 merchandise cards.

Interview and Focus Group Participants: Buyers, Suppliers, and Key Stakeholders

The NMFMA identified 11 individuals directly involved in NM Grown at administering and other agencies to recruit for interviews and focus groups. Fourteen buyers and suppliers also expressed interest in interview or focus group participation while completing the survey. These 25 individuals were contacted by email and phone and could choose to participate in an individual interview or a focus group.

Data Collection Methods

Data were collected through surveys, one-on-one interviews, and focus groups, described here.

Buyer and Supplier Surveys

Two original surveys were developed through an iterative process to collect data from MPP suppliers and NM Grown buyers. The NMFMA provided 22 documents (e.g., NM Grown and MPP background and recruitment information, supplier applications, reports) to guide survey development; drafts were discussed extensively in team meetings. Buyer and supplier surveys included closed- and open-ended questions and took approximately 20 minutes to complete. Survey questions assessed buyers' and suppliers' type and location, meat products purchased or sold during the MPP, satisfaction with MPP components, agreement with program impacts, and interest in future participation (see Appendix B). Respondents were not required to answer all

questions in order to promote participation and limit burden.

Interviews and Focus Groups

Three members of the research team conducted five virtual 30-minute semi-structured interviews and two virtual 60-minute focus groups in October and November 2023. All interviews and focus groups were conducted in English and audio recorded. The research team and the NMFMA co-developed interview and focus group guides focusing on participants' roles and satisfaction with the MPP and perceptions of outreach and recruitment; technical assistance and support; and overall effectiveness, successes, outcomes, and barriers. Interviewers took notes during interviews. Interviewees received a $30 merchandise card and focus group participants received a $50 merchandise card.

Data Management and Analysis

At the end of the data collection period, survey data were downloaded, cleaned, and analyzed using Statistical Analysis Software (SAS) Version 9.4. Not all survey questions were required, and incomplete responses are included in this analysis. For Likert scale questions, Strongly Agree and Agree were combined to Agree and Strongly Disagree and Disagree were combined to Disagree. Similarly, Very Satisfied and Satisfied were combined to Satisfied and Very Dissatisfied and Dissatisfied were combined to "Dissatisfied." Descriptive statistics—mean (*M*) and standard deviation (SD) for continuous variables, frequency (n) and percentage (%) for categorical variables—were calculated for survey responses and examined by supplier type (producer, processor, or "other," which included food hubs, producer collectives, and distributors) and buyer type (K–12, early childhood, senior center, food bank).

Stakeholder Interviews and Focus Groups

Individual interviews and focus groups were transcribed verbatim using Trint software. The research team first reviewed transcripts to familiarize themselves with the data. Inductive content analysis was performed to identify themes and concepts for each question. A codebook was created after initial data familiarization and was revised in an iterative process throughout coding. Using NVivo, a primary coder coded all interviews and focus groups and a secondary coder coded approximately 20% of the data; coder agreement was assessed by Cohen's kappa (≥ 0.80, indicating reliable coding).

Results

Of the 151 individuals representing 148 buyers and 28 suppliers contacted, 66 (44%) consented to participate in the survey. Twenty-four (36%) were not eligible based on screening questions, largely due to not being involved in their organization's or operation's MPP participation for at least six months. After completing screening questions, 42 complete or partial responses were received from 28 individuals representing 39 buyers and 14 suppliers, yielding response rates of 26% and 50%, respectively.

Of the 25 potential stakeholders, five participated in an interview and six participated in one of two focus groups (response rate = 44%). Interview and focus group participants represented suppliers, buyers, and other key stakeholders. Fourteen did not respond to recruitment attempts.

Supplier Results

Fourteen (50%) of the 28 Approved Supplier meat vendors participating in the MPP completed a survey. Most were producers (n = 9, 64%), processors (n = 5, 36%), or food hubs (n = 5, 36%). Four distributors and two producer collectives also participated. Six of the nine producers (67%) identified as socially disadvantaged.

Figure 1 shows the types of meat products sold by MPP suppliers that completed a survey. All suppliers sold beef and frozen meat products (100%) and most sold grass-fed or grass-finished (64%) and hormone-free meat products (57%) during the MPP. No suppliers that responded to the survey sold bison or USDA-certified organic meat products.

Figure 2 shows meat suppliers' satisfaction with components of the MPP. More than half were satisfied with all components evaluated. All that responded to these questions (n = 13, 100%) were satisfied with their knowledge of expectations and requirements for participating in the MPP and the Approved Supplier application process. Some sup-

pliers were dissatisfied with the amount of product sold (23%), ability to find interested buyers (15%), and ease of doing business with meat buyers (15%).

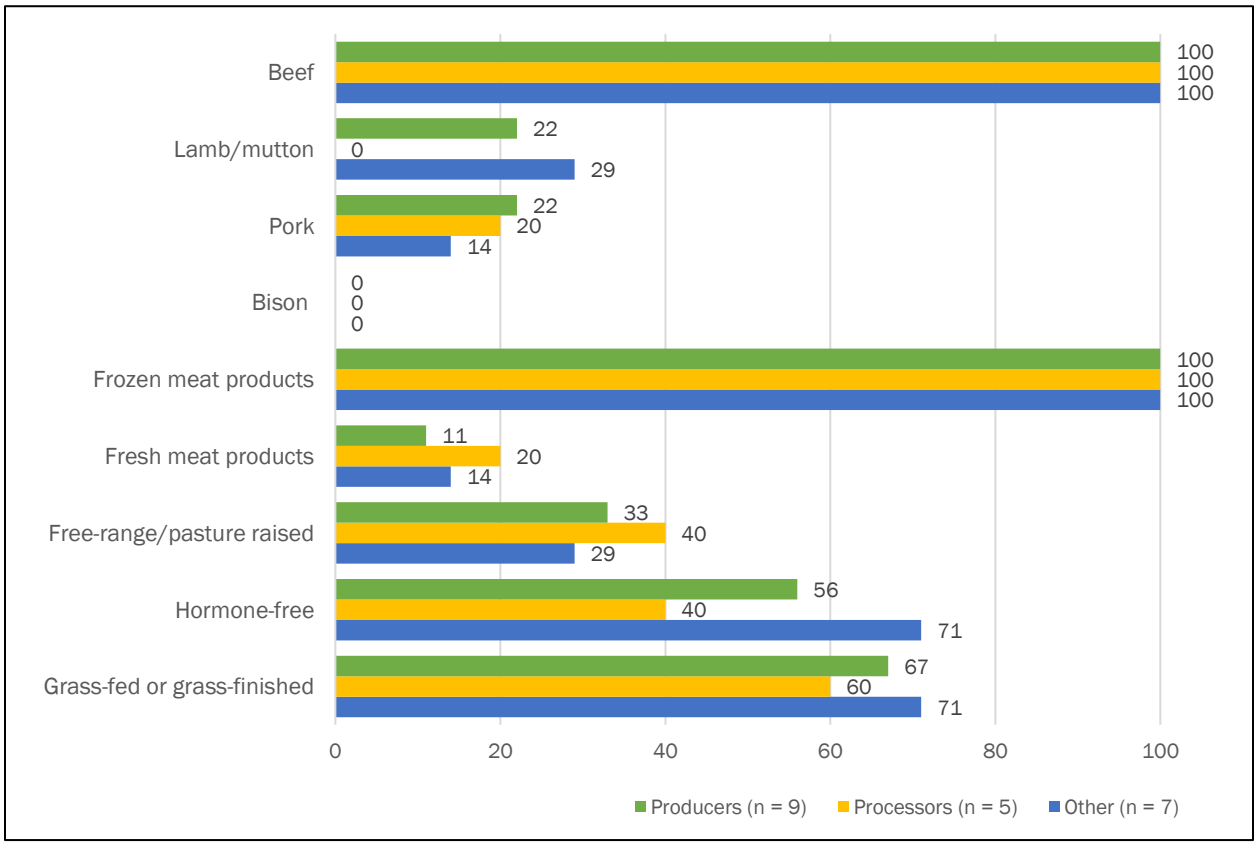
Twelve suppliers rated their ability to respond to buyer requests during the MPP (data not shown). Most reported that requests for packaging of meat products (75%) and volume of meat products (67%) were easy or very easy to respond to. Most were neutral on their ability to respond to the volume of products buyers actually purchased (58%). Importantly, 92% of suppliers were satisfied with their overall experience participating in the MPP and 100% indicated they would participate in the future.

Three MPP suppliers participated in an interview or focus group. Suppliers discussed successes related to opportunities for expanding local markets and connecting with buyers, and for potential impact on local food security and the economy. Suppliers noted that the MPP offered an opportunity for a special group of New Mexico ranchers to sell clean, healthy, thoughtfully grown beef and other meat products to new, local markets. Suppliers reported the MPP has the potential to impact the local economy by expanding the local market through sustainable and responsible practices, illustrated by the following remark:

> The concept of the Program is something we heavily believe in and support. [Redacted] is made up of small New Mexico ranches that produce beef in the most environmentally friendly, humane, and clean manner possible. We would like to see this Program continue and grow on a long-term basis.

Suppliers also explained that the MPP offered an opportunity to improve food security in their communities, which was a motivating factor to participate. As one supplier said, "Our operation as a

Figure 1. Percent (%) of MPP-Approved Supplier Survey Respondents (*n* = 14) that Reported Selling Each Meat Product Type



[redacted] facility is to expand market opportunities for local ranchers and provide locally produced food to the food insecure residents in the communities we serve."

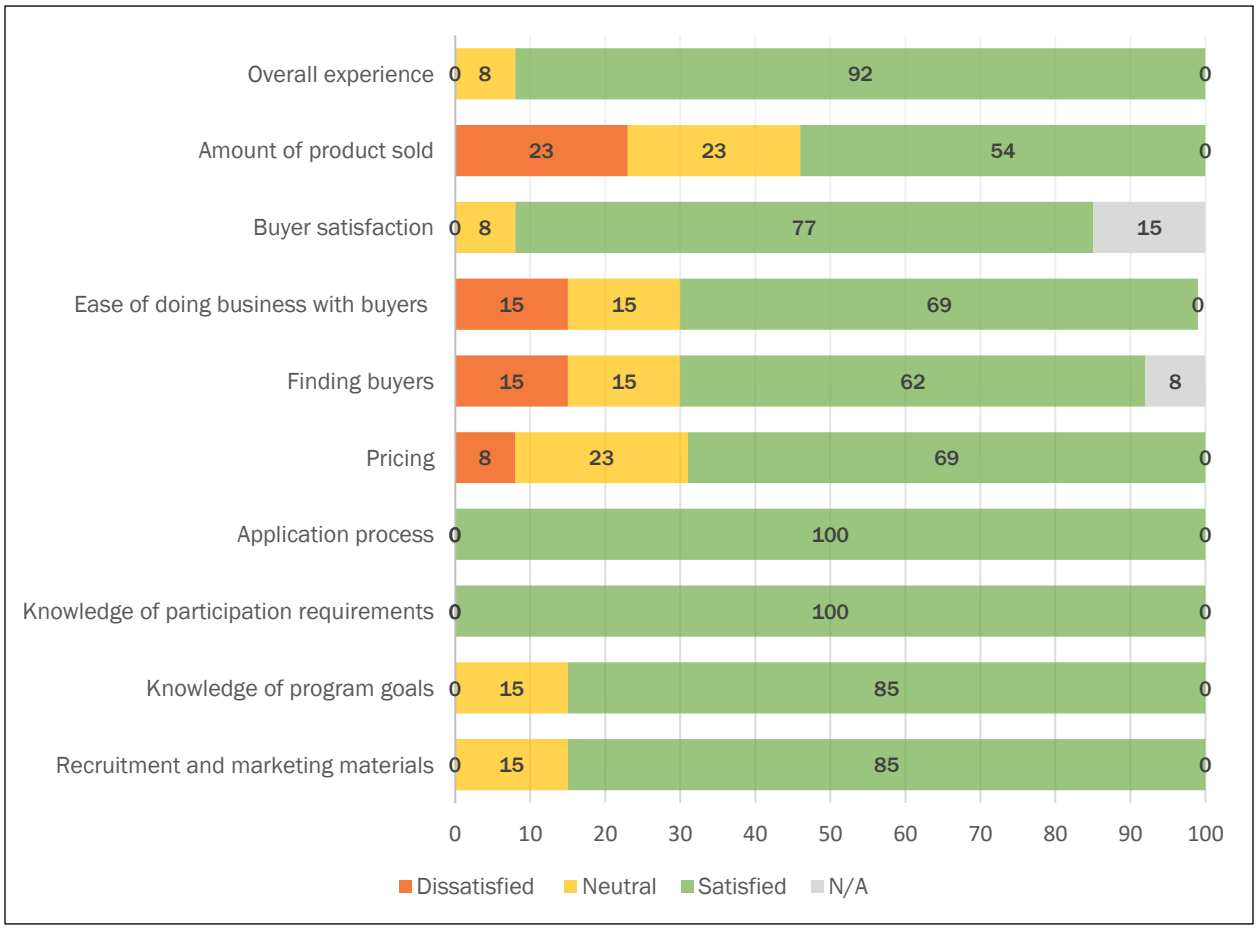
Suppliers discussed barriers related to order fulfillment logistics and buyer demand. For example, individual suppliers may not be equipped to meet buyer requests for significant amounts of product (e.g., 5,000–10,000 pounds). One supplier stated that "people requesting fresh meat products and not understanding liability/transportation/storage issues with fresh products for small producers [was challenging]." Suppliers also explained that buyer requests for large volumes of specific cuts (e.g., steaks, roasts) were difficult to fulfill compared to selling a whole or half animal. Suggestions for improvement were related to expanding the pool of buyers and providing them with more complete information about supplier capacity.

Suppliers also discussed how their expectations for significantly expanding into new markets were not met. Recommendations for expansion included access to more buyers, with particular attention to overcoming barriers in rural locations. One participant suggested: "Understanding the challenges and needs of rural communities and locations. Identifying the suppliers that are willing to provide and distribute meat products to rural locations." Educating buyers on suppliers' capacity was also suggested (e.g., "communication with buyers of what we can provide") to facilitate more realistic and fulfillable requests. Suppliers also suggested expanding the MPP but acknowledged practical challenges related to growth.

Buyer Results

Twenty-eight (28) individuals representing 39 FY23 NM Grown buyers completed a survey (response

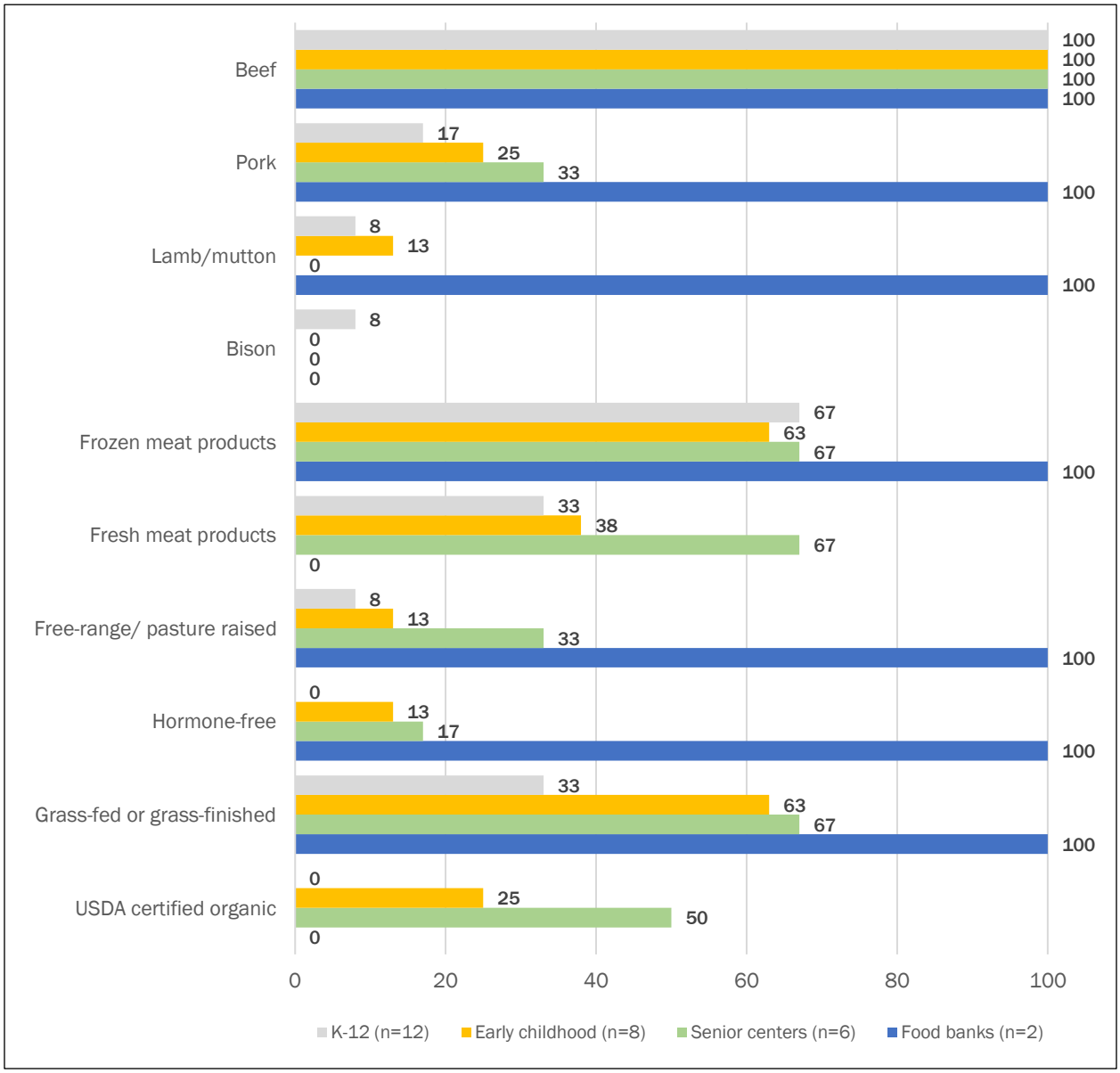
Figure 2. Approved Supplier Survey Respondents' (*n* = 13) Satisfaction (%) with Components of the MPP



rate = 26%). Twelve K–12 schools (response rate = 21%), eight early childhood education centers (response rate = 24%), six individuals representing 17 senior centers (response rate = 30%), and two individuals representing one food bank (response rate = 100%) completed surveys. Most identified as individual buyers purchasing meat products to distribute directly to clients (79%), and fewer identified as collective buyers (21%), purchasing meat products to provide to other locations/centers to distribute. On average, buyers spent more than one-third (34%) of their NM Grown grant allocation for local purchasing of meat products during the MPP. This amount varied greatly, ranging 0%–80%.

All buyers that completed a survey purchased beef (100%); fewer purchased pork (29%), lamb/mutton (14%), and bison (4%) (Figure 3). The majority purchased frozen (68%) and grass-fed or grass-finished meat products (54%). Fewer pur-

Figure 3. Percent (%) of NM Grown Buyer Survey Respondents (*n* = 28) that Reported Purchasing Each Meat Product Type



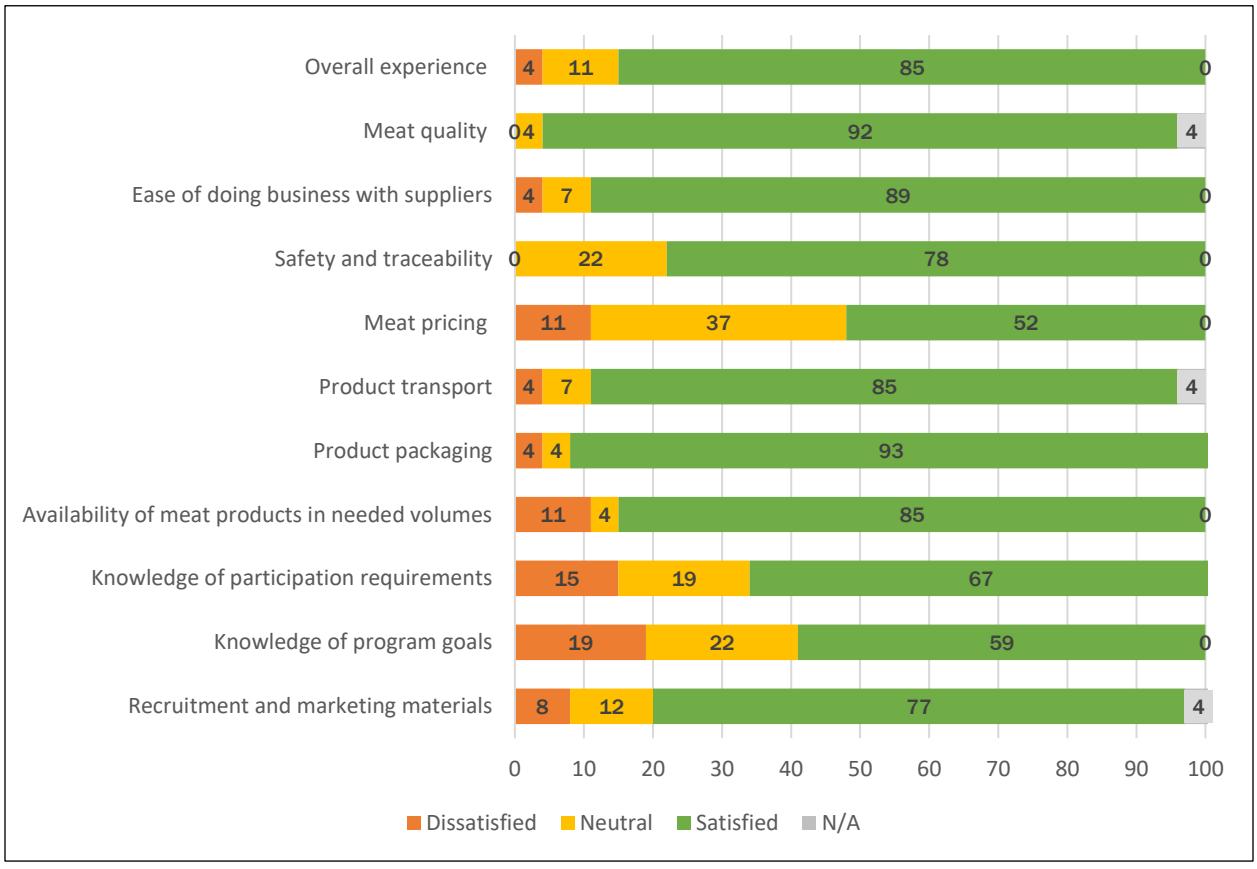
chased USDA-certified organic (18%) or hormone-free products (14%).

Figure 4 shows buyers' satisfaction with MPP components. At least 50% of buyers were satisfied with all components except technical assistance and support received from the NMFMA (44% satisfied) or the NMDA (30% satisfied) (data not shown). Satisfaction was highest for packaging of meat products (93%) and meat quality (92%) while dissatisfaction was highest for knowledge of MPP goals (19%) and knowledge of participation requirements (15%).

Buyers agreed that the MPP impacted recipients and local ranchers and meat suppliers. All who responded to this question (n = 27, 100%) agreed the MPP provided ranchers and other meat suppliers an important economic opportunity, 96% agreed recipients were satisfied with products, 89% agreed the MPP improved recipient diet and meal quality, and 78% agreed the MPP improved recipient food security status (data not shown). Overall, 100% of buyers who completed a survey indicated they would purchase meat products through NM Grown in the future.

Five NM Grown buyers participated in an interview or focus group. They reported successes related to the quality and types of meat provided to them, impacts on their meal programs, broader community-level impacts, and a positive experience working with suppliers. Overall, buyers remarked that the quantity and quality of beef available through the MPP was outstanding. Buyers described interest in continuing to purchase NM Grown meats due to the high quality of meat and due to the opportunity to provide locally sourced meats to the community. As one buyer stated, "Yes, we love serving healthy, locally sourced meats to our clients and we love supporting our local New Mexico farmers and ranchers! We believe it results in healthier communities and contributes to a more resilient food system." Another stakeholder said, "See, talk to some of the, say for

Figure 4. NM Grown Buyers' (n = 28) Satisfaction (%) with Components of the MPP



example, the seniors, and they know when it's not in New Mexico. They know when it's New Mexico carrots. They know when it's New Mexico beef. They taste the difference, and they appreciate the value of it."

Providing nutrient-dense foods to consumers aligned with buyers' motivation for participating in the MPP. Buyers explained the value of offering nutritious foods to the vulnerable populations, such as children, that they serve. Regarding meat types, beef was noted as the greatest success. The inclusion of culturally relevant meat products such as bison and mutton was appreciated, with desire for more bison. Buyers from schools mentioned that students loved trying new types of meat like brisket and roasts, and that staff enjoyed the meals as well. Some schools used creative strategies like "Nuevo Thursdays" to highlight new menu items. Buyers even reported that the MPP contributed to increased participation in senior and K–12 meal programs. One buyer stated, "Participation in our senior meals program has increased 25% since we started to use NM Grown products."

Buyers also noted that the MPP benefitted local agriculture and the local economy; one buyer further discussed the urgency for agricultural transformation: "I think that has helped to make agriculture sexy again, and that's what we got to get it to. Because as much as [redacted] alluded to, we have a small window of opportunity to change the catastrophic agricultural problem that is brewing."

Buyers offered suggestions for MPP improvement involving needs for additional administrative support (e.g., submitting for reimbursement) and more opportunities to foster personal connections with vendors. One participant said, "I'd really like some events where we can meet the farmers and build relationships with them. I'd love for them to be able to show their product and us to get food samples." Additional information about Approved Suppliers, such as proximity and location, delivery, and product details (e.g., type, fat content), was also sought in order to streamline the procurement process and promote transparency regarding traceability of products, nutrient content, and confidence in food safety. Buyers also explained that they would appreciate more meat supplier options and that many ranchers, producers, and processors are currently missing from the Approved Supplier list.

Logistical issues such as needing to drive to pick up items ordered in cases where suppliers were not close posed barriers for some buyers. School-specific barriers were related to financial and physical resources, with schools suggesting allowing more than 40% of their NM Grown budget to be spent on meat, and reporting having to struggle to purchase items 1–2 months in advance, requiring advanced planning. Storage space (e.g., freezers) was also a barrier to ordering large quantities.

Discussion

This study evaluated meat suppliers, buyers, and other stakeholders' participation in and perspectives on the FY23 MPP, which introduced meat products to New Mexico's statewide local food procurement program, NM Grown. Fourteen MPP Approved Suppliers (50%) participated in the study survey, representing producers, processors, food hubs, and distributors selling beef, pork, and lamb/mutton. Just 26% of NM Grown buyers were represented in the study survey, potentially due to high turnover in foodservice staff, timing of the survey in early fall which is a busy time for schools and other participating institutions, and competing responsibilities. Despite their low participation rate, buyers represented all types (K–12, early childhood education, senior centers, food banks) and perceptions of the MPP were largely positive, particularly packing and quality of meat products and ease of doing business with suppliers. Suppliers' perceptions of the MPP were also positive, but several were dissatisfied with the amount of product sold, pricing, and ability to find interested buyers. Differences in buyer and supplier perceptions of the MPP are important to consider in NM Grown improvement efforts, and by other meat-to-institution programs, to ensure supplier expectations and needs are met.

New Mexico is a unique, largely rural state with a high proportion of socially disadvantaged producers, and our results align with other published research on farm-to-institution and meat-to-institution programs. A 2024 systematic review found that facilitators for local food system approaches

and programs among low-income populations include health-promoting environments, community cohesion, financial incentives, and high-quality produce (Garrity et al., 2024). Social marketing and dynamic nutrition education were also tied to positive changes in diet quality and fruit and vegetable intake among multimodal short value chain intervention participants. Social marketing strategies such as promotional activities, printed recipes, and newsletters increase awareness of and engagement in local food programs. Nutrition education complements seasonal local food provision and may further enhance positive outcomes of short value chain interventions related to knowledge, skills, and diet quality. Our study similarly found that community connections, positive perceived impact on recipients and communities, and high-quality products were important components of the MPP and were primary motivators for buyers and suppliers to participate.

In this study, buyers affirmed recipients' satisfaction with products and there were positive economic benefits for producers, results consistent with previous studies (Becot et al., 2017; Izumi, Alaimo et al., 2010; Izumi, Wynne Wright et al., 2010). A qualitative study of school foodservice professionals found primary motivators for buying locally grown food to be expressed in the statements "The students like it," "The price is right," and "We're helping our local farmers" (Izumi, Alaimo et al., 2010). Economic benefits noted by MPP buyers and suppliers align with modest economic impacts of farm-to-school programs (Becot et al., 2017); however, more research is needed to demonstrate the effects on the economy of comprehensive local food procurement, especially meat-to-institution. Participants in this study also valued new connections formed between New Mexico meat producers and local institutions, and the opportunity for expanded markets for local meat producers.

Buyer motivations for participating in the MPP were not directly captured in surveys, but interview and focus group results show that supporting local ranchers, adding diverse and culturally relevant meat to menus, and improving the nutritional quality of meals were primary motivators across settings. Similar benefits were reported by South Dakota's Beef to School program participants, including better quality foods; increased positive perceptions of school nutrition programs among parents, school staff, students, and the community; lower school meal program costs; and increased consumption of school meals (Dunn et al., 2024). A case study of Montana's Beef-to-School project also found high quality products, community partnerships, food literacy, and enhancing local identity were important motivators for schools to participate (Byker Shanks et al., 2019).

Motivators for participating in farm-to-institution programs may vary by setting, as described in our literature review. Early childhood center staff report that attending or receiving training and having a dietitian on staff are important facilitators to local purchasing, while senior center staff claim primary motivators include staff training, administrative support, nutrition education for clients, access to a dietitian, and positive relationships with food producers (Ames et al., 2019). Our results are consistent with these findings, further emphasizing the importance of cultural relevance, expanding markets, and improving diet quality and food security, important insights for meat-to-institution programs in other rural or underserved regions.

Buyers and suppliers acknowledged a variety of MPP barriers in this study, including administrative burdens of participating, difficulties connecting with suppliers or buyers, and potential difficulties producing the volume of product requested by larger institutions like school districts, exacerbated by inadequate meat processor capacity. These barriers resemble those reported in the farm-to-institution literature, including lack of program awareness and limited accessibility (Garrity et al., 2024). Indeed, few early childhood facilities were found to participate in local food procurement in Colorado due to barriers such as time, cost, and knowledge (McCloskey et al., 2020), and, in New York, due to high food costs and delivery barriers (Ames et al., 2019). School food service directors in Mississippi report that few K–12 schools purchase local foods directly from farmers, and that lack of connection with local producers is a barrier (Thomson et al., 2024). Senior center staff note the inability of centers to meet order minimums required by local food producers as a primary bar-

rier in New York City (Ames et al., 2019), while food pantry representatives, rather than food flowing through a larger food bank, prefer more frequent fresh food delivery directly from local growers, which is a barrier as it may not always be an option (Huang et al., 2023).

In further insights into meat-to-institution program barriers, the South Dakota Beef to School survey found lack of storage, limited slaughter facilities, and difficulty finding local producers and processors were barriers experienced by participating schools (Dunn et al., 2024). Three schools that participated in a case study of Montana's Beef-to-School project cited higher costs, limitations of processors in providing products required by schools that may have inadequate kitchens or training on utilizing local products, school size and meal participation, and supply chain logistics and product availability as key barriers (Byker Shanks et al., 2019).

To alleviate barriers, meat-to-institution programs should ensure reimbursement and/or purchasing incentives are high enough to discourage increases in total food costs associated with purchasing local foods (Long et al., 2021). Providing resources and support for tracking and reporting purchasing data for buyers and suppliers and emphasizing flexibility and innovation in programming may decrease barriers associated with purchasing from small-scale local producers (Whitehouse et al., 2025), as is common in New Mexico. Assessing and aligning producer and buyer values is critical to ensure program success (Janssen, 2014), as well as considering creative evaluation methods that promote engagement and empowerment (Inwood et al., 2023).

Limitations

Recruitment of survey, interview, and focus group participants was a barrier in this study. Participants received incentives, but the survey response rate was low for buyers in particular. Low buyer response rates may reflect high turnover among food procurement staff, lack of time due to competing responsibilities, and attempting to recruit participants during a very busy time of year. Requiring survey participants to be involved in their organization or operation's MPP participation for at least six months in FY23 led to the disqualification of 14 willing participants. Additionally, no suppliers selling bison and just one buyer purchasing bison during the MPP were represented in surveys. Respondents also were not required to complete all questions, leading to missing data. Therefore, these results are exploratory, reflecting the experiences of some organizations and operations that participated, and may not be generalizable.

Moreover, detailed purchasing data were unavailable for many buyers, limiting the ability to more fully understand the meat pilot marketplace. Suppliers' and buyers' motivations for participating in the MPP were not directly assessed via survey, and while we assessed perceived impacts of the MPP on recipient diet quality and food security, impacts on other outcomes were not examined. Future research must assess short- and long-term impacts of meat-to-institution initiatives on health and wellbeing, alongside in-depth examinations of local economic impacts.

Recommendations

Based on findings from this exploratory study and a review of the literature, NM Grown and other meat-to-institution programs may consider (1) providing comprehensive information about suppliers (vendor location, delivery information, product details, capacity) to buyers and organizing more meetings and networking (in-person and remote) to facilitate community and trust building; (2) offering culturally relevant options and prioritizing the recruitment of small-scale and diverse producers; (3) increasing marketing and outreach strategies to eligible suppliers and further exploring barriers to supplier participation, particularly among socially disadvantaged, smaller-scale, and rural producers that may lack access to the scale-appropriate processing, storage, and infrastructure required to meet buyer needs; (4) ensuring adequate buyer knowledge of the nuances of local meat purchasing as well as resources to meet suppliers' expectations and needs (e.g., funding and assistance meeting program requirements, troubleshooting logistical issues, and accessing to buyers and large-scale processing); (5) providing nutrition education, which has been found to be successful

alongside local food procurement in K–12 school settings (Rains et al., 2019); and (6) collecting and sharing high-quality participation and purchase data to further meat-to-institution knowledge.

Future research should assess the impacts of implementing these participant-driven recommendations on meat-to-institution program participation, barriers, and outcomes, especially during a time of devastating funding cuts to farm-to-institution programs in the U.S.

Conclusions

The FY23 MPP was designed to introduce meat products to NM Grown, connecting New Mexico food producers to K–12 schools, early childhood and senior centers, and food banks. During the MPP, 28 producers, processors, distributors, food hubs, and producer collectives sold local beef, lamb/mutton, pork, and bison to over 100 NM Grown buyers. In turn, buyers served locally raised, culturally relevant and sometimes novel meat products to New Mexico's priority populations. Lessons learned from the NM Grown MPP can inform meat-to-institution initiatives in other rural or culturally diverse regions, particularly those attempting to overcome barriers related to supplier infrastructure, administrative burden, and limited program awareness. This study also reveals a clear gap in the meat-to-institution literature, highlighting the need for additional research.

Acknowledgments

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References

Ames, M., Ilieva, R. T., Rauh, L., Shapiro, S., Wolf, S., Willingham, C., Capers, T., & Freudenberg, N. (2019). *Barriers and facilitators to local and regional food procurement at institutions serving children, seniors, and food insecure families in Central Brooklyn* (Policy Brief). CUNY Urban Food Policy Institute. https://cunyurbanfoodpolicy.org/wp-content/uploads/2022/04/CUFPI-Restoration_Policy_Brief_11.26.19_final.pdf

Avuwadah, B. Y., & Kropp, J. D. (2022). Impact of introducing a farm to school program on the number of school lunches served. *Appetite*, *168*, Article 105741. https://doi.org/10.1016/j.appet.2021.105741

Becot, F., Kolodinsky, J. M., Roche, E., Zipparo, A. E., Berlin, L., Buckwalter, E., & McLaughlin, J. (2017). Do farm-to-school programs create local economic impacts? *Choices*, *32*(1), Article 90014633. https://www.choicesmagazine.org/UserFiles/file/cmsarticle_565.pdf

Bersamin, A., Izumi, B. T., Nu, J., O'Brien D, M., & Paschall, M. (2019). Strengthening adolescents' connection to their traditional food system improves diet quality in remote Alaska Native communities: Results from the Neqa Elicarvigmun Pilot Study. *Translational Behavioral Medicine*, *9*(5), 952–961. https://doi.org/10.1093/tbm/ibz087

Bobronnikov, E., Prenovitz, S., & Yadav, L.M.B. (2021). *2019 Farm to School Census report*. U.S. Department of Agriculture, Food and Nutrition Service. https://fns-prod.azureedge.us/sites/default/files/resource-files/2019-Farm-to-School-Census.pdf

Bontrager Yoder, A. B., Liebhart, J. L., McCarty, D. J., Meinen, A., Schoeller, D., Vargas, C., & LaRowe, T. (2014). Farm to elementary school programming increases access to fruits and vegetables and increases their consumption among those with low intake. *Journal of Nutrition Education and Behavior*, *46*(5), 341–349. https://doi.org/10.1016/j.jneb.2014.04.297

Byker Shanks, C., Bass, T. M., & Schumacher, J. B. (2019). Montana's beef-to-school project: Making connections to enhance local agriculture. In S. E. Thottathil & A. M. Goger (Eds.), *Institutions as conscious food consumers: Leveraging purchasing power to drive systems change* (pp. 195–218). Academic Press. https://doi.org/10.1016/B978-0-12-813617-1.00009-5

Campbell, C. G. (2023). Values-based institutional food procurement programs: A narrative review. *Journal of Agriculture, Food Systems, and Community Development*, *12*(4), 123–133. https://doi.org/10.5304/jafscd.2023.124.005

Code of Federal Regulations Title 7. Agriculture § 7.1291.2 Definitions. (2024). FindLaw. https://codes.findlaw.com/cfr/title-7-agriculture/cfr-sect-7-1291-2/

Colasanti, K., & Matts, C. (2013). *Farm to institution in Michigan: A summary of research on local food purchasing by institutions*. Michigan State University Center for Regional Food Systems. https://www.canr.msu.edu/foodsystems/uploads/files/fti-summary.pdf

Dunn, M., Eidem, K., & He, T. (2024). *South Dakota Beef to School survey report*. South Dakota State University Extension. https://doe.sd.gov/farmtoschool/documents/BeefReport.pdf

Feeding the Economy. (2025). *U.S. food and ag industries: New Mexico*. https://goodstone.guerrillaeconomics.net/reports/b1d7d60a-279f-45a0-94f1-755dbb0b9991

Galloway, C., Devine, S., Parison, J., & Jones, H.-A. (2023). Procurement from local producers for food service in primary and secondary school settings: A scoping review. *Health Promotion Journal of Australia*, *34*(2), 316–327. https://doi.org/10.1002/hpja.618

Garrity, K., Krzyzanowski Guerra, K., Hart, H., Al-Muhanna, K., Kunkler, E. C., Braun, A., Poppe, K. I., Johnson, K., Lazor, E., Liu, Y., & Garner, J. A. (2024). Local food system approaches to address food and nutrition security among low-income populations: A systematic review. *Advances in Nutrition*, *15*(4), Article 100156. https://doi.org/10.1016/j.advnut.2023.100156

Harris, D., Lott, M., Lakins, V., Bowden, B., & Kimmons, J. (2012). Farm to institution: creating access to healthy local and regional foods. *Advances in Nutrition*, *3*(3), 343–349. https://doi.org/10.3945/an.111.001677

Haynes Stein, A., & Brinkley, C. (2023). Farm to food bank: Exploring the ties between local food producers and charitable food assistance. *Rural Sociology*, *88*(3), 682–707. https://doi.org/10.1111/ruso.12489

Hoffman, J. A., Schmidt, E. M., Wirth, C., Johnson, S., Sobell, S. A., Pelissier, K., Harris, D. M., & Izumi, B. T. (2017). Farm to preschool: The state of the research literature and a snapshot of national practice. *Journal of Hunger & Environmental Nutrition*, *12*(4), 443–465. https://doi.org/10.1080/19320248.2016.1227747

Huang, J., Acevedo, S., Bejster, M., Kownacki, C., Kehr, D., McCaffrey, J., & Nguyen, C. J. (2023). Distribution of fresh foods in food pantries: challenges and opportunities in Illinois during the COVID-19 pandemic. *BMC Public Health*, *23*(1), Article 1307. https://doi.org/10.1186/s12889-023-16215-4

Inwood, S., Rumble, J., Meeks, S., & Ryan Haden, V. (2023). Engaging, empowering, and evaluating farm-to-school projects with photovoice. *Journal of Agriculture, Food Systems, and Community Development*, *12*(4), 173–185. https://doi.org/10.5304/jafscd.2023.124.014

Izumi, B. T., Alaimo, K., & Hamm, M. W. (2010). Farm-to-school programs: Perspectives of school food service professionals. *Journal of Nutrition Education and Behavior*, *42*(2), 83–91. https://doi.org/10.1016/j.jneb.2008.09.003

Izumi, B. T., Wynne Wright, D., & Hamm, M. W. (2010). Market diversification and social benefits: Motivations of farmers participating in farm to school programs. *Journal of Rural Studies*, *26*(4), 374–382. https://doi.org/10.1016/j.jrurstud.2010.02.002

Janssen, B. (2014). Bridging the gap between farmers and food service directors: The social challenges in farm to school purchasing. *Journal of Agriculture, Food Systems, and Community Development*, *5*(1), 129–143. https://doi.org/10.5304/jafscd.2014.051.012

Jia, F., Shahzadi, G., Bourlakis, M., & John, A. (2024). Promoting resilient and sustainable food systems: A systematic literature review on short food supply chains. *Journal of Cleaner Production*, *435*, Article 140364. https://doi.org/10.1016/j.jclepro.2023.140364

Joshi, A., Azuma, A. M., & Feenstra, G. (2008). Do farm-to-school programs make a difference? Findings and future research needs. *Journal of Hunger & Environmental Nutrition*, *3*(2–3), 229–246. https://doi.org/10.1080/19320240802244025

Lehnerd, M. E., Sacheck, J. M., Griffin, T. S., Goldberg, J. P., & Cash, S. B. (2018). Farmers' perspectives on the adoption and impacts of nutrition incentive and farm to school programs. *Journal of Agriculture, Food Systems, and Community Development*, *8*(1), 147–165. https://doi.org/10.5304/jafscd.2018.081.012

Long, A. B., Jablonski, B. B. R., Costanigro, M., & Frasier, W. M. (2021). The impact of state farm to school procurement incentives on school purchasing decisions. *Journal of School Health*, *91*(5), 418–427. https://doi.org/10.1111/josh.13013

Machata, N., Jennings, L., Morrison, H., & Boyle, M. (2024). *2023 Farm to school census report*. U.S Department of Agriculture, Food and Nutrition Service. https://fns-prod.azureedge.us/sites/default/files/resource-files/2023FarmToSchoolCensusReport_v3.pdf

McCloskey, M. L., Kesterson, H., Mena, N. Z., Dellaport, J., & Bellows, L. L. (2020). Farm to early care and education programming: A descriptive study of challenges and opportunities to promote healthful foods to young children. *International Journal of Environmental Research and Public Health*, *17*(18), Article 6857. https://doi.org/10.3390/ijerph17186857

Mishra, S. K., Khanal, A. R., & Collins, W. J. (2022). Farm-to-school programmes, benefits, health outcomes and barriers: A structured literature review. *Health Education Journal*, *81*(7), 781–792. https://doi.org/10.1177/00178969221119290

New, J. S. (2023). *Agriculture's impact to NM economy: Opportunities for investment*. New Mexico Department of Agriculture. https://www.nmlegis.gov/handouts/IPOC%20081823%20Item%203%20NMDA--Agriculture's%20Impact%20to%20NM%20Economy%20and%20Opportunities%20for%20Investment.pdf

New Mexico Grown. (2024). *What is New Mexico Grown?* https://newmexicogrown.org/

Office of the Governor Michelle Lujan Grisham. (2023). *The Food, Farm, and Hunger Initiative*. https://newmexicogrown.org/wp-content/uploads/2023/08/FACT-SHEET-Hunger-Initiative_FINAL-002.pdf

Pinard, C. A., Smith, T. M., Carpenter, L. R., Chapman, M., Balluff, M., & Yaroch, A. L. (2013). Stakeholders' interest in and challenges to implementing farm-to-school programs, Douglas County, Nebraska, 2010–2011. *Preventing Chronic Disease*, *10*, Article 130182. https://doi.org/10.5888/pcd10.130182

Prescott, M. P., Cleary, R., Bonanno, A., Costanigro, M., Jablonski, B. B. R., & Long, A. B. (2020). Farm to school activities and student outcomes: A systematic review. *Advances in Nutrition*, *11*(2), 357–374. https://doi.org/10.1093/advances/nmz094

Rabbitt, M. P., Hales, L. J., Michael Burke, P., & Coleman-Jensen, A. (2023). *Household food security in the United States in 2022* (Report No. ERR-325). U.S. Department of Agriculture, Economic Research Service. https://doi.org/10.32747/2023.8134351.ers

Rabbitt, M. P., Reed-Jones, M., Hales, L. L., & Michael Burke, P. (2024). *Household food security in the United States in 2023* (Report No. ERR-337). U.S. Department of Agriculture, Economic Research Service. https://doi.org/10.32747/2024.8583175.ers

Rains, C. B., Giombi, K. C., & Joshi, A. (2019). Farm-to-school education grants reach low-income children and encourage them to learn about fruits and vegetables. *Translational Behavioral Medicine*, *9*(5), 910–921. https://doi.org/10.1093/tbm/ibz092

Smith, S., Wleklinski, D., Roth, S. L., & Tragoudas, U. (2013). Does school size affect interest for purchasing local foods in the midwest? *Childhood Obesity*, *9*(2), 150–156. https://doi.org/10.1089/chi.2012.0055

Stephens, L., & Oberholtzer, L. (2020). Opportunities and challenges for farm to early care and education in settings serving low-income children. *Journal of Hunger & Environmental Nutrition*, *15*(1), 93–106. https://doi.org/10.1080/19320248.2018.1547670

Thomson, J. L., Landry, A. S., & Walls, T. I. (2024). Mississippi school food service directors' interest and experience with local food procurement and farm to school activities. *Health Promotion Practice*, *25*(4), 623–633. https://doi.org/10.1177/15248399231178543

Thomson, J. L., Walls, T. I., & Landry, A. S. (2022). Mississippi farmers' interest in and experience with farm to school. *International Journal of Environmental Research and Public Health*, *19*(13), Article 8025. https://doi.org/10.3390/ijerph19138025

U.S. Department of Agriculture, Agricultural Marketing Service [USDA AMS]. (n.d.-a). *List of signed local food purchase assistance cooperative agreements*. Retrieved April 22, 2025, from https://www.ams.usda.gov/selling-food-to-usda/lfpacap/exec-summaries

USDA AMS. (n.d.-b). *Local Food for Schools Cooperative Agreement Program*. Retrieved April 22, 2025, from https://www.ams.usda.gov/selling-food-to-usda/lfs

USDA National Agricultural Statistics Service [USDA NASS]. (2022). *Table 9. Land in farms, harvested cropland, and irrigated land by size of farms: 2022 and 2017*. https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_1_State_Level/New_Mexico/st35_1_009_010.pdf

Vitiello, D., Grisso, J. A., Whiteside, L. K., & Fischman, R. (2015). From commodity surplus to food justice: Food banks and local agriculture in the United States. *Agriculture and Human Values*, *32*(3), 419–430. https://doi.org/10.1007/s10460-014-9563-x

Whitcotton, M., Bautista, M., & Gustason, K. (2024). *New Mexico agricultural statistics 2023–2024 annual bulletin*. U.S. Department of Agriculture, National Agricultural Statistics Service, Mountain Regional Field Office. https://www.nass.usda.gov/Statistics_by_State/New_Mexico/Publications/Annual_Statistical_Bulletin/2023-2024/2023-2024-NM-Ag-Statistics.pdf

Whitehouse, C., Conner, D., & Moen, A. (2025). Overcoming the "game of pennies": Challenges and opportunities for farm to institution in Vermont. *Journal of Hunger & Environmental Nutrition*. Advance online publication. https://doi.org/10.1080/19320248.2025.2468332

Appendix A. Approved Supplier Criteria and Requirements for the FY23 Meat Pilot Program

To meet food safety and product specification requirements, vendors must:

- Attest that the meat products they plan to sell meet 3 out of the 4 of the following criteria to be considered locally grown:
    1. Animal was born/raised in New Mexico
    2. Animal was fed/finished in New Mexico
    3. Animal was slaughtered/processed in New Mexico
    4. Animal ownership was maintained by a New Mexico producer
- Product must have been slaughtered and processed at a Federal or State (future) Inspected Facility, and vendor must attest to all three of the following:
    - Product must be in its original packaging with the USDA FSIS inspection stamp on the packaging from the USDA FSIS inspected processor.
    - No further processing is allowed without further USDA FSIS inspection
    - Vendor will provide buyers proof of FSIS certification (packaging, invoice, etc.) alongside a corresponding invoice for administering agency reimbursement.
- Vendor must ensure the safe transportation of product to the end market, which facilitates food safety and quality management throughout the cold-chain distribution process. Specifically, the vendor must ensure that acceptable temperature ranges have been maintained, depending on whether the meat is transported in a fresh or frozen state in temperature-controlled trucks. Frozen meat should stay frozen and fresh meat should be held at a temperature of 41°F or below.
- Vendor is required to hold a current USDA Food Safety and Inspection Service (FSIS) Distribution License. Providing documentation of having applied to FSIS for a registration number is part of the application process, and for a vendor to become approved they must provide their FSIS registration number.
- Vendor must be bonded.
    - Processors and distributors must hold product liability insurance at a minimum of 1 million dollars.
    - In the case of individual producers who are engaged in direct marketing, product liability insurance is required. If not engaged in direct marketing, it's highly encouraged.
    - Appropriate documentation will be submitted as part of the application process.
- Vendor must participate in the no-cost NMDA Taste the Tradition/Grown with Tradition Logo Program. License agreement must be completed and submitted to NMDA.

Appendix B. Approved Supplier Criteria and Requirements for the FY23 Meat Pilot Program

NM Grown Buyer Survey

Please answer all survey questions on behalf of your organization.

1. Please type of the name of your organization:
2. Which of the following best fits how your organization purchased and distributed meat products through the New Mexico Grown FY23 Meat Pilot program?
    a. Individual buyer: we purchased meat products to directly distribute to clients.
    b. Collective buyer: we purchased meat products to distribute to other centers/locations to distribute to clients.
3. Please select which meat products your organization purchased during the NM Grown FY23 Meat Pilot program. You may select more than one.
    a. Beef
    b. Bison
    c. Lamb/mutton
    d. Pork
    e. None of the above
4. Please select types of meat products your organization purchased during the NM Grown FY23 Meat Pilot program. You may select more than one.
    a. Fresh meat products
    b. Frozen meat products
    c. USDA certified organic meat products
    d. Grass-fed and/or grass-finished meat products
    e. Free-range/pasture raised meat products
    f. Hormone-free meat products
    g. Other (please specify: _____)
    h. None of the above
5. Approximately what percent of your organization's NM Grown grant allocation for local food purchasing was spent on meat products in FY23 (July 2022-June 2023)?

Please rate your organization's satisfaction with the following components of the FY23 (July 2022-June 2023) NM Grown Meat Pilot program: (scale: very dissatisfied, dissatisfied, neutral, satisfied, very satisfied, not applicable)

6. Recruitment and marketing materials inviting your organization's participation in the program
7. Knowledge of Meat Pilot program goals

8. Knowledge of expectations and requirements for participating in the Meat Pilot program
9. Availability of supply of preferred meat products in needed volumes
10. Packaging of meat products
11. Transport of meat products
12. Pricing of meat products
13. Safety and traceability of meat products
14. Ease of doing business with meat suppliers
15. Quality of meat products purchased
16. Technical Assistance and support received from the New Mexico Farmers' Marketing Association (NMFMA)
17. Technical Assistance and support received from the NM Department of Agriculture (NMDA)
18. Overall experience participating in the NM Grown FY23 Meat Pilot program
19. Please expand upon any ratings here:

Please rate your organization's agreement to the following statements regarding the FY23 (July 2022-June 2023) NM Grown Meat Pilot program: (scale: strongly disagree, disagree, neutral, agree, strongly agree, not applicable)

20. Users/consumers were satisfied with NM Grown meat products.
21. The FY23 NM Grown Meat Pilot improved users'/consumers' food security status.
22. The FY23 NM Grown Meat Pilot improved users'/consumers' diet/meal quality.
23. The FY23 NM Grown Meat Pilot provided ranchers and other meat suppliers an important economic opportunity.
24. Will your organization purchase NM Grown meat products in the future?
    a. Yes
    b. No
    c. I'm not sure
25. If "yes" is selected for Q24: Please list reasons why your organization will purchase meat products through NM Grown in the future; If "No" is selected for Q25: Please list reasons why your organization will not purchase meat products through NM Grown in the future. If "I'm not sure" is selected for Q25: Please list reasons why you aren't sure if your organization will purchase meat products through NM Grown in the future.
26. What NM Grown meat products are you most interested in in the future?
27. What worked well during the FY23 NM Grown Meat Pilot Program? Why?
28. What was most challenging for your organization during the FY23 NM Grown Meat Pilot Program? Why?
29. What can be improved upon moving forward to ensure meat buyer needs are met?
30. Please enter any other comments here.

Approved Supplier Meat Vendor Survey

Please answer all survey questions on behalf of your operation.

1. Please type of the name of your operation:
2. What type of operation do you represent? You may select more than one.
    a. Producer
    b. Processor
    c. Distributor
    d. Food Hub (a centrally located facility with a business management structure facilitating the aggregation, storage, processing, distributions, and/or marketing of locally/regionally produced food products)
    e. Producer Collective
3. Please select which meat products your operation sold as an Approved Supplier Meat Vendor during the NM Grown FY23 Meat Pilot. You may select more than one.
    a. Beef
    b. Bison
    c. Lamb/mutton
    d. Pork
    e. None of the above
4. Please select types of meat products your operation sold as an Approved Supplier Meat Vendor during the NM Grown FY23 Meat Pilot program. You may select more than one.
    a. Fresh meat products
    b. Frozen meat products
    c. USDA certified organic meat products
    d. Grass-fed and/or grass-finished meat products
    e. Free-range/pasture raised meat products
    f. Hormone-free meat products
    g. Other (please specify: _____)
    h. None of the above

The USDA defines a "Socially Disadvantaged Producer" as a producer who is a member of a Socially Disadvantaged Group. A Socially Disadvantaged Group is a group whose members have been subject to discrimination on the basis of race, color, national origin, age, disability, and, where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program.

5. If you are an individual producer, would your operation be classified as a Socially Disadvantaged Producer?
    a. Yes
    b. No
    c. Not applicable
6. If you are not an individual producer (in other words, you are a processor, food hub, distributor, etc.): do you source meat products from Socially Disadvantaged Producers?
    a. Yes
    b. No
    c. Not applicable

Please rate your operation's satisfaction with the following components of the FY23 (July 2022–June 2023) NM Grown Meat Pilot program: (scale: very dissatisfied, dissatisfied, neutral, satisfied, very satisfied, not applicable)

7. Recruitment and marketing materials inviting your operation's participation in the program
8. Knowledge of Meat Pilot program goals
9. Knowledge of expectations and requirements for participating in the Meat Pilot program
10. Application process to become an Approved Supplier Meat Vendor
11. USDA Food Safety and Inspection Service (FSIS) registration and inspection process for meat handling and distribution
12. Pricing of meat products
13. Ability to find interested buyers
14. Ease of doing business with meat buyers (including communications, invoicing, distribution requirements, payment terms)
15. Buyer satisfaction with meat products
16. Amount of product sold during the Meat Pilot program (July 2022-June 2023)
17. Participation in the New Mexico Department of Agriculture (NMDA) Taste the Tradition/Grown with Tradition Logo Program
18. Technical Assistance and support received from the New Mexico Farmers' Marketing Association (NMFMA)
19. Technical Assistance and support received from the NM Department of Agriculture (NMDA)
20. Overall experience participating in the FY23 Meat Pilot program
21. Please expand upon any ratings here.

Please rate your operation's ability to respond to buyer requests during the NM Grown FY23 Meat Pilot for the following: (scale: very difficult, difficult, neutral, easy, very easy, not applicable)

22. Buyer requests for specific meat products
23. Volume of meat products **requested** by buyers
24. Volume of meat products **purchased** by buyers
25. Packaging of meat products
26. Transport of meat products
27. Please expand upon any ratings here.
28. Will your operation participate as an NM Grown Approved Supplier Meat Vendor in the future?
    a. Yes
    b. No
    c. I'm not sure
29. If "Yes" is selected for Q28: Please list reasons why your operation will participate as an NM Grown Approved Supplier Meat Vendor in the future; If "No" is selected for Q28: Please list reasons why your operation will not participate as an NM Grown Approved Supplier Meat Vendor in the future. If "I'm not sure" is selected for Q28: Please list reasons why you aren't sure if your operation will participate as an NM Grown Approved Supplier Meat Vendor in the future.
30. Briefly describe why your operation participated in the FY23 NM Grown Meat Pilot program.
31. What worked well during the FY23 NM Grown Meat Pilot Program? Why?
32. What was most challenging for your operation during the FY23 NM Grown Meat Pilot Program? Why?
33. What can be improved upon moving forward to ensure Approved Supplier Meat Vendor needs are met?
34. Please enter any other comments here.

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Leveraging the innovation potential of informal midstream actors to enhance food systems outcomes

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Abstract

Scholars and policymakers alike acknowledge that the informal midstream is an important linkage in Africa's food system, providing a crucial connection between production and consumption of nutritious fruits and vegetables. In several instances, development practitioners have deliberately engaged informal midstream actors in interventions to enhance food systems outcomes, such as introducing plastic crates in Nigeria to reduce

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Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

postharvest losses. Using this initiative as a case study, we interview key actors to explore the relationship between challenges, motivations, innovation capacity, and conditions in the innovation and adoption of plastic crates. We conclude from our findings that successful innovation in food system depends on collaboration between informal midstream actors and formal sector service providers, and necessitates a deep understanding of socioeconomic realities and power dynamics, especially in relation to gender norms. We highlight approaches that actors in the formal sector can take to enable informal midstream actors to engage in innovation processes for positive food systems outcomes; specifically, decreased postharvest losses, improved food safety, and increased incomes for women.

Keywords
agricultural value chains, midstream actors, informal economy, innovation, food systems outcomes

Introduction

Adequate and safe consumption of fruits and vegetables has recently received considerable attention for its important role in enhancing food and nutrition security in Africa (de Steenhuijsen Piters et al., 2021; Nyamete et al., 2024), supported by growing emphasis from national governments and food system experts on the importance of micronutrient rich diets (Herforth et al., 2019). To enhance food systems outcomes such as reduced food waste and more affordable vegetable prices for low-income consumers, innovations and interventions that effectively address challenges across horticultural value chains are crucial (Walsh et al., 2020). This recognition has led to a focused engagement with midstream actors in the value chains, who can play a pivotal role in the innovation lifecycle, from development to utilization (Kalmpourtzidou et al., 2020; Sharma & Dahlstrand, 2023).

The midstream segment of the horticultural value chain includes a wide variety of actors, encompassing the "vast network of agrifood enterprise activities between the farmer's gate and the consumer's plate" (International Fund for Agricultural Development, 2021, p. 14). In low- and middle-income countries, midstream actors often operate in the informal sectors of the food system, which means that both in law and practice, formal arrangements, such as official employment contracts, tax paying, and other regulatory measures, are largely absent (International Labour Organization, 2012). While some scholars assumed that with increased economic development, the informal economy would eventually disappear, informal economies worldwide are not diminishing in size; so far, many policy interventions designed to reduce informal practices, such as cutting formal registration costs and simplifying tax laws, have had very limited effects (De Andrade et al., 2016; Floridi et al., 2020; Rothenberg et al., 2016).

There is a lack of knowledge of how stakeholders can work with—rather than against—actors in informal midstream segments to address value chain challenges and inefficiencies, as they operate beyond formal market mechanisms or legal and regulatory frameworks (Dijkxhoorn et al., 2021; Vorley, 2013). The absence of comparable incentives or pressures as experienced in the formal sectors necessitates a comprehensive understanding of the mechanisms that motivate these actors to innovate and adopt, in order to contribute to enhanced food systems outcomes. Furthermore, there is a need to understand how to establish an enabling environment for innovation use and adoption, to ensure effective use and scale; this includes both formal (policy, government structures, regulations, regulated financial systems) and informal (social, cultural, and informal economic norms) support systems (Schuetz et al., 2017).

This paper utilizes a case study approach to explore and evaluate the incentives that promote innovation and its adoption by midstream actors within the informal economy through assessing a postharvest intervention, reusable plastic crates, in the tomato value chain in Nigeria. The research questions are*:*

1. What are the primary incentives for midstream actors in the informal tomato value chain in Nigeria to adopt the reusable plastic crate innovation?
2. What barriers do these actors face in adopt-

ing and increasing the use of reusable plastic crates?
3. What are perceived enablers of innovation and innovation adoption?
4. How should interventions be adjusted to address different food systems outcomes?

By addressing these questions, the study intends to provide a comprehensive understanding of the complex interplay between innovation, informal sector dynamics, and food systems outcomes, offering insights for policymakers, practitioners, and researchers focused on agricultural innovation and food systems.

Conceptual Framework: This research is underpinned by a conceptual framework that attempts to broadly comprehend the integration of food systems outcomes with the components of the enabling environment necessary for effective innovation adoption in informal horticultural sectors. The framework identifies three primary food systems outcomes from the crate intervention, based on the original intention of the case study intervention: Reduced postharvest losses, improved food safety, and increased income for women actors.

The analysis aims to provide a comprehensive understanding of resources, constraints, and motivations that influence behavior towards achieving diverse societal outcomes, as they relate to innovation adoption in the informal sector (Klerkx et al., 2010). The mechanisms that contributed to these outcomes, and subsequently to potential improvements to the innovating and scaling process, are assessed in the context of the survey results, culminating in a discussion on how enabling environments can support pathways that lead to these outcomes in the informal economy.

Literature Review

This literature review explores current research on innovation in informal fruit and vegetable economies, highlighting the unique drivers, constraints, and equity considerations that shape innovation processes and outcomes.

Informal Horticultural Markets

In many low- and middle-income countries, informal horticulture (or "fruit and vegetable") supply chains represent over 90% of traded volumes (de Steenhuijsen Piters et al., 2021). The informal fruit and vegetable sector plays a key role in food and nutrition security, increasing access, availability, and consumption of nutrient-dense foods, especially for low-income households (Mekonnen et al., 2022). In Lagos, Nigeria, for example, more than 30 informal markets supply produce for 21 million, with fresh produce markets in most communities (Plaisier et al., 2019). They also substantially contribute to the livelihoods of poor women, more likely to be employed in informal settings than men (Mekonnen et al., 2022).

Informal economies are characterized by a high degree of self-organization and structure. Regulations originate from various non-state actors and informal institutions, such as powerful entrepreneurs and religious leaders, but also trade unions, associations, and other social networks (Mekonnen et al.. 2022). These arrangements form an economic structure in the absence of state-led regulatory authority (Schoofs, 2015). In some cases, informal governance structures result in the formation and upholding of certain standards, such as food safety and quality (Nicolini et al., 2022). Networks of actors provide important functions, such as market regulation, service provision (water, security, electricity), finance (joint investments), and resource allocation (Kinyanjui, 2010). However, there are inefficiencies in informal vegetable value chains that can result in high food loss and price uncertainty in the market, negatively impacting the incomes of all actors involved as well as the affordability of fresh vegetables for consumers (de Steenhuijsen Piters et al. 2021).

Innovation for Development Outcomes

Innovation within the informal sector presents distinct characteristics compared to formal sectors (Rivera-Huerta & López-Lira, 2022). Informal sector innovation often originates from factors beyond market forces, such as individual creativity or the necessity to address local challenges. Knowledge acquisition among informal actors tends to rely more heavily on experiential learning and practical training than on formal education. Limited capital resources within the informal sector

may hinder the widespread dissemination of innovations, leading to more localized impact. Successful innovation in informal sector economies necessitates a sense of ownership among local actors and a supportive role from formal institutions (Cozzens & Sutz, 2014). Intermediaries, acting as mediators between different sources of knowledge and communities, play a crucial role in facilitating the adoption and diffusion of innovations within informal settings.

Gender Considerations in Informal Markets

The importance of focusing innovation studies on informal settings is underscored by their significant role in inclusive development, benefiting marginalized populations and improving livelihoods (Cozzens & Sutz, 2014). Women in informal markets face unique, and more severe, barriers compared to men. In informal horticulture value chains specifically, women are unequally compensated in either assets or income for their labor and time, and generally are more prone to occupational insecurity and abuse in the form of harassment (Henry & Adams, 2018; Mekonnen et al., 2022). In Nigeria, women in the informal market are left unheard and lack decision-making power, and policies to correct inequities are either absent or fail to recognize women's contribution to food security and agricultural productivity (Ajibade et al. 2021). When designing and disseminating innovations, recognizing that there are gender-specific barriers to adoption is critical (Ajibade et al., 2021). Failing to consider gender when scaling an innovation can exacerbate gender inequities (McGuire et al, 2022). Furthermore, gender considerations do not only pertain to the innovation itself, but the enabling environment, the systems surrounding the innovation, that can be determinative of whether constraints are overcome and an innovation is adopted (Petesch et al., 2018).

Methodology

To explore the complex dynamics of innovation within informal horticultural sectors, this study employs a case study methodology, focusing on the use of reusable plastic crates in Nigeria's tomato value chain. The choice of a case study approach is driven by the need to deeply understand the uniquely contextual, multifaceted incentives and barriers faced by midstream actors in adopting innovations. Case studies serve to observe and contextualize actions and structures relevant to social innovation theory, providing in-depth insights from various perspectives to foster a holistic understanding and facilitate theoretical innovation and generalization (Feagin et al., 1991).

Case Study Selection

The case study of tomato crates in Nigeria presents a unique opportunity to explore several dimensions of innovation in the informal sector and provides a valuable opportunity to empirically evaluate a real-life scenario (Yin, 2009). The tomato value chain is critical to Nigeria's agriculture sector, making innovations in this space particularly impactful. Given the significant role of informal sectors in distributing tomatoes, understanding how innovations are adopted and scaled in these settings can provide insights applicable across similar market situations. It is essential to understand that the tomato value chain involves a range of stakeholders, from smallholder farmers to large aggregators, each with distinct motivations and constraints regarding innovation adoption. By analyzing this case study, we aim to uncover insights into how midstream actors respond to innovations like reusable crates and what drives their decisions to adopt such technologies. It is helpful that the research team had familiarity with this work.

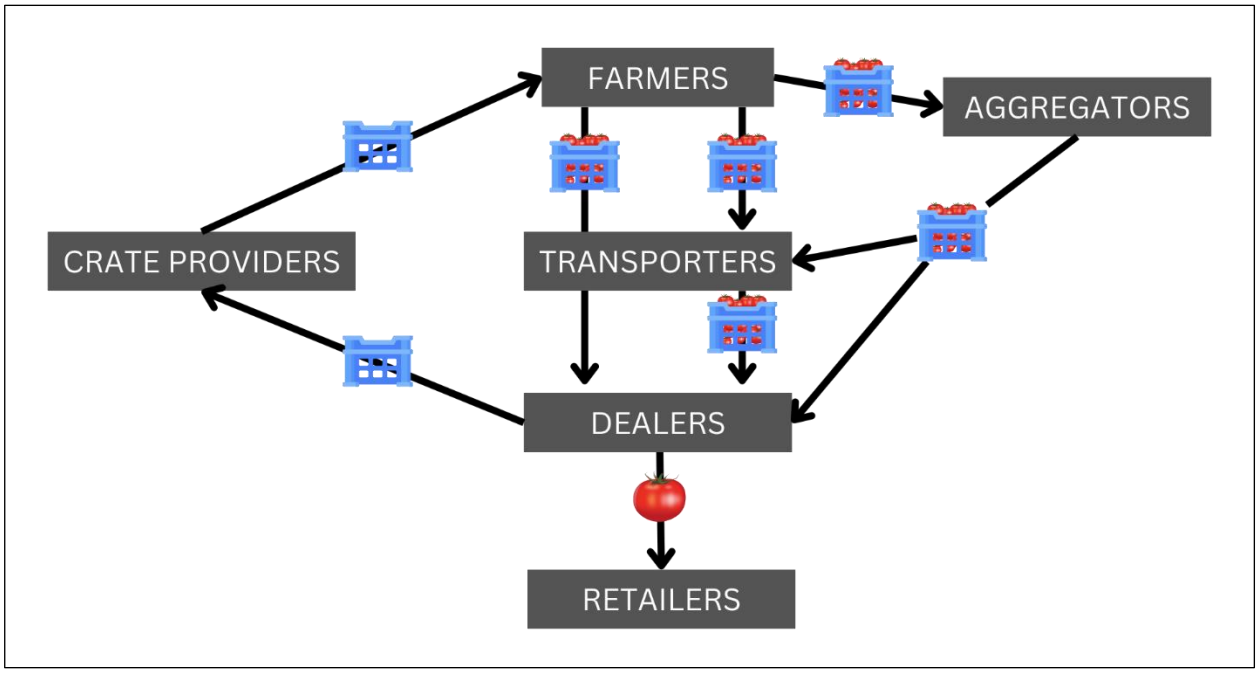
Beginning in 2016, a project funded by the Multi-Donor Trust Fund for Sustainable Logistics aimed to reduce significant tomato losses along the value chain. Following workshop-based consultations, tomato value chain actors prioritized plastic crates as a desirable intervention, resulting in pilot projects in North and Southwest regions (Kok et al., 2019; Plaisier et al., 2019). Crate use resulted in reduced losses and quality decay compared to the traditional raffia baskets (Kok et al., 2019). Thereafter, other institutions and entrepreneurs in Nigeria's tomato value chain also began piloting plastic crates, resulting in approximately ten crate renting companies becoming active in Nigeria, and subsequently becoming a new tomato value chain (Table 1; Figure 1).

Table 1. Actors in the Tomato Value Chain in Nigeria

Farmers	Cultivate tomatoes from small-scale (60%) to large-scale production (10%) (Ugonna et al., 2015). Over 50% of tomato production occurs in the north in Kano and Kaduna States under irrigated systems, but in the wet season production occurs in the south on small, rain-fed plots, with closer proximity to major markets.
Aggregators	Collect tomatoes from farmers and resell tomatoes to processors, dealers, retailers, or consumers.
Dealers	Act as intermediaries between producers and retailers, purchasing tomatoes from farmers or aggregators in larger volumes than any other marketing actors, and transporting or coordinating transport to wholesale or retail markets, primarily in the south.
Transporters	Transport tomatoes from farms to various actors (dealers, retailers, or consumers). Transportation methods vary depending on infrastructure availability and distance, which can be as far as 1,000 kilometers (620 miles) from the north to south.
Retailers	Purchase tomatoes from wholesale dealers and sell them to end consumers through informal local markets or roadside stalls. Retailers are the only value chain actors dominated by females, and notably they are no longer given access to plastic crates and continue to sell out of raffia baskets at market because of incidents of crates not being returned to the crate service providers.
Crate service providers	Rent out plastic crates to farmers, and sometimes dealers. Operations and returns of rented crates are loosely overseen and supported by the Tomato Crates Dealers Association of Nigeria, which was formed by members with sufficient financial capacity to invest.

Cited from Plaisier et al., 2019 unless otherwise noted.

Figure 1. Crate Rental Value Chain, Author's Depiction



Data Collection

A comprehensive literature review was undertaken to identify potential drivers that influence the innovation, adoption, and scalability of interventions aimed at midstream actors operating in the informal economy. Insights from the literature review informed the development of survey questions designed to gain a broad understanding of innovation and adoption motivations, challenges, and barriers for midstream actors, considering socio-

economic factors. A transdisciplinary team developed, piloted, and revised a survey during an initial field visit in August 2022 with midstream actors in the tomato value chain.

Data collection took place from 10–18 November 2022 in Kano, Ife (Osun State), Ibadan (Oyo State), and Lagos State, chosen because they cover all the significant markets where tomatoes are both sourced and sold. Crate providers and farmers were interviewed in the North (Kano), where major production occurs, while retailers and dealers were interviewed at the major markets in the south (Osun, Oyo, Lagos). This largely follows the pattern of the crate rental value chain from north to south.

Respondents were selected via snowball sampling, according to their type of value chain activity. The initial respondents were selected from the research team's previous contacts, who had been involved in the original crate intervention activities. In alignment with the scope of the study, interviews lasting 40–60 minutes were conducted with 58 value chain actors. Interviews were recorded and then transcribed.

Data Analysis

Following the interviews, data was analyzed qualitatively in Atlas.ti to gain insights into the motivations behind plastic crate adoption and into barriers to uptake, and to identify potential entry points for incentives within the informal sector during a First Cycle analysis (Saldana, 2013). Interview data were coded collaboratively, with two primary coders analyzing transcripts from each segment of the value chain to identify recurring themes and patterns and to develop a coding tree, which was discussed and approved by the transdisciplinary research team. Primary coders individually coded a subset of transcripts for comparison to ensure consistent coding, resolving discrepancies through consensus discussions. Structural coding was initially used based on survey questions, then codes were expanded (Saldana, 2013). Primary coders completed the coding and reviewed results collaboratively to verify consistency. A Second Cycle analysis was conducted, first by the primary coders then verified by a transdisciplinary team for code consolidation. Codes were interpreted to organize emerging patterns.

Limitations

The snowball sampling approach could have led to a bias in selection of the actors we approached and invited to participate, leading to a potentially biased representation of the tomato value chain. Additionally, qualitative research is inherently subjective and open to interpretation; and the coding and analysis of data involves researcher judgment, which introduces the possibility of bias or misinterpretation. The use of multiple coders and regular discussions among researchers was intended to help mitigate this effect (Saldana, 2013). Furthermore, the sample size was not large enough to capture the full diversity of perspectives within the tomato value chain, so our findings may not be generalizable to the entire population or might overlook important potential data from non-interviewed groups.

Results

A total of 58 actors within the value chain were interviewed: 20 farmers, 20 retailers, 14 dealers, three crate service providers, and one transporter (Table 2). Discussion of results emphasizes farmers, retailers, and dealers because of their larger sample size. The sample consisted of a higher proportion of male respondents (39) than female (19), primarily attributable to gender division within value chain activities: all actors were male except among retailers, where the majority of actors are female, accounting for 19 of 20 individuals.

Group Membership and Registration: Across the value chain, groups were reported to be highly structured, including formal roles such as elected chairpersons, secretaries, treasurers, and financial secretaries. This finding aligns with current understanding of the informal sector in West Africa, in which groups and market associations play a primary role in organization and regulation, as well as coordination with local governments (Mekonnen et al., 2022). Of the 20 retailers, 17 indicated being part of a tomato seller association at the market, with a majority (11) stating that it is mandatory. Of the 20 farmers, only six are members of associations/cooperatives. All dealers indicated being part

Table 2. Descriptive Results of Respondents

		South		North		
Characteristic	Option	Retailer (*n*=20)	Dealer (*n*=14)	Farmer (*n*=20)	Crate Service provider (*n*=3)	Transporter (*n*=1)
Age	30–39 years	5	4	1	–	–
	40–49 years	9	8	11	2	1
	>50 years	6	2	8	1	
Gender	Male	1	14	20	3	1
	Female	19	–	–	–	–
Years in business	1–10 years	6	1	0	3	–
	11–20 years	7	7	8	–	1
	21–29 years	5	5	8	–	–
	>30 years	2	1	4	–	–
Education	Primary	2	4	3	2	–
	Secondary	14	10	10	1	1
	Higher	1	–	3	–	–
	None	3	–	1	–	–
	Informal	–	–	3	–	–
Business Entry	Formal	–	11	1	–	–
	Informal (familial)	18	–	15	–	–
	Informal (other)	2	3	4	3	1

of dealer associations, stating that participation is mandatory after completion of an apprenticeship.

For registration requirements, 15 retailers indicated that there was no requirement to be individually registered to sell at their market, while 12 of the 14 dealers reported being registered to either the market, local government, or as a business entity with the Nigeria Corporate Affair Commission.

Crate Use: All farmers interviewed responded that they use crates (Figure 2). Of the 14 dealers, 13 stated that they use crates; however, five indicated that their own use "depends on what farmers supply you with" (Dealer 2). Of the 20 retailers, 11 indicated that they do not use crates; Retailer 11 stated "I use more of [the] baskets. I take my baskets to market and pour the content of the crates into my basket. Sometimes, the dealers give us crates too but we must return it so that they can return it to the northern part of the country." Seven of the 11 retailers that do not use crates stated similar indications that dealers control their access to crates. Overall, many respondents reported observing high adoption throughout the value chain: "stakeholders embraced the use of crate almost more than the baskets for people trading the North and South corridor" (Dealer 5).

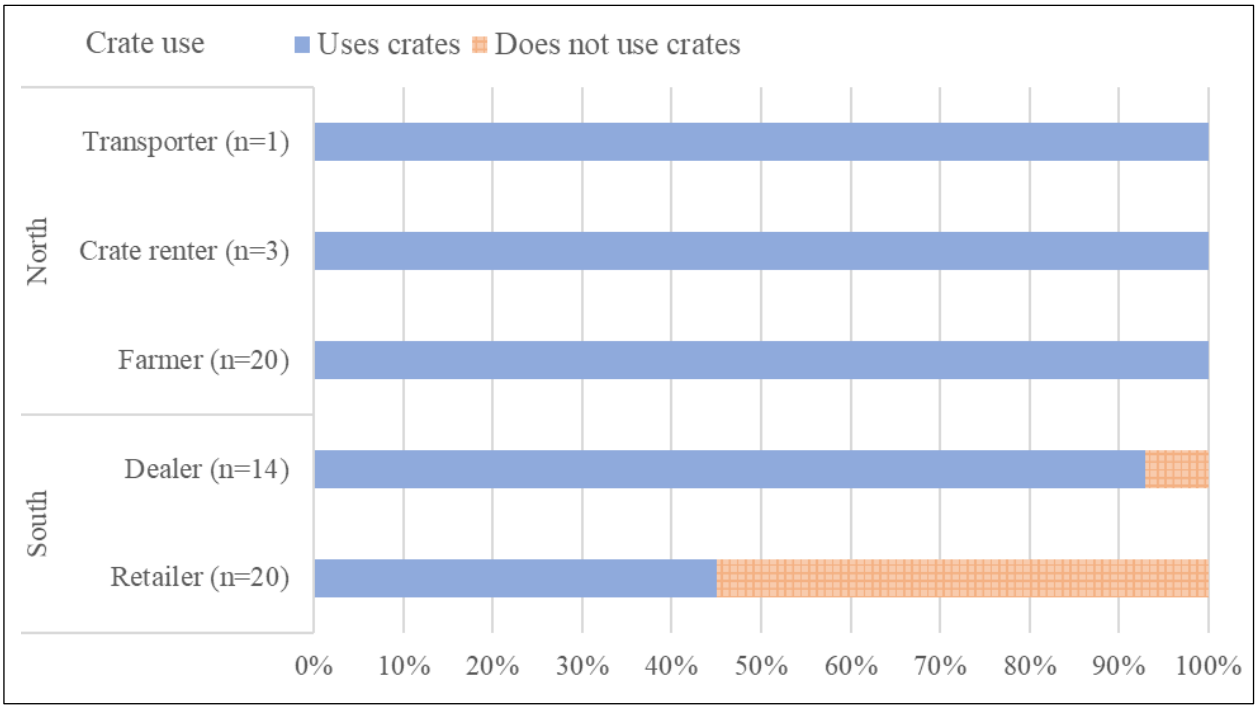
Incentives for Adoption

Several interview questions were designed to elicit responses that could provide insights into the incentives for adopting new innovations to address challenges. Overall, when asked about the main challenges in tomato trading, the four most prominent responses among the 58 participants were, overwhelmingly, postharvest losses (32), price fluctuations (30), oversupply (22), and market uncertainty (18):

> Food loss is real especially in tomato production. The major cause can be seen from market price volatility. In addition, when the harvest time is due and [the] market does not want it at that time…you have two or three options, sell at lower price, cut and dry, or allow it to rot. Therefore food loss cripples capital investment. (Farmer 19)

These salient challenges are interrelated, as oversupply of highly perishable crops increases market uncertainty and price fluctuations, which in turn negatively impact the incomes of all actors

Figure 2. Crate Use of Respondents by Value Chain Segment



involved (de Steenhuijsen Piters et al., 2021). Uncertainty regarding market demand can lead to shortages, and also glut during peak seasons, which increases incidences of postharvest loss (Balana et al., 2022). Other prominent challenges include: loss of investment, poor infrastructure, low sales, capital, transportation delays, and lean periods. These challenges align closely with findings from previous literature assessing the tomato value chain in Nigeria (Norbert et al., 2023; Plaisier et al., 2019; Sibomana et al., 2019).

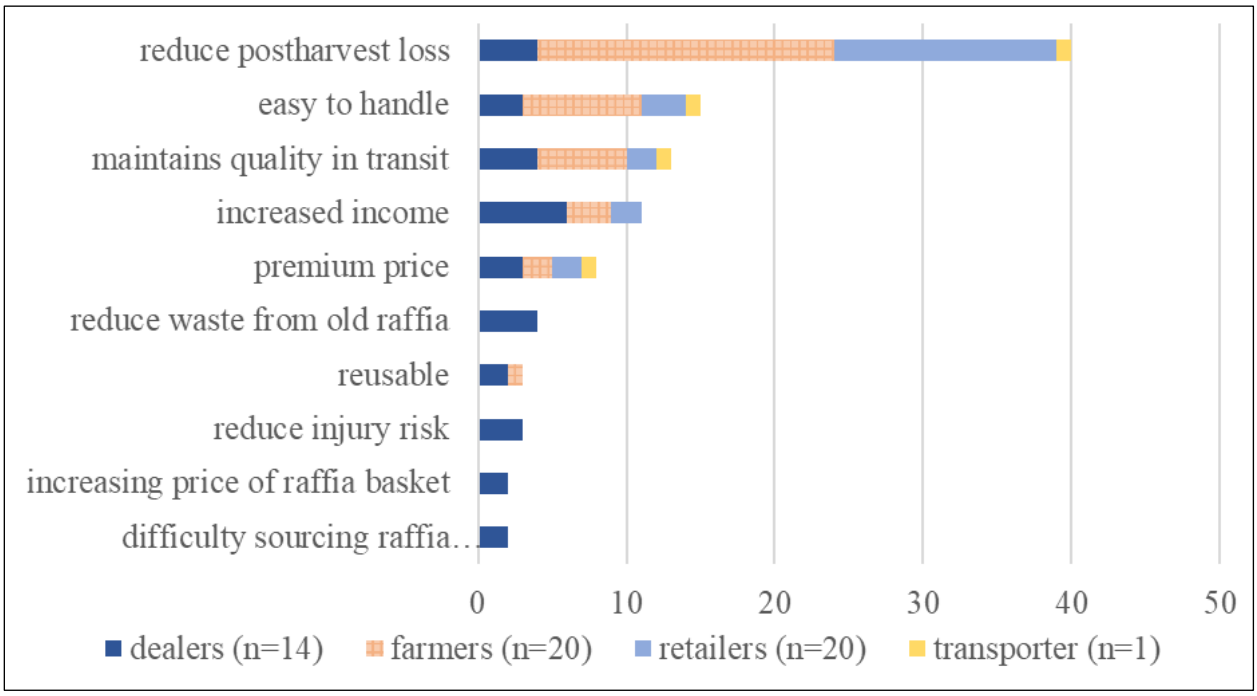
Nearly all respondents (97%) expressed concerns about food loss within their segment, with 82% citing economic factors, as "waste represents economic loss" (Retailer 9). This is especially severe in the farming segment, the "biggest losers" financially (Dealer 4). Many respondents stated that there is no enabling environment capable of addressing postharvest loss. A majority of respondents (40) believed that the primary benefit of crate use was to reduce postharvest losses and waste: "It has proven to be the best in controlling losses. It is better than anything used to convey tomatoes in the past" (Farmer 2). This data suggests that because the crates are perceived to directly address the common issue of high postharvest losses, adoption is high. Subsequent reasons for adoption described by actors include ease of handling and increased incomes (Figure 3).

While food safety was not initially listed as a challenge by any actor, when specifically asked a majority of respondents (88%) indicated that food safety is a concern for their business. While there is some inconsistency in reporting food safety practices among different actors, a majority (45) claim to apply food safety control measures. Retailers and farmers stand out as consistently reporting that they implement some level of food safety practices, particularly in sorting and grading (19 farmers, 16 retailers), and washing (20 retailers). However, five of the 14 dealers did not consider food safety a concern and 13 stated they have no food safety practices, with many associating food safety only with farmers' use of pesticides or otherwise being out of their control, indicating gaps in food safety knowledge.

Barriers to Adoption and Use

Affordability: A significant barrier to crate adoption stated by respondents is the high cost of pur-

Figure 3. Benefits and Motivations for Crate Use



chasing crates (25), making it difficult for all value chain actors to adopt them widely. One barrier impacting the affordability of crates is limited or difficult access to finance. About 33% of respondents stated that financing is difficult to access, while 36% do not engage in borrowing funds at all, with retailers in particular avoiding borrowing completely or stating they have no need to borrow. Seventeen percent of actors borrow through informal channels, from friends, family, or group members. The barriers to finance access include collateral requirements, high interest rates, lengthy processing time, and general lack of knowledge about loan application processes and protocols.

A majority of dealers stated they have accessed finance through formal means, indicating potentially lower barriers for them to afford investing in crates. In some instances, dealers stated they support farmers and aggregators by sponsoring the upfront procurement and transportation costs of the crates, allowing farmers and aggregators without access to necessary capital the opportunity to use crates.

Availability and Awareness: Limited availability of crates (25) was stated as a challenge to crate adoption, primarily by farmers. Barriers include a limited supply of different colored crates, which is the current system used to indicate who owns which crates, and geographical limitations in production and distribution of crates.

Lack of awareness of crate use was stated as a barrier (10), especially by farmers who viewed it as an impediment to adoption by other actors along the value chain. Only two retailers and three dealers reported participating in a training involving plastic crates, whereas 11 farmers directly participated in a crate training. While some dealers (six of 14) and farmers (11 of 20) reported involvement in some sort of formal training or project in the tomato sector (including but not limited to a training on plastic crates), a majority of retailers (19 of 20) reported that they had never been involved in a training or project.

Perceived Value and Suitability: Nine actors expressed reservations about the suitability of crates for local tomatoes, perceiving crates as being more suited for farmers and "dealers from the north," therefore rendering their utility seasonal and less favorable for locally transported tomatoes in the south. Similarly, transportation costs are

cited as a concern, particularly among retailers (7), who note that the stackable and rigid design of crates makes them best suited for larger modes of transport, and less ideal for individual transport, thus catering more to farmers and dealers who work on larger scales. Retailer 7 states that raffia crates "contain the content of three plastic crates, so for transportation to this market, it is more expensive to use crates." Furthermore, many retailers (8) cite the lower carrying volume of crates as undesirable, compared to raffia: "Baskets can contain more tomatoes than crates, so it might not be profitable using crates to buy" (Retailer 2). Although there is uncertainty about economic benefit, four retailers do recognize the potential for price premiums:

> The cost of produce in crates is relatively more expensive than the one in the baskets. Notwithstanding, I still buy those from crates because of perceived higher quality which should give me better marginal returns than baskets. (Retailer 20)

Access and Control Imbalance: Almost all actors along the chain perceived the crates as beneficial to reduce postharvest loss in their business; however, willingness and capacity to make the required investment, including in the logistics, was varied. The value chain segment with the lowest adoption of crates in our sample are retailers, who are notably excluded from the crate renting value chain: "I regularly buy crate tomatoes but the dealers will never release their crates to us" (Retailer 1).

It is notable that Retailer 14, one of the retailers involved in a plastic crate training and who was given her own crate stated that the "plastic crate I got from the intervention project is still with me. … It makes people buy my products too. I always put my tomatoes inside the crate and it has helped me a lot," indicating that retailers with direct access to the crates may stand to use and benefit from them. Of the retailers, nine state that they do not use crates because "dealers will not give us the crates," with many sharing sentiments that "if the dealers are ready to give us crates, I'm ready to use it" (Retailer 15, 18). This data suggests that dealers, and crate service providers indirectly, control adoption of crates by retailers. Because of the dealers' highly formalized structure and greater ability to access finances, as discussed previously, they are powerful actors in terms of influence and control. They are also often the main link between farmers and retailers. Although six of the 14 dealers state that their own use of crates is dependent on the farmer, their acceptance of crate use determines whether or not a farmer can adopt the crates to begin with, since farmers rely on dealers to link them to the market.

Social Considerations: When directly asked, 78% of participants stated they believe men and women have equal opportunities within their segment of the tomato value chain. However, upon further reflection many described significant sociocultural factors indicating underlying barriers for women actors to value chain mobility and adoption:

> It is free for all but the rigor of the business makes it more favorable to men than women. For example, we dealers sleep in the markets here because produce from the farm mostly arrive in the middle of the night. For married women, how many of their husband will allow that? I have not gone home for the past 3 weeks now. If I am a woman with children to take care of, will that be possible? There are few women who are divorced and or allowed by the husband to do. (Dealer 4)

Aside from not aligning with accepted gender norms, market structural obstacles, such as mandatory registration, necessary education and apprenticeship, and the significant financial investment required may further dissuade women from pursuing dealing opportunities:

> The opportunities are the same for both men and women but what I notice is that men usually have more money to invest in this business than women. (Retailer 4)

This dynamic is supported in the literature, as men can be better positioned to adopt new innovations due to social imbalances, as women are discouraged from breaking gender norms (Badstue et

al., 2018). On the other hand, multiple respondents said that they perceived retailing to be "unsuitable" or "insulting" to men, which discourages men from taking part in this segment.

Furthermore, a majority of farmers noted that crate renting was a lucrative business opportunity, but only available to those who already had capital—which excludes poorer actors, as well as retailers who are both less likely to have capital and less encouraged to take business risks because of social expectations. While the adoption of crates and the emergence of the crate renting companies indicate compelling evidence for ground-up innovation approaches, the data suggest that it can also reinforce persisting social gaps.

Perceived Enablers of Innovation Use

Eighty-four percent of respondents identified capital as a critical factor in growing their business, which indicates access to capital as a barrier to adoption and innovation, a finding that aligns with other studies in the Nigerian tomato value chain (Amurtiya & Adewuyi, 2021). Respondents highlighted the significance of making the crates "cheap and available, then [increasing] awareness" (Farmer 11). Information exchange within networks about an innovation can be determinative for adoption and use. The current internalized networks were reported to be beneficial for information exchange, as 47% of respondents described it as their group's primary benefit; however, they have not consistently formalized opportunities for co-investment to enable the adoption of an innovation. A slight majority of retailers are willing to collaborate or co-invest with each other (although some expressed a lack of trust) while, alternatively, a majority of dealers stated that co-investing is "not possible" in their segment and many concluded that "if there is an innovation from external sources, we can embrace it," but they are unlikely to address postharvest issues jointly because of a sense of competition (Dealer 9). All farmers stated they were willing to invest with other value chain actors to pursue joint objectives, especially with crate renters who are seen to "have common goals and benefits" (Farmer 1). There is little mention of collaborating across the value chain by the retailers or dealers, with some agreement that co-investment would not occur "across the whole value chain" (Dealer 6, Retailer 20).

Discussion

To identify optimal entry points in the value chain, we assess the innovative agency of each actor based on our results, assessing resources, constraints and motivations that influence behavior towards achieving diverse societal outcomes (Table 3).

We have developed three possible scenarios for pathways that address different desired food systems outcomes: community food safety, reduced postharvest losses and waste, and increasing income for women. Each scenario describes both the desired and observed outcomes, followed by examining the mechanisms that contributed to these outcomes. Subsequently, we explore potential improvements to the value chain process and discuss how the enabling environment can support these outcomes by identifying various pathways, policy recommendations, broader implications for agricultural development and informal economies, improved interventions and possible tradeoffs.

Outcome 1: Reduction of Postharvest Losses and Waste

Desired Outcome: Minimizing postharvest losses and waste in the horticulture supply chain through improved handling and storage practices facilitated by the crate system.

Observed Outcome: Crates were used by a majority of actors in this study along the tomato value chain due to their perceived ability to reduce postharvest losses. However, food loss remains one of the biggest issues facing all actors, indicating that adoption of crates, while effective in reducing losses, requires complementary initiatives to address losses and complementary interventions addressing systemic inefficiencies, such as improved storage facilities, better road infrastructure, and enhanced coordination across the supply chain.

Process (Mechanisms that Led to Outcome): Crate service providers' investment in the renting plan allowed for adoption of crates by lowering the

barrier to entry among farmers who were generally constrained by capital, which was further facilitated by dealers accepting the innovation and adapting to the new operational logistics. While retailers were initially engaged in crate renting, they were eventually excluded because crates were not effectively returned, despite many retailers stating they would like to use crates. Furthermore, infrastructural (roads, storage) and logistic (market uncertainties) limitations along the value chain hinders the ability of actors to use crates to reduce losses further.

Improved Process: The crate system can be optimized to reduce postharvest losses more effectively by addressing the interconnected challenges within the value chain. An improved process would involve a more inclusive and coordinated approach to crate system implementation, ensuring participation from all value chain actors, including retailers. This can be achieved through:

Enhanced Communication Networks: Despite the formal organization of groups along the value

Table 3. Resources, Constraints and Motivations of Value Chain Actors

	Resources and Competencies	Constraints and Barriers	Motivations
Farmers	• Willing to share information and collaborate across segments for mutual benefit. • Willing to engage in collective decision-making, especially as part of an association.	• Financial constraints and limited access to capital for investment in technology adoption.	• Reducing postharvest losses and improving food safety standards to enhance product quality. • Reduce economic risks, improve income. • Find alternative markets during oversupply.
Retailers	• Strong networks within retailer groups, enabling collaboration, information sharing, and potential co-investment.	• Limited formal business training or access to technology education. • Reliance on dealers for access to technologies like reusable plastic crates. • Gender-related social norms impacting participation and access to resources.	• Reducing postharvest losses and improving food safety standards to enhance product quality. • Increase profitability and competitiveness and reduce uncertainty in the market.
Dealers	• Formal business entry through apprenticeships, indicating structured knowledge acquisition. • Participation in dealer associations, facilitating information exchange and coordination. • Better access to capital and financial resources compared to other actors in the value chain. • Ability to support and sponsor farmers and aggregators.	• Reluctance to co-invest within their value chain. • Gendered norms impacting participation. • Can constrain crate access for other actors.	• Optimize logistics and transportation to improve efficiency. • Maintain good relations with their farmers.
Crate service providers	• Control over logistical availability of reusable plastic crates. • Potential to facilitate wider adoption through rental programs, reduced upfront costs for other actors. • Risk takers, entrepreneurial, have capital.	• Logistical challenges of crate losses, transport distances. • Manufacturing and geographic limitations.	• Crate renting is a profitable new business opportunity.
Transporters	• Willingness to share information about markets, harvests, and transportation logistics.	• Prioritize logistical efficiency over postharvest loss.	• Optimize route planning and vehicle loading space to minimize costs.

chain, this study suggests there is limited collaboration across different segments and actors within the value chain. Improving communication and cooperation among these groups could enhance overall efficiency to further address postharvest losses, and mitigate market fluctuations. Improvement might involve initiatives aimed at fostering trust and, particularly for women farmers and retailers, addressing social norms that hinder their integration and credibility within the industry. In addition, promoting innovation and use of appropriate information and communications technologies (ICT) can enhance market efficiency by optimizing crate rentals and returns, reducing delays, and improving communication and coordination between actors to align supply with demand.

Capital Investment: With an understanding that many actors, especially farmers and retailers, do not trust or wish to seek out finance options, private sector actors and crate service providers can be leveraged to front the capital and bear investment risk to address postharvest losses and potential oversupply issues. Private sector entities can work closely with farmer cooperatives to facilitate adopting postharvest innovations, and can even facilitate forming cooperatives, as was done with a former tomato processing factory. Private entities with sufficient capital may also allow for the integration of research and development efforts aimed at improving seed quality, conducting varietal trials, and optimizing nursery production. Crate service providers, who are more willing and able to take some investment risk, can be encouraged to branch out into other areas of concern to address postharvest losses, such as lack of cold storage and lack of crates available to retailers.

Capacity Strengthening: The organized groups within each segment present an opportunity for effective dissemination of best practices and innovation within segments. Farmer groups can benefit from collective training in production and market planning to align their output with market demand, thereby minimizing oversupply. Similarly, leveraging groups to advocate to the government for rural road repairs and reducing checkpoints along transportation routes could lead to lower transportation costs for all, enabling actors to gain better prices from informal market channels (Liverpool-Tasie et al., 2020). Due to farmers' apparent willingness to share information and collaborate across segments for mutual benefit, as seen with their eagerness to form better connections with crate service providers and sealers, and compounded with their perceived economic benefit of reducing losses, they may be a key entry point for introducing complementary postharvest loss reduction opportunities.

Outcome 2: Community-Wide Food Safety

Desired Outcome: Enhancing the safety of food products throughout the value chain by reducing contamination risks during transportation and sale.

Observed Outcome: While crates can minimize spoilage and reduce contamination to address food safety concerns, actors do not currently perceive them as food safety innovations, limiting their potential impact. Additionally, the absence of formal food safety standards reduces the incentive for value chain actors to prioritize hygiene and quality control.

Process (Mechanisms that Led to Outcome): There is limited formal regulation for food safety along the value chain, contributing to lack of knowledge among some actors in this sample and limited capacity to act on best practices. As is common in informal sectors, the current marketing is based on grades, leading to some good practices on food safety because of the economic incentive. There is also limited infrastructure for food safety, and associations often bear the cost of ensuring a clean market space, with many dealers paying a fee through their association to remove waste from the markets.

Improved Process: Because food safety is not considered a challenge by actors due to lack of standards and regulations, emphasizing the economic advantages of crate use (e.g., reducing postharvest loss), rather than food safety messaging, likely is a stronger motivator for adoption. But it is crucial to recognize that sensitization and training in other aspects are necessary to deter other prac-

tices from undermining the food safety benefits of crates. To effectively address food safety in the informal sector through crate use, addressing knowledge and infrastructure gaps, as well as ensuring widespread access to crates throughout the value chain, is crucial. A process that complements the use of crates may include:

Capacity Strengthening: Education programming or training for actors across the value chain on food safety practices, both in general practice and focused on crate benefits, can help close knowledge gaps, specifically among groups like dealers who, in this sample, did not know how they could contribute to maintaining food safety within their role. Retailers need to be more included in capacity-strengthening initiatives, considering their significant role in ensuring the safety of food for consumers.

To address infrastructure limitations, coordination between actors in advocating for improved infrastructure storage facilities, market shade structures, and access to clean wash water may encourage faster response from government entities, who are eager to help build the tomato industry because of its importance to the Nigerian economy. Collaborative efforts to tackle common challenges like these may necessitate trust-building interventions to overcome social barriers, particularly related to gender dynamics.

Crate Access for Retailers: Restructuring of the crate renting plan to integrate retailers may be challenging at this stage, but could be feasible in certain areas where past issues can be resolved. A tailored approach could involve leveraging crate service providers and market associations to offer market-specific crate rentals specifically for retailers. External organizations could play a role in subsidizing initial crate purchasing, while association fees could contribute to some form of security or safekeeping, enhancing accountability and accessibility for retailers without penalizing them.

Consumer Awareness: Given the characteristics of the informal sector, strengthening the capacity of regulatory bodies to monitor food safety compliance and enforce regulations across the entire value chain is not necessarily an appropriate intervention, especially when taking into account differential effects on poorer actors (Roseboom, 2012). Instead, leveraging existing economic food safety incentives indirectly through consumer awareness campaigns can teach consumers more about relevant topics, increasing demand for high quality and food-safe products. This is a promising route because actors in this sample stated that in many cases consumers already associate tomatoes from crates with higher quality products.

Outcome 3: Increased Income for Women

Desired Outcome: Elevating the economic status of women involved in the market by improving tomato quality through crate use, providing women retailers with more quality tomatoes that can be sold at higher prices.

Observed Outcome: Women interviewed along the value chain, all retailers due to gendered divisions of labor, had varying levels of belief in the capacity of crates to improve their incomes, especially because they are not directly given access to the innovation.

Process (Mechanisms that Led to Outcome): While the crate renting plan created a pathway for adoption for many, retailers encountered logistical barriers in adopting crates, including capital constraints, operational scales incompatible with crate designs, and transportation limitations exacerbated by crate design. Additionally, power dynamics and social barriers contributed to the exclusion of women retailers from crate rental when they failed to meet return standards set by more influential actors. Instead of implementing corrective measures, exclusion became the default solution.

Improved Process: Innovating and scaling to elevate women's income involves designing inclusive innovation and outcome-based strategies that address the specific social constraints faced by women, as well as logistical constraints faced by retailers in the value chain, recognizing that gender dynamics are deeply embedded in the retailing segment. Scaling efforts and enabling environments

for crate adoption that increases income for women must be tailored to address these gender-specific considerations, while also taking into account alternative pathways for generating income in some cases. These may include:

Optimizing Suitability: Adapting crates to address the needs and constraints of retailers can facilitate their adoption and integration into daily activities. For instance, introducing in-market crate rentals that address the scale and transportation challenges faced by retailers could include encouraging crate service providers to offer a range of crate sizes to accommodate varying volume needs throughout the supply chain (Sibomana et al., 2019). This tailored approach addresses the gendered roles along the value chain, improving the suitability of crates for women retailers to encourage adoption, decrease losses, and increase incomes. Given the current power dynamics along the value chain, this approach may involve providing a solution that allows for greater autonomy and control over innovation use.

Diversification Opportunities: Diversification opportunities present a promising avenue for increasing women incomes, such as engaging them in value-added processing activities like solar drying that address oversupply challenges. Diversification can also be accomplished through leveraging social enterprises that already operate in this space, like Cold Hubs, which employs women in mobile cold storage operations.

Furthermore, a new innovation always takes the place of an old one—in this case, the woven raffia basket which has traditionally provided income for many in the southeast of Nigeria, especially poor women (Babarinsa et al., 2022). As with retailing, basket making is the chosen profession by many because of the low barriers to entry, in terms of capital and skills required. Some basket makers are willing to diversify into other sectors, like trading, but lack the necessary capital and skills (Babarinsa et al., 2022). This approach could hold particular significance for basket makers, who could benefit from alternative income streams and opportunities for diversification.

Further Research

These findings have broader implications for agricultural innovation adoption, informal market dynamics, and gender-inclusive economic strategies across Africa. Nigeria is the frontrunner, leading in this particular innovation with a business model that effectively connects informal value chain actors with formal service providers. This approach offers a replicable model for other countries to adopt and tailor to their own conditions. However, further research is needed to understand what enables successful and inclusive adoption, as well as the potential challenges and trade-offs involved in scaling this model across different food systems. Key areas for further research include:

- Enhancing food safety in informal markets: What hybrid regulatory models (formal and informal) can be developed to improve food safety compliance without disproportionately disadvantaging smaller market actors? Can consumer demand play a stronger role in driving food safety improvements in the absence of stringent regulatory enforcement?
- Gender-inclusive innovation adoption: Research should explore how women can maximize economic gains from crate use and what interventions are necessary to ensure their economic empowerment, while taking into account that in most cases they do not have direct access to crate use. This may include greater efforts to facilitate access to crates by women, through adapting the current innovation to better suit their needs or agribusiness trainings to equip women with essential skills to effectively manage their businesses and maximize profits.
- Mitigating unwanted trade-offs: As new innovations replace traditional practices, such as crates replacing woven raffia baskets, how can policymakers and development programs support affected groups, such as basket makers, in transitioning to alternative livelihoods if necessary?
- Private sector engagement: How can financial mechanisms and investment strategies

be tailored to support micro-scale and small-scale actors in informal food systems while minimizing risk in participation for private sector actors?

Conclusions

A critical factor in success for uptake of innovations for actors in the informal midstream segment is collaboration with other service providers and investors from the formal sector. As this case study highlights, it is possible for formal providers to offer services that enable midstream actors operating in an informal environment to adopt innovations. Understanding the relationships between actors and value chain segments is critical to determining the incentive and disincentive structures for innovation adoption. When understanding the actor-based levers and relationship-based incentive structures, participatory innovation processes can be effectively designed. At the same time, this analysis also shows that not all actor interests can be met by a single innovation. Investigating the trade-offs and power dynamics that may resist innovations must be incorporated into feasibility studies or other preliminary research. Successful innovation in food systems requires collaboration between informal midstream actors and formal sector service providers, understanding the socio-economic realities of all stakeholders, and addressing trade-offs and power dynamics.

References

Ajibade, Y. E., Oyibo, F. O., Ameh, O. E., & Enimola, M. O. (2021). Analysis of gender roles in tomato production in Municipal Area Council, Abuja, Nigeria. *Journal of Agricultural Science and Practice*, *6*(1), Article CD9179F61. https://doi.org/10.31248/jasp2020.237

Amurtiya, M., & Adewuyi, K. (2020, September 21–22). *Analysis of Tomato production in some selected local government areas of Kano State, Nigeria* [Conference presentation]. Third International Network for Economic Research [INFER] Symposium in Agri-tech Economics for Sustainable Futures, Harper Adams University, Kingston, UK. https://doi.org/10.22004/ag.econ.308160

Babarinsa, O., Okoruwa, A., & Babarinsa, F. (2022). Potential socio-economic impact of replacing traditional woven baskets with reusable plastic crates on livelihoods of basket makers in Southeast Nigeria. *African Journal of Food, Agriculture, Nutrition and Development*, *22*(6), 20581–20595. https://doi.org/10.18697/ajfand.111.22035

Balana, B. B., Aghadi, C. N., & Ogunniyi, A. I. (2021). Improving livelihoods through postharvest loss management: Evidence from Nigeria. *Food Security*, *14*(1), 249–265. https://doi.org/10.1007/s12571-021-01196-2

Badstue, L., Lopez, D. E., Umansteva, A., Williams, G., Elias, M., Farnworth, C. R., Rietveld, A., Njuguna-Mungai, E., Luis, J., Najjar, D., & Kandiwa, V. (2018). What drives capacity to innovate? Insights from women and men small-scale farmers in Africa, Asia, and Latin America. *Journal of Gender, Agriculture and Food Security*, *3*(1), 54–81. https://doi.org/10.22004/ag.econ.293588

Cozzens, S., & Sutz, J. (2014). Innovation in informal settings: Reflections and proposals for a research agenda. *Innovation and Development*, *4*(1), 5–31. https://doi.org/10.1080/2157930x.2013.876803

De Steenhuijsen Piters, B., Dijkxhoorn, Y., Hengsdijk, H., Brouwer, I., Tichar, T., & Carrico, C. (2021). *Synthesis report of the Global Fruits and Vegetables Scoping Study: Assessing opportunities for philanthropic investment* (Report No. 2021–113). Wageningen Economic Research. https://doi.org/10.18174/553671

Dijkxhoorn, Y., De Steenhuijsen Piters, C., Brouwer, I., Hengsdijk, H., & Tichar, T. (2021, October 1). *Enhancing fruit and vegetable consumption in low- and middle income countries through a food systems approach* (Report No. 2021–092). Wageningen Economic Research. https://research.wur.nl/en/publications/enhancing-fruit-and-vegetable-consumption-in-low-and-middle-incom

Feagin, J. R., Orum, A. M., & Sjoberg, G. (Eds.) (1991). *A case for the case study*. The University of North Carolina Press.

Floridi, A., Demena, B. A., & Wagner, N. (2020). Shedding light on the shadows of informality: A meta-analysis of formalization interventions targeted at informal firms. *Labour Economics*, *67*, Article 101925. https://doi.org/10.1016/j.labeco.2020.101925

De Andrade, G. H., Bruhn, M., & McKenzie, D. (2016). A helping hand or the long arm of the law? Experimental evidence on what governments can do to formalize firms. *The World Bank Economic Review*, *30*(1), 24–54. https://doi.org/10.1093/wber/lhu008

Henry, C., & Adams, J. (2018). *Spotlight on sexual violence and harassment in commercial agriculture: Lower and middle income countries* (Research Department Working Paper No. 31). International Labour Organization. https://researchrepository.ilo.org/esploro/outputs/encyclopediaEntry/Spotlight-on-sexual-violence-and-harassment/995219554102676

Herforth, A., Arimond, M., Álvarez-Sánchez, C., Coates, J., Christianson, K., & Muehlhoff, E. (2019). A global review of food-based dietary guidelines. *Advances in Nutrition*, *10*(4), 590–605. https://doi.org/10.1093/advances/nmy130

International Fund for Agricultural Development. (2021). *Transforming food systems for rural prosperity* (Rural Development Report 2021: Overview). https://www.ifad.org/documents/38714170/43704363/rdr2021_overview_e.pdf/503cf76b-2a61-1d7e-44bd-7b4bf3739b85?t=1631621451944

International Labour Organization. (2012). *Informal economy and atypical forms of employment*. https://www.ilo.org/resource/informal-economy-and-atypical-forms-employment

Kalmpourtzidou, A., Eilander, A., & Talsma, E. F. (2020). Global vegetable intake and supply compared to recommendations: A systematic review. *Nutrients*, *12*(6), Article 1558. https://doi.org/10.3390/nu12061558

Kinyanjui, M. N. (2010). *Social relations and associations in the informal sector in Kenya* (Social Policy and Development Programme Paper No. 43). United Nations Research Institute for Social Development. https://cdn.unrisd.org/assets/library/papers/pdf-files/kinyanjui-pp.pdf

Klerkx, L., Aarts, N., & Leeuwis, C. (2010). Adaptive management in agricultural innovation systems: The interactions between innovation networks and their environment. *Agricultural Systems*, *103*(6), 390–400. https://doi.org/10.1016/j.agsy.2010.03.012

Kok, M. G., Groot, J. J., Dastoum, S., Plaisier, C., Dijkxhoorn, Y., & Wagenberg, C. P. (2019). *A measurement tool on food losses and waste: Applied in a tomato value chain in Nigeria* (Report No. 1906). Wageningen Food & Biobased Research. https://doi.org/10.18174/470201

Liverpool-Tasie, L. S. O., Wineman, A., Young, S., Tambo, J., Vargas, C., Reardon, T., Adjognon, G. S., Porciello, J., Gathoni, N., Bizikova, L., Galiè, A., & Celestin, A. (2020). A scoping review of market links between value chain actors and small-scale producers in developing regions. *Nature Sustainability*, *3*(10), 799–808. https://doi.org/10.1038/s41893-020-00621-2

McGuire, E., Rietveld, A. M., Crump, A., & Leeuwis, C. (2022). Anticipating gender impacts in scaling innovations for agriculture: Insights from the literature. *World Development Perspectives*, *25*, Article 100386. https://doi.org/10.1016/j.wdp.2021.100386

Mekonnen, D. A., Termeer, E., Soma, K., Van Berkum, S., & De Steenhuijsen Piters, B. (2022). *How to engage informal midstream agribusiness in enhancing food system outcomes : What we know and what we need to know better* (Working Paper No. 2022-034). Wageningen Economic Research. https://doi.org/10.18174/567791

Nicolini, G., Guarin, A., Deka, R. P., Vorley, B., Alonso, S., Blackmore, E., & Grace, D. (2022). Milk quality and safety in the informal sector in Assam, India: Governance, perceptions, and practices. *Cogent Food & Agriculture*, *8*(1). Article 2137897. https://doi.org/10.1080/23311932.2022.2137897

Norbert, S., Kaka, Y., & Gona, A. (2023). Analysis of tomato (*Solanum lycopersicum L*) value chain in Kebbi State, Nigeria. *Direct Research Journal of Agriculture and Food Science*, *11*(8), 217–223. https://www.ajol.info/index.php/drjafs/article/view/269614

Nyamete, F., Majaliwa, N., & Chove, L. (2024). Food-based intervention for boosting micronutrient status and health—A comprehensive review. *World Journal of Food Science and Technology*, *8*(1), 23–34. https://doi.org/10.11648/j.wjfst.20240801.13

Petesch, P., Bullock, R., Feldman, S., Badstue, L., Rietveld, A., Bauchspies, W., Kamanzi, A., Tegbaru, A., & Yila, J. (2018). Local normative climate shaping agency and agricultural livelihoods in sub-Saharan Africa. *Journal of Gender, Agriculture and Food Security, 3*(1), 108–130. https://doi.org/10.22004/ag.econ.293590

Plaisier, C., Sibomana, M., Van Der Waal, J., Clercx, L., Van Wagenberg, C. P. A., & Dijkxhoorn, Y. (2019). Approach for designing context-specific, locally owned interventions to reduce postharvest losses: Case study on tomato value chains in Nigeria. *Sustainability*, *11*(1), Article 247. https://doi.org/10.3390/su11010247

Rivera-Huerta, R., & López-Lira, N. (2021). Innovation in the informal sector: The case of plastic recycling firms in Mexico. *African Journal of Science Technology Innovation and Development*, *14*(2), 291–301. https://doi.org/10.1080/20421338.2020.1864881

Roseboom, J. (2012). Creating an enabling environment for agricultural innovation. In *Agricultural innovation systems: An investment sourcebook* (pp. 449–537). The World Bank. https://doi.org/10.1596/9780821386842_CH06

Rothenberg, A. D., Gaduh, A., Burger, N. E., Chazali, C., Tjandraningsih, I., Radikun, R., Sutera, C., & Weilant, S. (2016). Rethinking Indonesia's informal sector. *World Development*, *80*, 96–113. https://doi.org/10.1016/J.WORLDDEV.2015.11.005

Saldana, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). Sage.

Schuetz, T., Förch, W., Thornton, P., & Vasileiou, I. (2017). Pathway to impact: Supporting and evaluating enabling environments for research for development. In J. I. Uitto, J. Puri, & R. D. van den Berg (Eds.), *Evaluating climate change action for sustainable development* (pp. 53–79). Springer. https://doi.org/10.1007/978-3-319-43702-6_4

Schoofs, S. (2015). *Making sense of informal economies in fragile contexts: Issues, dilemmas and questions* (Policy Brief). Conflict Resolution Unit, Netherlands Institute of International Relations. https://www.clingendael.org/sites/default/files/2016-02/PB_Informal_Economies_0.pdf

Sharma, G., & Dahlstrand, Å. L. (2023). Innovations, informality, and the global south: A thematic analysis of past research and future directions. *Technology in Society*, *75*, Article 102359. https://doi.org/10.1016/j.techsoc.2023.102359

Sibomana, M., Clercx, L., & van der Waal, J. W. H. (2019). An integrated analysis of tomato supply networks in Nigeria to improve efficiency and quality. *Acta Horticulturae, 1258*, 171–182. https://doi.org/10.17660/ActaHortic.2019.1258.24

Ugonna, C. U., Jolaosa, M. A., & Onwualu, A. P. (2015). Tomato value chains in Nigeria: Issues, challenges and strategies. *Journal of Scientific Research and Reports*, *7*(7), 501–515. https://doi.org/10.9734/JSRR/2015/16921

Vorley, B. (2013). *Meeting small-scale farmers in* their *markets: Understanding and improving the institutions and governance of informal agrifood trade*. International Institute for Environment and Development (IIED), Humanist Institute for Development Cooperation (Hivos), Mainumby Ñakurutú. https://www.inclusivebusiness.net/sites/default/files/wp/16548IIED.pdf

Walsh, P., Murphy, E., & Horan, D. (2020). The role of science, technology and innovation in the UN 2030 agenda. *Technological Forecasting and Social Change*, *154*, Article 119957. https://doi.org/10.1016/j.techfore.2020.119957

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Sage.

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Beyond self-report surveys: Leveraging multimodal large language models (MLLMs) for farmers market data harvesting from public digital resources

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Abstract

Traditional farmers market research using self-reported surveys has been constrained by high costs, extended timelines, recall bias, and frequently outdated findings. To address these limitations, this study introduced multimodal large language models (MLLMs) as a scalable, cost-efficient approach to extracting farmers market data through automated processing of diverse public digital sources, including websites, social media, photographs, and government documents. This study adopted a two-step framework to extract relevant information and transform unstructured multimodal data into an analysis-ready format. Benchmarked against the Michigan Farmers Market Census and Directory (MIFMA, 2024), our framework covered 76% of their topics. The MLLMs demonstrated robust performance, achieving near-zero hallucination rates, 98% accuracy of key variables extractions, and the ability to support real-time updates. While this approach cannot capture confidential or subjective data, it paves the way for a future hybrid framework that integrates the comparative advantage of two methods: MLLMs for efficient, factual data collection and human researchers for conducting targeted surveys to capture subjective insights. This

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efficient, reliable, and scalable approach empowered policymakers, market managers, and researchers to dynamically monitor trends and obtain accurate, detailed, and timely data, fostering resilient and inclusive food systems. Beyond farmers markets, the applications of this adaptive framework could extend to other domains, such as public health, urban planning, and economic policy, highlighting artificial intelligence (AI)'s transformative potential for streamlining data-centric decision-making.

Keywords
multimodal large language models (MLLMs), agricultural information systems, farmers market research, local food systems, structured data extraction, public digital sources, artificial intelligence, AI

Introduction

Farmers markets serve as vital nodes within local food systems, fostering economic resilience, community engagement, and equitable access to fresh produce. Effective management and evidence-based policymaking for farmers market sectors rely on accurate, timely, and operational data, such as vendor structures, fee schedules, and participation in nutrition assistance programs. Historically, this type of data has been collected through resource-intensive survey efforts. For example, the Michigan Farmers Market Census (MFMC), conducted by the Michigan Farmers Market Association (MIFMA), required managers to answer over 50 questions during hour-long sessions and provided financial incentives to participants exceeding US$50 per response (MIFMA, 2024). While these instruments have yielded valuable insights, their manual nature leads to standard survey limitations: high costs, recall bias, incomplete records, extended timelines, and rapid obsolescence. For instance, the 2021 MFMC report was released almost three years after the data collection (MIFMA, 2024).

Previous studies (Kreuter, 2013; Low et al., 2015) indicate that a significant amount of survey-collected data, especially factual information, might be optimized through the use of existing administrative records, thereby minimizing redundancy and improving accuracy. A case in point is the collection of data on food assistance program infrastructure in Michigan farmers markets. MFMC collected this data by surveying market managers and relying on their recall (MIFMA, 2024). However, a more reliable alternative existed: publicly available, compliance-grade records from the Michigan House of Representatives (2023). As a verified and complete dataset, it guarantees 100% coverage without any response rate concerns. Consequently, when fact-based content (e.g., program participation, funding allocations) exists in primary sources, continued data collection through surveys constitutes both methodological redundancy and resource misallocation (Meyer et al., 2015).

Recently, the richness of records that are available has significantly reinforced the value of document-based data collection. The breadth of publicly accessible data has grown exponentially since the early 2000s (Aziz et al., 2024; Meyer et al., 2015). This shift has lifted the technological constraints of traditional resourse-intensive survey methods. Nowadays, farmers markets utilize multiple digital platforms for customer engagement (e.g., messaging through social media) and operational administration (e.g., vendor application and agreements, seasonal schedules, bookkeeping DUFB transactions). Market rules, vendor agreements, and regulatory filings contained operationally critical details, from fee structures to product source standards, with precision that may exceed the reliability of the traditional survey responses. These fragmented but rich data streams, which were previously too cumbersome to analyze effectively, can now be efficiently parsed and structured using advanced natural language processing methods, including MLLMs.

Accordingly, this study sought to answer two important questions: (1) Can MLLMs systematically extract comprehensive farmers market data from public digital sources with greater efficiency and accuracy than traditional surveys? (2) To what extent can document-derived data replace traditional survey content? These questions were investigated through a Michigan-based case study, which used Google Gemini-2.0-Flash in a two-step framework to retrieve and structure data from 2,961 public documents (websites, social media, and government records) and approximately 3,000

application programming interface (API) calls for Michigan farmers markets. This methodology combined iterative prompt engineering with domain-specific taxonomies to convert unstructured inputs into analyzable data. Its effectiveness and coverage were assessed against the MFMC and the Michigan Farmers Market Directory (MFMD).

This study makes four major contributions. First, it pioneers a practical framework combining MLLMs with domain-specific taxonomies to systematically harvest structured data from fragmented public sources (e.g., social media, regulatory documents). The approach provides a replicable, cross-disciplinary model for domains such as urban planning, public health, and local food systems while reducing reliance on manual surveys. Second, the framework significantly expands the depth and contextual richness of collected farmers market data by capturing variables often omitted in traditional surveys, such as market stall management and vendor categories. Third, while preserving real-time monitoring capabilities, this automated method allows for smooth scaling, boosting the feasibility of large-scale initiatives both geographically (from Michigan to multistate and nationwide implementation) and temporally (from single-year snapshots to continuous multi-year analysis). Finally, the study positions MLLMs as a strategic addition to regular surveys, not a substitute. While the MLLMs cannot capture confidential data or subjective insights, they can enhance routine survey content, ultimately supporting more complete and policy-relevant datasets.

Literature Review

The following literature review examines the current state of farmers market data collection practices and the emerging potential of larges language models for automated data extraction. The analysis also covers established frameworks for evaluating model performance and accuracy metrics for document-based information extraction.

Methodologies in Farmers Market Data Collections

Farmers market research has largely relied on the same methodological foundation over the past three decades, primarily centered on qualitative interviews and focus groups and quantitative surveys. This dual approach was established through foundational studies conducted in the 1990s and early 2000s, including the work of C. Brown (2003), Hinrichs (2000), Holloway et al. (2007), and Guthrie et al. (2006). Despite survey design and research scope having been refined, the field has seen limited progress in adopting innovative data collection methods. Recent large-scale efforts, such as the USDA's 2019 National Farmers Market Managers Survey (USDA, 2020) and the Michigan Farmers Market Census (MIFMA, 2024), continued to rely on traditional approaches to a certain degree, namely, mail-in questionnaires, online surveys, phone surveys, etc. In parallel, research in the broader agricultural and rural development literature suggested that factual operational data, often gathered through surveys, may be more accurately and efficiently obtained through administrative records and structured public data sources (e.g., Low et al., 2015).

General Applications of LLMs in Automated Data Extraction

The application of large language models (LLMs) for automated data extraction has rapidly advanced across various scientific domains. In healthcare, LLMs have been employed to extract clinical information such as diagnoses and medications from unstructured patient notes with high accuracy, outperforming traditional rule-based systems (Gu et al., 2025; Siepmann et al., 2025). In the fields of chemistry and materials science, models have been used to mine complex properties from research literature, significantly reducing the need for manual data curation (Schilling-Wilhelmi et al., 2025). Social science researchers have applied LLMs to clean noisy historical records (Schwitter, 2025) and analyze crowdsourced geographic data (Huang et al., 2025). GPT-3 and similar models were able to extract scientific relationships into structured formats like Java Script Object Notation (JSON), as shown in materials chemistry by Dagdelen et al. (2024). Despite these developments, there is currently no documented application of LLM-based data extraction methods in local food system or farmers market research, where traditional surveys still dominate data collection practices.

LLMs and MLLMs in Document Analysis: Techniques and Performance Benchmarking

Extracting structured data from documents, including text, forms, images, and tables, has historically been challenging due to diverse layouts and unstructured text. Recent progress in LLMs and MLLMs research has provided promising solutions by interpreting text alongside its visual layout and semantics, mimicking human-like understanding (P. Liu et al., 2023). MLLMs have improved this capability by directly analyzing scanned documents using both textual and visual cues. However, these models depend heavily on well-crafted prompts to focus on relevant information and deliver accurate outputs, particularly for documents with high variability or novel structures. Research has shown that well-designed prompts can achieve reliable results without extensive retraining (Bommasani et al., 2022; T. Brown et al., 2020). Key strategies for optimizing prompt performance include specifying roles, using chain-of-thought prompting, incorporating exemplars, and employing synonymous terms (T. Brown et al., 2020; Lao et al., 2023; Wu et al., 2024; Y. Zhou et al., 2023). Despite their strengths, LLMs and MLLMs might not perform well when extracting multiple fields or answering numerous questions simultaneously from complex or semi-structured documents since they often struggle with reasoning through a large amount of content, especially when handling several types of information at the same time. A cutting-edge two-step approach might be a solution: first, generating plain-language interpretations, then converting them into structured schemas with a follow-up prompt (Wu et al., 2024; Y. Zhou et al., 2023). This stepwise method has outperformed single-shot extraction, aligned with human analytical processes, and been widely adopted in advanced document analysis systems (R. Liu et al., 2023).

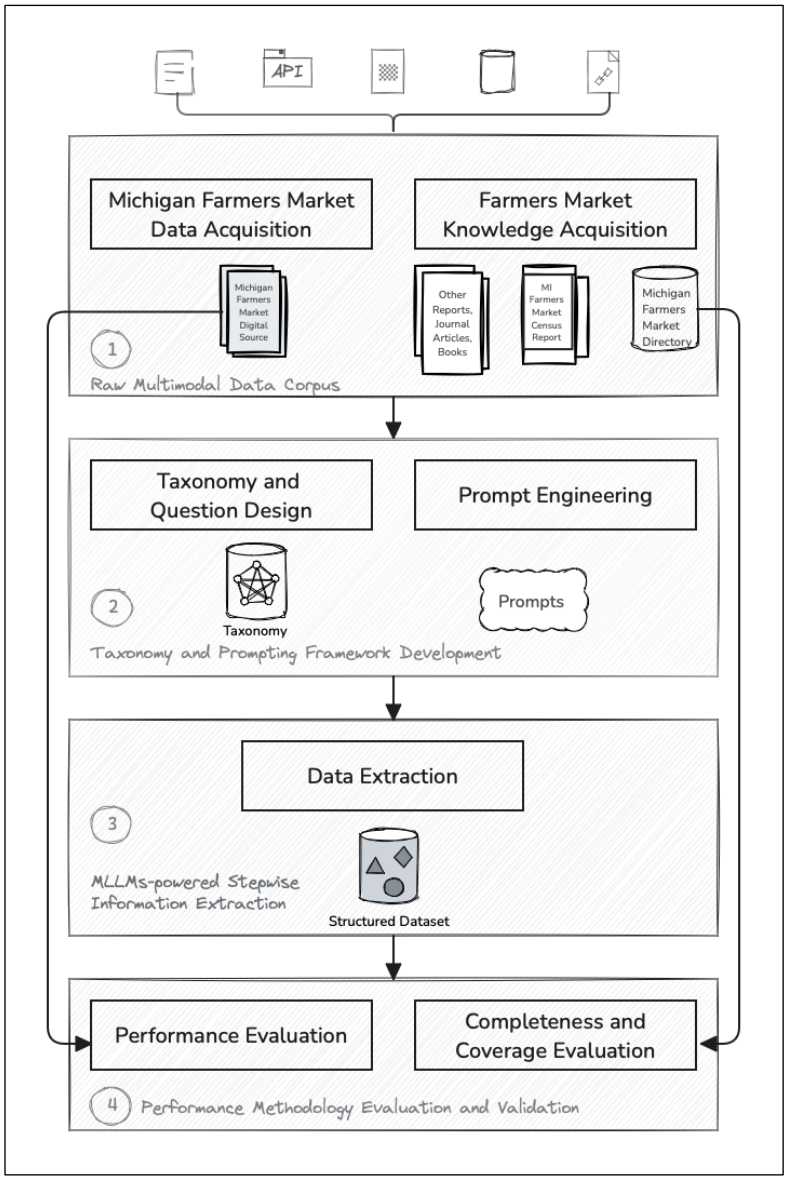
LLMs use prompt-driven reasoning to generate semantically rich outputs, though these responses can occasionally exhibit inconsistencies or gaps. Recent research has prioritized four core evaluation dimensions to measure the models' performance: accuracy, consistency, completeness, and hallucination rates. Accuracy is typically assessed using metrics such as Exact-Match, field-level similarity, token-level precision, question-answer correctness, and manual validation (Kumar, 2024; Ouyang et al., 2025; Sushil et al., 2024). Consistency refers to the model's ability to yield stable responses across identical or similar prompts and is evaluated using prompt sensitivity, output variance, and drift analysis (Greyling, 2024; Joshi, 2025; Lai et al., 2025). Techniques such as the "LLM-as-a-judge" framework also provide scalable solutions for benchmarking consistency in large-scale evaluations (Shah, 2024). Completeness assesses the model's ability to extract all relevant information, with coverage and recall as common metrics. Research has highlighted the role of prompt decomposition and stepwise querying, essentially a divide-and-conquer approach that breaks complex tasks into smaller, more manageable step-by-step tasks, in enhancing completeness, especially for complex documents (P. Liu et al., 2023; Rasool et al., 2024; Zhang et al., 2024). Hallucination, which refers to cases when AI systems generate unverifiable or fabricated information, can be detected from human verification to automated systems such as span/claim detection, retrieval-augmented generation, and knowledge graph comparison (Elchafei & Abu-Elkheir, 2025; Lee & Yu, 2025; S. Liu et al., 2025; Sansford et al., 2024; S. Zhou et al., 2022). These strategies are often integrated into hybrid workflows that combine automated checks with manual oversight to mitigate fabricated or unsupported outputs (Zhang et al., 2024). Together, these studies have established a robust framework for evaluating and improving LLM performance in document-based information extraction.

Methodology

This study used MLLMs to extract information related to farmers markets from digital sources. The workflow is illustrated in Figure 1.

Given the analytical demands posed by diverse multimodal content such as websites, social media posts, images, lengthy texts, and tables like farmers market bylaws, this study chose Gemini-2.0-Flash as the core MLLM based on three features: minimal hallucinations (Hughes et al., 2024), advanced reasoning (Jain, 2025), and scalable multimodal document handling (Google DeepMind, 2024).

Figure 1. Proposed Data Extraction Pipeline



Raw Multimodal Data Corpus

This study aimed to collect publicly available digital sources for Michigan farmers markets. All data acquisition activities adhered to terms of service permissions (e.g., robots.txt files) to ensure ethical data reuse (Hacker & Mason, 2003; Powell et al., 2022). No personally identifiable information was collected or stored, even if it was incidentally encountered during processing. Examples in this article used anonymized references (e.g., market name, detailed address) to prevent re-identification while preserving analytical value (Zimmer, 2018).

This study also did not interact with market personnel directly in order to comply with human-subject research ethics. Table 1 lists Michigan farmers market data sources. In addition, published farmers market surveys, reports, journal articles, and books were reviewed and synthesized to serve as knowledge bases for taxonomy design and prompt framework development.

Taxonomy and Prompting Framework Development

This work began by using Gemini-2.0-Flash to conduct unsupervised knowledge extraction from digital sources detailed in the Raw Multimodal Data Corpus section. The major goal was to identify key thematic areas (e.g., vendor management), entities (e.g., product categories), and contextual relationships (e.g., seasonal product availability). The taxonomy development followed an iterative, structured process. Initial themes and categories emerged from raw textual sources and farmers market knowledge bases. These were then systematically reviewed and refined to generate a coherent set of structured extraction prompts analogous to survey questions. To validate coverage and accuracy, the emerging taxonomy was compared against existing survey instruments to identify conceptual gaps or inconsistencies. New themes were developed to fill the gaps detected during this process. Iterative cycles refined the taxonomy through repeated revisions and testing against the original source documents to maintain interpretive accuracy and empirical relevance. Revisions continued until a stable, conceptually coherent taxonomy was achieved. This finalized taxonomy formed the foundation for developing structured prompts for the MLLM to extract, interpret, and organize relevant content.

One example of this work was the product eli-

Table 1. Public Data Sources for Michigan Farmers Markets

Source	Content	Data Format
Farmers market websites	Operational details, governance policies, vendor applications, annual reports, etc.	Markdown, PDF, Image, Word Document
Social media	Event announcements, community engagement metrics, promotional materials	Markdown, Image
Local news	Market establishment announcements, operational updates	Markdown
Lifestyle magazines, blogs, and travel websites	Curated listings, visitor perspectives, and promotional content positioning markets as cultural attractions and community highlights	Markdown
Government datasets	Nutrition program listings and regulatory documents	Markdown, PDF, Word Document, CSV
Local websites	Events and content related to farmers markets	Markdown, PDF, Image, Word Document
Events websites	Market schedules, locations, organizer details	Markdown
Additional public records	Geographic context (e.g., downtown), demographic data, urbanization levels (census tracts), population density, land use, zoning, public transportation, restroom availability	JSON (via API)

gibility issues for vendor management. The data extraction process started with unsupervised knowledge extraction from the sources and identified four categories (Table 2), which was a significantly different outcome from the MFMC (MIFMA, 2024).

The MFMC approach employed a purpose-driven, traditional survey framework comprising 18 static categories, which integrated product type, vendor type, and origin requirements. On the other hand, the MLLM method utilized discovery-driven data mining to create adaptive categorizations from unstructured document content. The process began by identifying granular product names (e.g., Strawberry) and was then applied to multiple categories, including product type (Fresh produce), vendor role (Direct producer), resale policy (Producer only), and origin requirements (within 50 miles). This method can reach analytical precision that the rigid frameworks (e.g., MFMC, in this example) might not be able to attain. These categories allow researchers to examine farmers markets from a variety of angles, such as (1) tracking seasonal dynamics through product-type ratios (Michigan markets move from early-season microgreens and nonperishables to peak-season vegetables and finally to autumn value-added products like apple cider), (2) quantifying authenticity threats (should farmers markets have fresh produce vendors?), and (3) classifying market typologies (flea markets have loose regulations and little fresh produce; community markets incorporate a variety of vendors with moderate produce; true produce markets prioritize direct-producer sales). It also enables the analysis of how policy enforcement, vendor composition, and targeted customer engagement initiatives collectively contribute to sustaining farmers markets' missions: promoting healthy local food, strengthening community connections, and supporting regional economies (a finding discovered through this MLLM analysis).

Given the complexity of the taxonomy-derived questions, a modular approach was adopted to prompt design by breaking schemas into smaller, related subschemas (e.g., separating "resale policy" from "product origin requirement") to improve output consistency and mitigate hallucinations. This methodology grouped questions into thematic clusters (e.g., vendor types, space or stall management), paired them with tailored instructions (e.g., are there rules or policies for competitive pricing or product dumping), and guided the model to extract specific answers.

Similar to the above taxonomy development,

Table 2. Product Eligibility Frameworks: MFMC vs. MLLM

Items	MFMC	MLLM
Data Collection	Purpose-Driven Survey	Discovery-Driven Data Mining
Categories of Products and Vendors	(1) Michigan farm products, sold by the producer or their representative (2) Honey (3) Cottage foods (4) Cut flowers (5) Food items not produced on farms (6) Plants (7) Handmade body care items (8) Handmade crafts (9) Prepared foods meant for immediate consumption (10) Food trucks (11) Michigan farm products, can be resold (12) Wild-harvested and/or foraged foods (13) Wine, hard cider, mead (14) Non-Michigan farm products (15) Non-handmade items, including multilevel marketing items (16) Topical CBD items (17) Pet supplies and treats (18) Services (e.g., knife sharpening)	**Product Category:** (1) Fresh produce (2) Bread and baking goods (3) Milk and dairy (4) Meat and seafood (5) Beverages (6) Condiments and sauces (7) Food trucks (8) Other food products (9) Plants and seedlings (10) Pet essentials (11) Crafts and artisan items (12) Services (13) Information table (14) Entertainment and activities (15) Others **Vendor Category:** (1) Direct producers (Farmers/Growers - Raw agricultural products) (2) Value-added producers (3) Prepared food vendors (4) Artisans and crafters (5) Nonprofit and community groups (6) Entertainment vendors (7) Other vendors **Resale Policy by Product Types:** (1) Producer only: Vendors must grow, raise, produce, gather, or create all products offered for sale at their booth (2) Allow limited reselling and maximum allowed [xx] percentage of resold products (3) No limitation for reselling **Geographic and Origin Requirements by Product Types** (1) Required radius ([xx] miles) for "locally sourced" products (2) Limited regions (e.g., Michigan Only, Upper Peninsula Only, Adjacent counties or states) (3) No geographic sourcing restrictions apply

the design of the prompts involved a systematically iterative refinement process with human-in-the-loop. The prompts were tested against a sample of documents covering diverse scenarios (e.g., reports, websites, vendor application forms, social media content, digitized survey responses, and market photos) and varied formats (pdf, html, docx, txt, md, jpeg, png, and others), as well as corner cases, such as lengthy texts, and documents with noises (e.g., news articles cluttered with ads). During this process, prompt engineering practices like chain-of-thought and few-shot prompting were adopted to improve the efficiency. The adjustments started with the feedback from an initial model output based on the taxonomy. The revised prompts were then embedded with these modifications, and the process was iterated until the prompts consistently performed well across all test cases in terms of accuracy and avoiding hallucination.

Stepwise Information Extraction

This study used a two-step structured data extraction process to improve the accuracy and output consistency of farmers market data extraction. First, we adopted Gemini-2.0-Flash as the MLLM to pinpoint and retrieve relevant plain language information from various sources. Prompts described in the Taxonomy and Prompting Framework Development section guided this process to focus the model on extracting the truly relevant, but unstructured, details. Then, the information extracted in the first step was combined with a predefined schema and specific prompts to transform the unstructured natural language answers into a structured JSON dataset that could handle both the flat tables in traditional surveys and hierarchical structures in data analysis aspects. The following example illustrated this process by transforming an unstructured social media post into analyzable data, using a Facebook post from a Michigan farmers market:

> We are thrilled to announce that vendor applications for the first [market name] are now open! The market will be held every other Saturday 9 am - 1 pm starting June 1st running through August. Please Like and Share this post so that we can reach as many folks as possible with this news. We are trying to increase access to fresh food in the [community name] area of our neighborhood and this is a big step in the right direction! Location: City High School Main Parking Lot, [address]. To apply for a vendor spot please complete the application here: [application link]

This message mixed announcements, operation details, and promotions in natural language. Table 3 illustrates how this two-step method was used to process the Facebook post with the designed framework. In the first step for contextual information retrieval, the system demonstrated its ability to understand the nuances of human language by locating pertinent data in plain language.

For example, it identified the context of phrases like "*first [Market Name]*" (indicating an inaugural year), "*every other Saturday 9 am - 1 pm starting June 1st running through August*" (an operating schedule), and "*Location: [school name] High School Main Parking Lot, [address]*" (a location description with detailed address). This step accurately isolated contextually significant details embedded in free-form text and focused on extracting the truly relevant details, whether structured or not. In Step 2, the MLLM applied the Taxonomy and Prompting Framework Development's structured prompts to organize unstructured data. For example, the model inferred that "*June 1st running through August, 2024*" corresponded to the date range 2024-06-01 to 2024-08-24. It interpreted "*Every other Saturday*" as implying a biweekly frequency on Saturday. "*High School Main Parking Lot*" was inferred to represent a site type as an educational institution. By using contextual reasoning, the model distinguished explicitly stated facts from implied content. Table 3 (Step 2 Output) shows the resulting JSON-formatted farmers market data, structured for seamless integration in statistical analysis and other applications.

Topic Coverage and Completeness Evaluation

Following USDA (2020), this study defined a farmers market as a venue that includes two or more vendors selling agricultural products directly to customers at a common, recurrent physical location. Because location is integral to this definition, markets that relocate seasonally (e.g., moving from an outdoor summer site to an indoor winter site) were considered separate market locations. To check how complete the data are and how well they cover topics related to farmers market research, this study used datasets from Michigan to compare two sources: (1) the MFMD (MIFMA, n.d.), a dataset for a consumer-oriented directory that was up to date as of May 15, 2025, matching our data collection deadline; (2) the MFMC (MIFMA, 2024), a management-focused survey report for Michigan farmers markets. The MFMD dataset contained a completed array of variables that permitted a direct and rigorous assessment of data availability and completeness against the MLLM dataset. However, a direct comparison with MFMC was not feasible for two reasons: (1) the MFMC report was published as a summary report without survey instruments and methodological documentation, and (2) the report was organized

Table 3. Example of the Two-Step Data Extraction Procedure

Data Item	Source Text	Answers from Step 1	Output from Step 2
Metadata	*Facebook, posted in 2024*	2024	{"post_year": 2024 }
Market Establish Year	*Vendor applications for the first [market name] are now open*	Market established in 2024	{"start_year": 2024, "#year": 1 }

Operation Schedule	*Every other Saturday 9 am –1 pm starting June 1st running through August.*	frequency: every other Saturday;
		
		time: 9 am – 1 pm;
		
		start: June 1st, 2024;
		
		end: August, 2024
			{
			"start_date": "2024-06-01"
			"end_date": "2024-08-24",
			"operation_month": [6, 7, 8],
			"weekdays": "Saturday",
			"frequency": "bi-weekly", "operation_time": {
			"start": "9:00",
			"end": "13:00" }
			}

Market Mission	*Increase access to fresh food in the community*	Increase access to fresh food	{
			"access_to_local_food": "yes",
			"connect_community": "",
			"boost_local_economy": "",
			"other": ""
			}

Location	*City High School Main Parking Lot, [address]*	Site: High School Main Parking Lot;
		
		Address: [address]
			{
			"site": "education institution",
			"surface": "parking lot",
			"street": "[street name]",
			"city": "[city name]",
			"state": "Michigan",
			"zipcode": "[zipcode] "
			}

Vendor Application	*To apply, complete application: [application link]*	Vendor application available at: [application link]	{
			"application_form": "yes"
			}

around thematic areas, which provided an overall response rate without itemized response metrics at the topic level. Therefore, the comparative analysis in this study adopted an "apples-to-apples" approach and concentrated on the topics explicitly reported within the MFMC.

Model Performance Evaluation

The evaluation measured model performance by accuracy, output consistency, and hallucination rates, based on a variety of data extraction tasks typical of farmers market data processing. Each task represented a defined information retrieval objective where the MLLM was prompted to extract a predefined set of data items. This framework included five distinct tasks reflecting common farmers market data types, testing model performance across modalities and complexities:

(1) Address Retrieval Task: Assessing basic entity extraction.
(2) Operational Schedule Retrieval Task: Evaluating the extraction of structured temporal data.
(3) Food Assistance Programs (FAP) Retrieval Task: Testing the identification of specific program participation.
(4) Vendor Fee Structure Retrieval Task: Assessing the ability to extract complex, often nuanced, financial details.

(5) Product from Images Task: Specifically testing the MLLM's multimodal capability to interpret visual data in conjunction with any accompanying text.

Technically, these tasks covered a spectrum of challenges, from straightforward directory facts (e.g., street and city variables in Address Task) to multimodal scenarios requiring visual-textual integration (e.g., product name in vendor images). This spectrum of difficulty helped align MLLM outputs and human annotations for a consistent and fair comparison. To systematically evaluate the performance of the proposed MLLM-based extraction pipeline, the study built a validation dataset consisting of 100 documents randomly selected for each task. Human annotators underwent training to carefully review the source documents and extract the relevant information according to the defined schema. The annotated values provided a ground truth benchmark used to assess the model's outputs.

Figure 2. Illustration of Operation Schedule Retrieval Verification

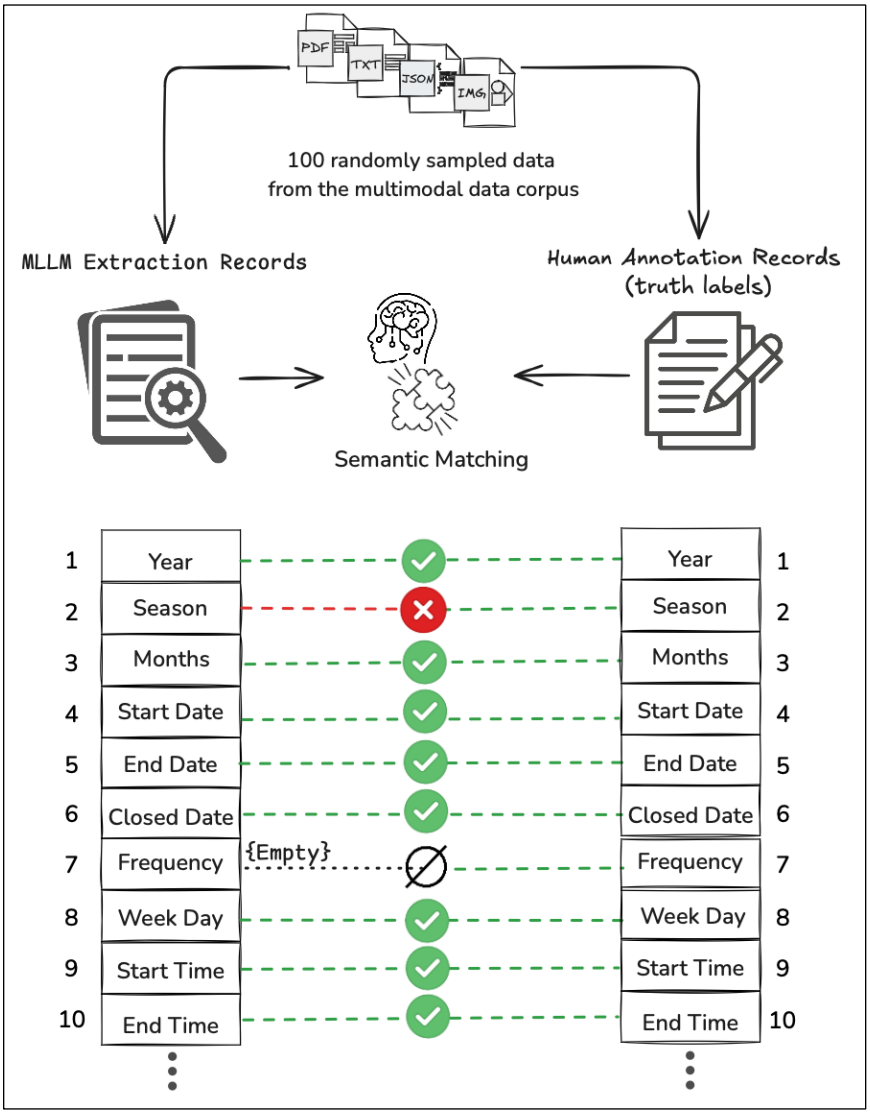


Figure 2 illustrates the accuracy evaluation workflow (one of three performance tests), benchmarking MLLM-extracted items against human-annotated ground truth per task, where:

(1) True Positive (TP): An item correctly extracted by the MLLM that semantically matches the ground truth (represented by a green tick in the conceptual figure).
(2) False Positive (FP): An item incorrectly extracted by the MLLM, or an item extracted by the MLLM that is not present in the ground truth (represented by a red cross).
(3) False Negative (FN): An item present in the ground truth that the MLLM failed to retrieve (represented by an empty set symbol).
(4) True Negative (TN): An item correctly not retrieved by the MLLM because it is also absent from the ground truth.

The aggregated counts of TPs, FPs, and FNs across the validation dataset were then used to calculate standard metrics *Precision*, *Recall* and *F-1*

score to represent the model's accuracy performance.

To gauge MLLM's reliability, the measurement incorporated hallucination rate, calculated as the number of fabricated or non-existent items retrieved by MLLM divided by the total number of items it retrieved across the validation set. In addition, this study measured output consistency to evaluate the model's stability by executing each extraction task on the validation documents 10 times using identical prompt settings. The consistency score for each task was measured by comparing the similarity of outputs across these 10 runs, and an overall consistency score was then derived by averaging these measurements across all validation cases.

Results

The data collection and extraction process produced comprehensive results across the three primary analysis focus. The following findings cover the scope of available digital source, performance benchmarking against established directories, and model performance metrics.

Raw Multimodal Data Corpus

Data acquisition spanned six weeks, followed by two additional weeks to complete the extraction process. As of May 15, 2025, the sources included 424 verified operational farmers market locations representing 348 distinct market organizers. This total has included 49 market locations active in 2024 and 375 confirmed for the 2025 season. This study compiled 2,961 documents from public sources (Table 4) and about 3,000 API calls, capturing fragmented digital presences across multiple documents per market. Newly established markets frequently lack centralized digital footprints (e.g., official websites or farmers market directories) and often rely on decentralized sources like local news articles or community social media posts. Specifically, we obtained 210 rules and regulations documents from publicly accessible market websites, representing a total of 248 market organizations and 320 market locations. Additionally, nine markets were identified as having such documents that were not available online but could be acquired through direct requests to market organizers. This indicates the potential to expand the dataset further through outreach efforts and appropriate data-sharing agreements.

Table 4. Publicly Available Digital Sources for Michigan Farmers Markets

Source	Data Format	Number of documents
Farmers market website	md, pdf, image, docx	830*
Social media channels	md, image, pdf	1,560
Local news	md	127
Lifestyle sources	md	145
Government datasets	md, pdf, txt, docx, table	8
Local community websites	md, pdf, images, txt, docx	90
Events websites	md	201
Other public records	JSON by API Calls	2,998

* Including 210 rules, regulations, and/or application documents

Table 5. Comparison of MLLM Results with Michigan Farmers Market Directory

Topics	MFMD	MLLM
Address	100%	100%
Operation Schedule	100%	100%
Marketing Channels	100%	95%
Food Assistance Programs (FAP)	57%	55%
Manager Name	100%	N/A
MIMFA Trained Manager	25%	N/A
Total Number of Records	**348**	**310**

Topic Coverage and Completeness Evaluation

In this study, the topic coverage was defined as the percentage indicating the proportion of MFMD and MFMC topics within each category that the MLLM dataset successfully captured. Table 5 compares the data coverage of the MLLM-

driven dataset, collected in 2024 and 2025, with the MFMD (MIFMA, n.d.). A key methodological divergence on seasonal markets was processed before a direct comparison. The MFMD aggregates seasonal locations under a single market entity per organizer, whereas our initial extraction recorded them as separate locations. The MLLM data was recoded to adopt the MFMD's convention, defining a "market" as an organizational entity rather than a physical location. Under this aligned framework, the MLLM-based dataset identified 348 markets from public digital sources, compared to the 310 markets listed in the Michigan Directory.

Of the total records, 298 farmers markets were found in both the MLLM dataset and the MFMD. The MLLM dataset excluded certain markets listed in the MFMD based on evidence from public sources that they were inactive (e.g., closed for construction) or permanently closed as of 2025. In contrast, the MFMD does not include several newly established markets (2024 and 2025) that were identified by the MLLM model. The MFMD appeared to include some farm stands that were outside the MLLM's farmers market inclusive criteria that at least two vendors are required in order to be considered a market. Both datasets provided full coverage (100%) for essential operational details like market address and schedule. Marketing channel inclusion was high (100% in the MFMD, 95% in MLLM), and coverage of food assistance programs was similar across sources (57% MFMD, 55% MLLM). In total, MLLM covered 4 out of the 6 variables (67%) in MFMD. Moreover, the MFMD uniquely captured administrative details less relevant to consumers: market manager names (100% coverage) and MIFMA-trained manager (25% coverage). This information was not collected in the MLLM dataset due to privacy considerations and limited public availability.

Table 6 compares MFMC and MLLM topic coverage. MFMC reported 176 market responses without topic-specific rates (MIFMA, 2024), while

Table 6. Topic Coverage Comparison of MFMC and MLLM

Topics	MFMC-Reported Items	#MFMC	#MLLM
Operation schedule	Operation Month, Weekdays	2	2
Location	Location Identification, Property Ownership, Indoor/Outdoor, Site Type (e.g., parking lots), Amenities, Customer Transportation Mode	6	5
Vendors	Vendor Count, Vendor Origin	2	2
Products	Products by categories, Cottages Foods by categories	2	2
Payments	Food Assistance Programs (FAP) counts, FAP transaction details, FAP infrastructures, and other accepted payments	4	3
Market organizer	Market Organization	1	1
Market manager	Responsibility, Pay, and Demographics	3	2
Volunteers	Has Volunteers, Total Volunteer Hours	2	1
Community issues	Community Activities and Engagement	1	1
Sponsor	Sponsors, How Sponsor Support Market	2	1
Labor force at markets	Employee Structure, Compensation, Demographics	3	0
Licensing and insurance	Licensing and Insurance	1	1
Budget and spending	Overall Budget, Budget Breakdowns, Total Revenue, Revenue Breakdowns	4	2
Training	Food Safety Training, MIFMA Certified Manager	2	1
Market evaluation	Visitor Counts, Vendor Matrix	2	0
Business Incubators	Market as Business Incubators	1	0
Longevity	Market Operation Years	1	1
Mission/Vision	Market Missions	1	1
Special topics	COVID, MIFMA leadership	2	0
Total		**42**	**26**

MLLM covered 348 markets with partial details. Among these, 210 markets included rules and regulations addressing detailed management topics, such as market organizers, managers, licensing and insurance, mission, vision, etc.

The table shows that the MLLM dataset captured 15 out of 19 topics (79%) and 26 out of 42 items (62%) from the MFMC. It reached 100% coverage on factual and operational topics, including operation schedules, locations, site characteristics, market size, vendors, products, season length, and mission statements. These topics were likely well-represented in publicly available digital sources. Partial coverage items included market governance (80%), market manager responsibilities (50%), volunteers (30%), community support (50%), vendor management (50%), food assistance programs (30%), budget and spending (5%), employment and compensation (10%), and market evaluation practices (5%), where data were often non-public. Demographics and time-sensitive special topics (e.g., COVID-19 issues) had no coverage, as MLLMs excluded personally identifiable information, even when such data might have been available in images on websites or social media, due to privacy constraints. By combining MFMD and MFMC, MLLM achieved 76% coverage (19/25 topics).

Model Performance Evaluation

Table 7 presents the MLLM's task-specific performance across five extraction tasks from farmers market datasets, evaluated using flexible semantic matching criteria.

The model demonstrated near-perfect performance on structured, text-based tasks, specifically on operational schedules (*F1* = 0.998), FAP identification (*F1* = 0.981), and vendor fee structures (*F1* = 0.974). Standardized, explicitly stated formats of these items led to high scores by minimizing ambiguity and enabling the model to achieve high precision with zero hallucination. In contrast, product retrieval from images (*F1* = 0.962) showed slightly diminished precision (0.944) and a small hallucination rate (1.9%), indicating the inherent challenges of interpreting visual content. The model performed reliably for prominent, centered items in an image but struggled with obscure, low-resolution, or peripheral elements, sometimes mislabeling or hallucinating objects. Address retrieval, while reaching a perfect recall, recorded the lowest precision (0.878). The decrease was largely due to inconsistent formatting and implicit contextual dependencies. Informal location descriptions (e.g., "Tractor Supply's parking lot") often omitted essential components such as street numbers or ZIP codes, while local shorthand in documents (e.g., "next to the County Courthouse") introduced ambiguity. As a result, the model's attempts to parse these informal descriptions sometimes led to false-positive (FP) records, which reduced the overall precision despite the impeccable identification of relevant descriptive phrases (perfect recall). In sum, these results validated the MLLM's capability to accurately extract structured information from both textual and visual farmers market sources. These consistently high-performing metrics across all tasks confirmed that this approach is a feasible solution for alleviating manual data entry burdens and achieving more comprehensive data collection. Meanwhile, challenges in clarifying complex addresses and subtle visual details also posed

Table 7. LLM Performance Metrics for Five Extraction Tasks

Tasks	Precision	Extraction Recall	Extraction F1-Score	Output Consistency	Hallucination Rate
Address Retrieval	0.878	1.000	0.935	0.995	0.000
Operational Schedule Retrieval	0.996	1.000	0.998	0.989	0.000
Food Assistance Programs (FAP) Retrieval	1.000	0.963	0.981	1.000	0.000
Vendor's Fee Structure Retrieval	1.000	0.950	0.974	0.963	0.000
Products Retrieval from images	0.944	0.981	0.962	0.929	0.019

an opportunity for the model's continued refinement.

Discussion, Limitations and Future Work

The application of MLLMS to farmers market documents analysis reveals both promising results and important consideration for effective utilizations. The following section addresses model's performance characteristics, the complementary relationship between automated extraction and traditional surveys, and the implication for broader research adoptions of the framework.

Performance of MLLM Method

This study introduced the first systematic application of MLLMs to automate farmers market data extraction from open online sources. The model achieved near-perfect retrieval performance on critical variables (e.g., operating schedules), confirming its reliability for structured text and image data extraction. This study used Google's Gemini-2.0-Flash as the MLLM due to its robust performance in analyzing both long-form text and visual data while maintaining low hallucination rates (Hughes et al., 2024). A key limitation of Gemini-2.0-Flash, like many proprietary models, is its lack of transparency in architecture and training data. To mitigate this, we adopted an iterative prompt engineering strategy to tailor the prompts to fit the farmers market data collection. Looking ahead, we plan to enhance the model's capabilities by (1) incorporating farmers market regulatory documents and expert-reviewed annotations to improve interpretation accuracy, and (2) combining Gemini-2.0-Flash with fine-tuned open-source multimodal frameworks, such as Llama (Meta, 2023), to build hybrid systems that prioritize transparency, adaptability, and enhanced multimodal capabilities.

Leveraging MLLMs to Enhance, Not Replace, Traditional Surveys

This study demonstrated the efficient extraction of data from public digital sources with unstructured traces. Based on comparison with the MFMD and MFMC, the MLLM framework successfully covered 76% of directory and survey contents, suggesting that it can take over a large share of routine data collection in farmers market surveys, such as MFMC. This study deliberately focused only on freely available sources in order to explore the utility boundaries of such data and illustrate what could be achieved using automated tools without relying on market manager surveys. This choice also echoed the existing research that has shown administrative records and digital sources often report operational details more consistently than self-reported survey data (Kreuter, 2013; Low et al., 2015) as well as prior calls to avoid redundant data collection while still maintaining rigor in community-based research (Meyer et al., 2015).

The comparison of the MLLMs framework with MFMD and MFMC confirmed that this method was not capable of collecting everything: MLLMs cannot access data that is private, subjective, or requires direct input from humans, such as manager opinions and employee compensation. Therefore, MLLMs cannot fully replace traditional surveys. However, this study showed that an MLLM approach can significantly augment and support the survey method. In addition to replicating the MFMD and MFMC survey content, this method was able to collect more detailed and expansive information that traditional surveys often do not capture. For example, in the "Location" category, it extracted market sites' walkability scores, urbanicity, demographic profiles, and zoning codes, offering a deeper view into the physical and social context of each market. Furthermore, MLLMs surfaced new themes not covered by existing surveys, including market governance practices and operational rules embedded in the markets' rules and regulations documents. These capabilities demonstrated how MLLMs can complement traditional survey methods by filling gaps in data collection and expanding the overall understanding of farmers market environments.

Future research should establish direct partnerships with farmers markets to streamline data collection. Rather than burdening managers with lengthy surveys for already publicly available facts, this approach would (1) request existing documents for objective data and (2) limit surveys to solely subjective or private questions. Under proper data-sharing agreements, such collaborations could provide privileged access to granular records, such as financials, transaction logs, cus-

tomer traffic analytics, and FAP data, and significantly enhance coverage beyond public sources alone.

Toward Scalable, Sustainable, and Structured Farmers Market Data Collection Across Time and Geography

This framework attained significant scalability by automatically harvesting and organizing decentralized factual data (e.g., operating schedules), offering three main advantages: (1) significant cost efficiency, with data extraction costing less than US$1 per market (API processing of less than 20K tokens at US$1.24/million tokens per market) compared to MFMC's minimum disclosed expenditure of US$50 (MIFMA, 2024); (2) immediate nationwide implementation, using standardized data extraction protocol and requiring no redevelopment across states or regions for consistent public data extraction; and (3) sustainable longitudinal tracking, where annual updates only require minimal marginal costs after the initial setup. This post-deployment cost structure, which solely includes document corpus and MLLM processing, makes longitudinal market surveillance economically viable, where traditional surveys remain highly resource-intensive.

Taxonomy-Driven Framework: A Paradigm for Transferable Research

In contrast to traditional surveys that flatten complex realities into tables, this study created a taxonomy-driven, two-step framework that demonstrated the potential of aligning unstructured data with structured schemas, enabling intuitive, human-like representations of information and relationships (such as fee structures) that mirrored the real-world relationships with maximum granularity. The method also drew attention to the practical utility of adopting AI: using this two-step framework, researchers (domain experts) can prioritize specialized knowledge over technical complexities. By minimizing the need for technology-intensive tasks, such as custom AI architecture, this framework allowed experts to iteratively refine outputs through prompt engineering while focusing on high-impact work: designing domain-specific schemas, optimizing data relationship representations, and leveraging extracted data for their research goals by eliminating barriers requiring deep technical skills in low-level engineering. In addition, this method's modular design could support cross-disciplinary transferability for researchers in other domains. By blending practical knowledge with scalable AI tools, this method could help researchers move beyond traditional survey constraints to generate equitable, adaptable findings.

Conclusion

This study pioneered the application of MLLMs to automate farmers market data extraction from public digital sources and provided a scalable and cost-effective data harvesting solution. By adopting Google Gemini-2.0-Flash with a two-step framework, the method systematically extracted Michigan farmers market data from various public sources. Compared to the MFMC and MFMD, this technique achieved an average accuracy of 98% on key variables and 76% on topic coverage. While MFMC's survey methodology cost a minimum US$50 per market in disclosed incentive costs, our AI-driven method extracted all data for less than US$1 per market after the initial setup, supported real-time updates, and had near-zero hallucination rates (0% for schedule extraction and 1% for image-based product identification). Though limited to publicly available data, the methodology could augment traditional surveys by automating the extraction of factual data from public records. The findings of this study provide a practical framework for local food system research, combining AI-processed public records and surveys to broaden access to timely, granular information for resilient and equitable food systems.

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References

Aziz, A., José Herrera-Murillo, D. J., Nogueras-Iso, J., Lacasta, J., & Lopez-Pellicer, F. J. (2024). Identifying the evolution of Open Government Data initiatives and their user engagement. *IEEE Access,* 12, 84556–84566. https://doi.org/10.1109/ACCESS.2024.3414282

Bommasani, R., Hudson, D. A., Adeli, E., Altman, R., Arora, S., von Arx, S., Bernstein, M. S., Bohg, J., Bosselut, A., Brunskill, E., Brynjolfsson, E., Buch, S., Card, D., Castellon, R., Chatterji, N., Chen, A., Creel, K., Davis, J. Q., Demszky, D., … Liang, P. (2022). *On the opportunities and risks of foundation models* (No. arXiv:2108.07258). arXiv. https://doi.org/10.48550/arXiv.2108.07258

Brown, C. (2003). Consumers' preferences for locally produced food: A study in southeast Missouri. *American Journal of Alternative Agriculture*, *18*(4), 213–224. https://doi.org/10.1079/AJAA200353

Brown, T. B., Mann, B., Ryder, N., Subbiah, M., Kaplan, J., Dhariwal, P., Neelakantan, A., Shyam, P., Sastry, G., Askell, A., Agarwal, S., Herbert-Voss, A., Krueger, G., Henighan, T., Child, R., Ramesh, A. A., Ziegler, D. M., Wu, J., Winter, C., … Amodei, D. (2020). Language models are few-shot learners. In H. Larochelle, M. Ranzato, R. Hadsell, M. F. Balcan, & H. Lin (Eds.), *Proceedings of the 34th International Conference on Neural Information Processing Systems* (pp. 1877–1901). Curran Associates. https://dl.acm.org/doi/10.5555/3495724.3495883

Dagdelen, J., Dunn, A., Lee, S., Walker, N., Rosen, A. S., Ceder, G., Persson, K. A., & Jain, A. (2024). Structured information extraction from scientific text with large language models. *Nature Communications, 15,* Article 1418. https://doi.org/10.1038/s41467-024-45563-x

Elchafei, P., & Abu-Elkheir, M. (2025). *Span-level hallucination detection for LLM-generated answers* (No. arXiv: 2504.18639). arXiv. https://doi.org/10.48550/arXiv.2504.18639

Google DeepMind. (2024, December 11). *Introducing Gemini 2.0: Our new AI model for the agentic era* [Technical report]. https://blog.google/technology/google-deepmind/google-gemini-ai-update-december-2024/#gemini-2-0-flash

Greyling, C. (2024, February 23). *LLM drift, prompt drift & cascading*. Medium. https://cobusgreyling.medium.com/llm-drift-prompt-drift-cascading-5a2ea2a5c455

Gu, B., Shao, V., Liao, Z., Carducci, V., Brufau, S. R., Yang, J., & Desai, R. J. (2025). Scalable information extraction from free text electronic health records using large language models. *BMC Medical Research Methodology, 25*, Article 23. https://doi.org/10.1186/s12874-025-02470-z

Guthrie, J., Guthrie, A., Lawson, R., & Cameron, A. (2006). Farmers' markets: The small business counter-revolution in food production and retailing. *British Food Journal, 108*(7), 560–573. https://doi.org/10.1108/00070700610676370

Hacker, K. L., & Mason, S. M. (2003). Ethical gaps in studies of the digital divide. *Ethics and Information Technology, 5*, 99–115. https://doi.org/10.1023/A:1024968602974

Hinrichs, C. C. (2000). Embeddedness and local food systems: Notes on two types of direct agricultural market. *Journal of Rural Studies, 16*(3), 295–303. https://doi.org/10.1016/S0743-0167(99)00063-7

Holloway, L., Kneafsey, M., Venn, L., Cox, R., Dowler, E., & Tuomainen, H. (2007). Possible food economies: A methodological framework for exploring food production–consumption relationships. *Sociologia Ruralis, 47*(1), 1–19. https://doi.org/10.1111/j.1467-9523.2007.00427.x

Huang, Z., Peng, P., Lu, F., & Zhang, H. (2025). An LLM-based method for quality information extraction from web text for crowed [*sic*]-sensing spatiotemporal data. *Transactions in GIS*, *29*(1), Article e13294. https://doi.org/10.1111/tgis.13294

Hughes, S., Bae, M., & Li, M. (2024). *Vectara Hallucination Leaderboard* [Python]. https://github.com/vectara/hallucination-leaderboard (Original work published 2023)

Jain, S. (2025, February 20). *Grok 3—The reasoning agent*. Medium. https://medium.com/@sulbha.jindal/grok-3-the-reasoning-agent-0eb8c97b55a0

Joshi, S. (2025). *Evaluation of large language models: Review of metrics, applications, and methodologies*. Preprints. https://doi.org/10.20944/preprints202504.0369.v2

Kreuter, F. (Ed.). (2013). *Improving surveys with paradata: Analytic uses of process information*. John Wiley. https://doi.org/10.1002/9781118596869

Kumar, S. (2024, February 28). *Detecting LLM hallucinations: Strategies and overview*. Medium. https://medium.com/@techsachin/detecting-llm-hallucinations-strategies-and-overview-57eea69e6a07

Lai, H., Liu, J., Bai, C., Liu, H., Pan, B., Luo, X., Hou, L., Zhao, W., Xia, D., Tian, J., Chen, Y., Zhang, L., Estill, J., Liu, J., Liao, X., Shi, N., Sun, X., Shang, H., Bian, Z., … On behalf of ADVANCED Working Group. (2025). Language models for data extraction and risk of bias assessment in complementary medicine. *npj Digital Medicine*, *8*, Article 74. https://doi.org/10.1038/s41746-025-01457-w

Lao, M., Pu, N., Liu, Y., Zhong, Z., Bakker, E. M., Sebe, N., & Lew, M. S. (2023). Multi-domain lifelong visual question answering via self-critical distillation. In A. El Saddik, T. Mei, R. Cucchiara, M. Bertini, D. P. Tobon Vallejo, P. K. Atrey, & M. S. Hossain (Chairs), *MM '23: Proceedings of the 31st ACM International Conference on Multimedia* (pp. 4747–4758). Association for Computing Machinery. https://doi.org/doi:10.1145/3581783.3612121

Lee, D., & Yu, H. (2025). *REFIND at SemEval-2025 Task 3: Retrieval-augmented factuality hallucination detection in large language models* (No. arXiv:2502.13622). arXiv. https://doi.org/10.48550/arXiv.2502.13622

Liu, P., Yuan, W., Fu, J., Jiang, Z., Hayashi, H., & Neubig, G. (2023). Pre-train, prompt, and predict: A systematic survey of prompting methods in natural language processing. *ACM Computing Surveys*, *55*(9), Article 195. https://doi.org/10.1145/3560815

Liu, R., Jafar, R., Girard, L. A., Thorlund, K., Rizzo, M., & Forsythe, A. (2023). P24 Improving efficiency of living systematic literature reviews (SLR) with artificial intelligence (AI): Assisted extraction of population, intervention/comparator, outcome, and study design (P-I/C-O-S). *Value in Health, 26*(12, Suppl.), S6. https://doi.org/10.1016/j.jval.2023.09.033

Liu, S., Halder, K., Qi, Z., Xiao, W., Pappas, N., Htut, P. M., John, N. A., Benajiba, Y., & Roth, D. (2025). *Towards long context hallucination detection* (No. arXiv:2504.19457). arXiv. https://doi.org/10.48550/arXiv.2504.19457

Low, S. A., Adalja, A., Beaulieu, E., Key, N., Martinez, S., Melton, A., Perez, A., Ralston, K., Stewart, H., Suttles, S. & Jablonski, B. B. R. (2015). *Trends in U.S. local and regional food systems: A report to Congress* (AP-068). U.S. Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/publications/pub-details?pubid=42807

Meta. (2023, February 24). *Introducing LLaMA: A foundational, 65-billion-parameter large language model* [Technical report]. https://ai.meta.com/blog/large-language-model-llama-meta-ai/

Meyer, B. D., Mok, W. K. C., & Sullivan, J. X. (2015). Household surveys in crisis. *Journal of Economic Perspectives, 29*(4), 199–226. https://doi.org/10.1257/jep.29.4.199

Michigan Farmers Market Association [MIFMA]. (n.d.). *Find a farmers market*. Retrieved May 15, 2025, from https://mifma.org/find-a-farmers-market/

MIFMA. (2024). *Census of Michigan farmers markets*. https://mifma.org/for-markets/census/

Michigan House of Representatives. (2023, January 5). *Double Up Food Bucks participating sites*. https://www.house.mi.gov/hfa/PDF/Agriculture/MDARD_DNR_Subcmte_Testimony_DU-MI-Participating-Locations-List_3-7-23.pdf

Ouyang, L., Qu, Y., Zhou, H., Zhu, J., Zhang, R., Lin, Q., Wang, B., Zhao, Z., Jiang, M., Zhao, X., Shi, J., Wu, F., Chu, P., Liu, M., Li, Z., Xu, C., Zhang, B., Shi, B., Tu, Z., & He, C. (2025). *OmniDocBench: Benchmarking diverse PDF document parsing with comprehensive annotations* (No. arXiv:2412.07626). arXiv. https://doi.org/10.48550/arXiv.2412.07626

Powell, A. B., Ustek-Spilda, F., Lehuedé, S., & Shklovski, I. (2022). Addressing ethical gaps in 'Technology for Good': Foregrounding care and capabilities. *Big Data & Society, 9*(2), 1–12. https://doi.org/10.1177/20539517221113774

Rasool, Z., Kurniawan, S., Balugo, S., Barnett, S., Vasa, R., Chesser, C., Hampstead, B. M., Belleville, S., Mouzakis, K., & Bahar-Fuchs, A. (2024). *Evaluating LLMs on document-based QA: Exact answer selection and numerical extraction using Cogtale dataset* (No. arXiv:2311.07878). arXiv https://doi.org/10.48550/arXiv.2311.07878

Sansford, H., Richardson, N., Maretic, H. P., & Saada, J. N. (2024). *Grapheval: A knowledge-graph based LLM hallucination evaluation framework* (No. arXiv:2407.10793). arXiv https://doi.org/10.48550/arXiv.2407.10793

Schilling-Wilhelmi, M., Ríos-García, M., Shabih, S., Gil, M. V., Miret, S., Koch, C. T., Márquez, J. A., & Jablonka, K. M. (2025). From text to insight: Large language models for chemical data extraction. *Chemical Society Reviews, 54*(3), 1125–1150. https://doi.org/10.1039/D4CS00913D

Schwitter, N. (2025). Using large language models for preprocessing and information extraction from unstructured text: A proof-of-concept application in the social sciences. *Methodological Innovations, 18*(1), 61–65. https://doi.org/10.1177/20597991251313876

Shah, D. (2024, November 1). Evaluating prompt effectiveness: Key metrics and tools. *Portkey* [Blog]. https://portkey.ai/blog/evaluating-prompt-effectiveness-key-metrics-and-tools/

Siepmann, R. M., Baldini, G., Schmidt, C. S., Truhn, D., Müller-Franzes, G. A., Dada, A., Kleesiek, J., Nensa, F., & Hosch, R. (2025). An automated information extraction model for unstructured discharge letters using large language models and GPT-4. *Healthcare Analytics, 7*, Article 100378. https://doi.org/10.1016/j.health.2024.100378

Sushil, M., Zack, T., Mandair, D., Zheng, Z., Wali, A., Yu, Y.-N., Quan, Y., Lituiev, D., & Butte, A. J. (2024). A comparative study of large language model-based zero-shot inference and task-specific supervised classification of breast cancer pathology reports. *Journal of the American Medical Informatics Association*, *31*(10), 2315–2327. https://doi.org/10.1093/jamia/ocae146

U.S. Department of Agriculture, Agricultural Marketing Service [USDA AMS]. (2020). *2019 National Farmers Market Managers Survey*. https://www.ams.usda.gov/services/local-regional/research-publications/fmms

Wu, H., Yuan, Y., Mikaelyan, L., Meulemans, A., Liu, X., Hensman, J., & Mitra, B. (2024). *Learning to extract structured entities using language models* (No. arXiv: 2402.04437). arXiv. https://doi.org/10.48550/arXiv.2402.04437

Zhang, Y., Fan, H., & Yang, Y. (2024). *Prompt-aware adapter: Towards learning adaptive visual tokens for multimodal large language models* (No. arXiv: 2405.15684). arXiv. https://doi.org/10.48550/arXiv.2405.15684

Zhou, S., Alon, U., Xu, F. F., Wang, Z., Jiang, Z., & Neubig, G. (2022). *DocPrompting: Generating code by retrieving the docs* (No. arXiv: 2207.05987). arXiv. https://doi.org/10.48550/arXiv.2207.05987

Zhou, Y., Muresanu, A. I., Han, Z., Paster, K., Pitis, S., Chan, H., & Ba, J. (2023). Large language models are human-level prompt engineers [Conference paper]. *The Eleventh International Conference on Learning Representations* (No. arXiv: 2211.01910). arXiv. https://doi.org/10.48550/arXiv.2211.01910

Zimmer, M. (2018). Addressing conceptual gaps in big data research ethics: An application of contextual integrity. *Social Media + Society*, *4*(2), Article 2056305118768300. https://doi.org/10.1177/2056305118768300

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"Not a siloed effort": Partnership strategies supporting regional grain value chains in the Upper Northeast, USA

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Abstract

The industrialization and commodification of grain production has had major environmental, health, and economic implications. Pushing back against this commodity system, grain value chains are emerging in the form of collaborations between farmers, millers, bakers, maltsters, and brewers. These partnerships are part of a broader movement toward the development of values-based supply chains in the food system, in which business partners establish long-term, strategic partnerships based on shared values like fairness, commitment

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to community, and environmental sustainability. In these arrangements, farmers capture a larger share of the food dollar than in commodity supply chains and are treated as valued partners rather than interchangeable suppliers. Despite the presence of localized grain value chains throughout the U.S., little research exists on their development or functioning. This study examines the nature of partnerships in grain value chains in the Northeast, where food-grade grain production is particularly challenging but nonetheless present. We present a multiple-case study of three established grain value chains—Maine Grains, Farmer Ground Flour, and Valley Malt—that examines the nature of their partnerships and the strategies they employ to navigate challenges in their values-based supply chains. The findings from this study, which are drawn from 41 in-depth interviews with grain growers, processors, end-users, and other key informants, demonstrate that developing committed, trusting, and interdependent partnerships that value one another's success is key to the functioning of these grain value chains.

Keywords
grain, grain value chain, local grain, Northeast, local and regional food systems (LRFS), values-based supply chains (VBSCs), value chain coordination (VCC)

Introduction and Literature Review

Over the course of the last 60 years, the industrialization and commodification of grains has had major environmental, health, and economic implications. In the U.S., communities have lost access to culturally significant and locally and agroecologically grown grains (Fedco Seeds, n.d.; Lindell, 2023; Wall Kimmerer, 2018). Grains have become global commodities and an industry dominated by four companies that control around 90% of the global grain trade (Murphy et al., 2012). In fact, collusion in global grain trade has occurred since the 1950s (Murphy et al., 2012). The intense consolidation and concentration in the grain sector leaves little to no room for small-scale producers to compete, affecting growers and communities worldwide (Heffernan et al., 1999; Murphy et al., 2012).

In response to these many threats and challenges, alternative grain movements are emerging globally as farmers, millers, maltsters, bakers, and brewers create noncommodity, local and regional grain value chains (Blair & Dimitri, 2017; Forrest & Wiek, 2021; Halloran, 2015; Simpson & McLeod, 2013; Ulmet, 2021). Organizations like the Maine Grain Alliance, the Artisan Grain Collaborative, the Colorado Grain Chain, and many others are evidence of this movement taking shape. These groups create a forum for sharing technical assistance and specialized equipment, provide access to suitable seed varieties, conduct market matchmaking, and raise consumer awareness to support small- and midscale farmers in grain value chains.

These grain value chains are part of a broader movement toward the development of values-based supply chains (VBSCs) in the food system, defined as long-term, collaborative business partnerships that prioritize values like price equity, transparency, and trust in their operations. VBSCs deliver value-added and differentiated end-products that allow farmers to capture a price premium (Stevenson & Pirog, 2008). A major goal of these models is to provide market access for small- and midscale farmers who cannot easily sell through existing commodity markets and for whom direct-to-consumer marketing outlets are insufficient (Dimitri & Gardner, 2019; Rosol & Barbosa, 2021). Grain networks based on values aside from profit are positioned to innovate and transform the marketplace (Choi, 2023).

Collaboration is crucial in grain value chains to overcome the many challenges they face. As examples, participatory methods are used to select, breed, and adapt alternative grain varieties to new regions and ensure their usability in both the field and end-use products through field trials and baking trials (Brouwer et al., 2016; S. S. Jones & Econopouly, 2018; Kissing Kucek et al., 2017; Sandro et al., 2022). Since the widespread adoption

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of roller milling in the 1900s, knowledge about stone milling and craft malting (which are more scale-appropriate to VBSCs) has largely been lost, so millers and maltsters have formed grassroots networks like the Craft Maltsters Guild and the Craft Millers Guild (Craft Millers Guild, n.d.; Craft Maltsters Guild, n.d.). Farmers work closely with millers and maltsters, who are in close communication with bakers and brewers, to understand specific needs along the supply chain.

Despite these collaborative efforts, challenges remain. In a needs assessment conducted from 2020 to 2022, the Northeast Grainshed Alliance (NGA) identified a number of critical obstacles inhibiting the development of the region's grainshed, including a lack of value chain coordination, insufficient infrastructure, limited access to primary and secondary markets, lack of purchasing commitments, and the high cost of growing food-grade grain varieties. "The most important action step" the NGA identified was for "people or organizations that can serve a bridging function between grainshed actors" to "bring buyers and sellers together, [facilitate] communication and [provide] supply chain coordination" (Northeast Grainshed Alliance, 2022, pp. 23–25).

Other research has revealed the challenges associated with grain value chains or local grain economies, many of which overlap with those of VBSCs more broadly. Our review of the literature identified five broad challenges that we investigated in this study: (1) Overcoming challenges associated with grain production and meeting food- or malt-grade grain quality specifications (Baker & Russell, 2017; Hills et al., 2013b; Stevenson et al., 2014; Stevenson & Pirog, 2013); (2) Securing and arranging post-harvest equipment and storage infrastructure in the supply chain (Baker & Russell, 2017; Blair & Dimitri, 2017; Hills et al., 2013a, 2013b; Ruhf & Clancy, 2022; Wang et al., 2020); (3) Developing effective logistical systems to plan for product aggregation, processing, and distribution, especially for procuring adequate grain supply (Hergesheimer & Wittman, 2012; Stevenson et al., 2011, 2014; Stevenson & Pirog, 2008); (4) Creating suitable contracts or agreements that facilitate risk-sharing among partners (Lev & Stevenson, 2013a; Stevenson et al., 2014; Stevenson & Pirog, 2008, 2013); and (5) Determining appropriate strategies for pricing and ensuring farmers' access to added value (Hergesheimer & Wittman, 2012; Hills et al., 2013a, 2013b; Lev & Stevenson, 2013a).

Understanding the partnership strategies that allow grain value chains to overcome these obstacles is therefore valuable for both the growth of grain networks and the development of VBSCs and regional food systems more broadly. This study examines how three established grain value chains in the Upper Northeast (the six New England states and New York state) are navigating these challenges. Our findings detail structural challenges and opportunities that may support the development of new grain value chains and clarify roles for organizations like the NGA, the Maine Grain Alliance, and university cooperative extension programs. It could also inform the development of VBSCs in other regions and in sectors that face similar obstacles, such as livestock, dry beans, and other staple crops.

Regionalizing the Northeast's Food System

A major goal of regional food system development is to move toward "regional food self-reliance," or producing as much food as possible for the region's population from within the region (Ruhf & Clancy, 2022, p. 62). Achieving regional self-reliance is a challenge for the Northeast because the region has a large population for its size (nearly a quarter of the U.S. population) and lacks large areas of land suitable for agriculture (just 3% of U.S. cropland) (Griffin et al., 2018). When assessing the potential for regionally grown grain in the 2014 *New England Food Vision* report, the authors call for being strategic as the region works toward increased self-provisioning (Donahue et al., 2014). While over half (56%) of farmland in the Northeast was dedicated to livestock feed production, only 8% was cropland in *food* production. Of that, food grains (grains for human consumption) accounted for the largest share of cropland (34%); yet this translated into a regional self-reliance rating (for grain for human consumption) of just 8% due to the fact that grain production requires a relatively substantial amount of land—an estimated five times as much land is needed for grain as for fruit and vegetable production (Griffin et al., 2015,

2018). An updated New England regional food system report in 2023 found that increasing the region's food self-reliance will require increasing regional grain production, which means agricultural land dedicated to food-grains would need to increase significantly (Peters et al., 2023). Considering the region's limited and decreasing amount of agricultural land, it would be unrealistic for the Northeast to provide even close to its total grain supply. However, grain's role in climate resilience through crop rotations and cover cropping, the benefits of regionally produced feed for local animal agriculture, and a flourishing market for local grain-based foods, beer, and spirits all underscore the need for increasing production and developing grain-focused value chains in this region (Donahue et al., 2014).

Values-Based Supply Chains to Regionalize the Northeast's Food System

In response to these efforts to increase regional food reliance, researchers are investigating VBSCs for their capacity to develop strategic partnerships along the supply chain to support price equity for farmers and create access to larger markets (Dimitri & Gardner, 2019; Rosol & Barbosa, 2021). VBSCs operate at a regional scale and handle "significant volumes" (Stevenson & Pirog, 2013, p. 3) of food products, offering the potential to contribute to regional food system development by both filling the marketing gap for midsized farms and aggregating products from many small farms (Clark et al., 2021; Hardesty et al., 2014; Stevenson & Pirog, 2008, 2013). VBSCs are generally better suited than direct marketing for low-value crops that require specialized cleaning and processing equipment, like food grains or legumes, when grown for local or regional markets. For the purposes of this paper, we use the term "grain value chain" for conciseness to refer to VBSCs that handle food grains, as distinct from the use of the term "value chains" used to describe commodity supply chains.

When faced with the impacts of the coronavirus pandemic, local and regional food systems, and VBSCs specifically, were recognized for their adaptability and resilience. Thilmany et al. attribute this "nimbleness" to the close relationships between supply chain partners that enabled them "to leverage community networks to find necessary inputs" (2021, p. 87). This ability of VBSC partners to quickly innovate under pressure starkly contrasted with the inflexibility of commodity and global food supply chains, which saw major disruptions.

Similarly, the small number of studies on local grain economies emphasize the values- and partnership-basis of grain value chains (e.g., Halloran, 2015; Ulmet, 2021). These studies highlight the mutually beneficial business partnerships (Baker & Russell, 2017); the connections between place, ethics, and passion for artisan products (E. Jones & Harvey, 2017); and the grower-to-miller and miller-to-baker-consumer links that are critical to the continuation of these networks, facilitating multiple connections and opportunities for the alternative grain network (Hergesheimer & Wittman, 2012). They emphasize the importance of trust among partners in these intermediated marketing chains and point out that "re-localization efforts for staple crops have been underrepresented in the local foods movement despite their importance in human diets" (Hills et al., 2013b, p. 29; 2013a). While the findings from these studies support the use of the VBSC framework, only one study we found has used this framework to examine a *grain* value chain. Lev and Stevenson's (2013b) case study provides an example of how a grain-based VBSC in the Pacific Northwest sourcing from about 20 growers determined a fair pricing structure, achieved economic sustainability, organized supply chain logistics, procured necessary equipment and infrastructure, and created effective internal organizational forms.

This small body of research reveals a need to understand the functioning of grain value chains more thoroughly. Forrest and Wiek call out the gap in existing research on the "size, structure, development, and sustainability" (2021, p. 508) of local grain economies. A gap also exists on the "[feedback] mechanisms between farmers, processors, handlers, and consumers," which is important to "increase efficiencies in sharing best practices, specifications, and needs throughout the [grain] supply chain" (Blair & Dimitri, 2017, p. 58). Our multiple-case study of grain value chains in the Upper Northeast contributes to this knowledge

gap by providing insights into the partnership strategies of three VBSCs that have persisted for over a decade. This study identifies key organizational elements connected to the functioning of grain value chains while also illustrating the importance of social relationships in shaping their overall effectiveness. In this way, the research contributes to understanding the barriers to the regional grain economy's growth and what might be needed to overcome those barriers. In addition, our study can support the development of new VBSCs in the region by demonstrating successful partnership strategies as well as lessons learned.

Applied Research Methods

This qualitative research uses a multiple-case study design to understand the functioning of three regional grain value chains in the Upper Northeast U.S. A multiple-case study design provided an appropriate framework for examining three distinct grain supply chains in sufficient depth and in comparison to each other (Yin, 2018). The three cases, Maine Grains, Farmer Ground Flour, and Valley Malt/Ground Up Grain, were selected after a year of preliminary research by the lead author that included nearly 20 conversations and attendance at five grain-focused events in the region. They were selected because they all meet the VBSC criteria as long-term, collaborative business partnerships prioritizing values like price equity, transparency, and trust in their operations (Stevenson & Pirog, 2008). All three cases are midscale processors that purchase primarily or exclusively Northeast-grown grain from multiple growers and sell to distributors, wholesalers, end-users (bakeries, breweries, distilleries, restaurants, etc.), and retailers, mainly within the region. Each is a privately owned business that began operating between 2007 and 2012 and has an aggregating intermediary entity (a flour mill or malthouse) that works closely with key partners on either side of the supply chain: farmers supplying grain, and bakers, brewers, and other end-users purchasing the processed product (cleaned grain, flour, malt, or other value-added product). The Northeast local grain sector as a whole is diverse, with some farms processing and marketing their own grains to consumers, some forming relationships directly with restaurants or breweries, and others contract growing (GrowNYC & Organic Growers' Research and Information-Sharing Network [OGRIN], 2016). These three cases represent the larger regional grain supply chains within the sector in terms of the number of producers, processors, and end-users involved, and those that fit the VBSC definition, of which there are likely fewer than 30 in the region.

Based on relationships the lead author established in the preliminary phase with the owners of the three grain processing businesses, the processor-owners invited key partners in each of their supply chains to participate in the study. The lead author conducted a total of 41 semi-structured interviews by Zoom or phone between August and December 2023 with each of the three owner-processors, and with three to four growers, four end-users, and one to three nonprofit or Cooperative Extension professionals directly involved in each of the three grain value chains. She also conducted interviews with an additional 10 key informants who worked outside the three grain value chains. The lead author began each interview by asking about the story and early development of the enterprise and its initial partners. The interviews included questions about the enterprise's organizational structure, its practices, the scale and type of its operation, its financial viability, and its current business partners. Next, the interviewer asked about the biggest challenges the enterprise has faced, how it has overcome them, and how its challenges have changed over time. If the challenge was not already raised, the lead author asked how the individual and their partners have navigated the five common challenges faced by grain value chains (and VBSCs broadly) identified in the literature review and preliminary research: grain production and quality, post-harvest handling, supply planning, contracts and agreements, and pricing.

All interviews were recorded, transcribed by a third-party transcription service, and analyzed with the qualitative analysis software NVivo. The lead author developed a coding scheme using Saldña's (2013) qualitative coding methodology. The coding scheme reflected the preliminary research and literature review to understand the nature of partnerships along the supply chain. Major themes in the analysis were the degree and effectiveness of trust,

transparency, communication, and information flow among partners, which are all factors identified as important to the functioning of VBSCs and the degree of fairness within the supply chain.

Once coding was complete, the lead author and a research assistant reviewed all material under each code and synthesized the findings for analysis. Considering the small number of regional food-grade grain processors in the Northeast, efforts to de-identify the three processors and many of the businesses in the study would have been extremely difficult. As a result, the lead author obtained consent from the study participants to use their names and their businesses' names in the case studies, with the exception of two farmers who elected to be de-identified. This research process was approved by the University of New Hampshire's Institutional Review Board in 2023 (#IRB-FY2023-201).

Findings

The following case descriptions provide a brief overview of the focal business of each of the three grain value chains (Table 1). We then present aggregated findings related to the five key challenges outlined in the Introduction and Literature Review, and the strategies the partners employ to address each challenge (Table 2). Based on our analysis we define *partnership strategies* as intentional actions that processors or intermediaries take, going beyond their basic business operations, that exercise values like trust and fairness. These findings address the questions, "What is the nature of partnerships in three grain value chains?" and "How do partners work together to overcome common challenges VBSCs and grain value chains face?"

Farmer Ground Flour

Thor Oechsner, an organic field crop grower in the Finger Lakes region of New York, founded the flour mill Farmer Ground Flour with another farmer in the area in 2008. Oechsner had been looking for ways to add value to his farm, as he realized he would otherwise need to dramatically expand his operation to support his livelihood in agriculture. The two farmers invited Greg Russo, a Cornell student who became the flour mill's first employee, to be one-third owner in the business. A few years after Farmer Ground Flour's founding, Oechsner teamed up with his close friend Stefan Senders to start a bakery down the street that would use Farmer Ground Flour to make bread and pastries, which they named Wide Awake Bakery. Oechsner and Russo are each still one-third owners of the flour mill, but the other founding farmer has since left the business, and a commercial electrician, Neal Johnson, joined the mill as an employee and co-owner. The mill continues to source grain from Oechsner as well as about 10 additional farmers in the area who grow organic grain. The mill sells flour wholesale to bakeries, restaurants, and co-ops, and wholesale-to-retail (two-pound bags) to Whole Foods, farm stores, and other retailers.

Maine Grains

Conversations among community members in rural Skowhegan, Maine, about reviving the state's local grain economy led to the first 'Kneading Con-

Table 1. Summary of Grain Value Chain Case Studies

Case	Organization type	Location	Motivation for starting	Year founded
Farmer Ground Flour	LLC, equally owned by one farmer and two mill employees	Trumansburg, New York	Add value to farm	2008
Maine Grains	C Corp, majority owned by CEO/co-founder	Skowhegan, Maine	Fill local/regional processing gap; Community development	2012
Valley Malt (VM) Ground Up Grain (GU)	Separate LLCs, both family-owned by the same owners	Holyoke, Massachusetts	Fill local/regional processing gap	2009; 2018

Table 2. Summary of the Partnership Strategies Employed in the Grain Value Chain Cases

Challenge(s)	Partnership strategy	Case(s) employing the strategy
Grain production and quality	Introduction of Crop Rotation beans as a branded product	Maine Grains
	Partnering with end-users for bake tests of grain quality and performance	Farmer Ground Flour; Maine Grains; Valley Malt
Grain production and quality; Supply planning	Annual farm visits before grain harvest	Valley Malt
Supply planning	Clear and ongoing communication with growers throughout the year	Farmer Ground Flour; Maine Grains; Valley Malt
	Farm and crop "matchmaking"	Farmer Ground Flour; Maine Grains; Valley Malt
	Annual planning with large-scale end-users	Farmer Ground Flour; Maine Grains; Valley Malt
Post-harvest handling	Lifetime leases on equipment	Maine Grains (Maine Grain Alliance)
	Technical assistance grants for equipment and infrastructure	Maine Grains (Maine Grain Alliance)
Contracts and agreements	Acreage contracts	Valley Malt; Maine Grains
	Processor provides seed to growers	Farmer Ground Flour; Valley Malt
	Required written contracts with all farm partners, with new or "high-risk" farm partners	Farmer Ground Flour; Valley Malt
Contracts and agreements; Pricing	Forward and fixed/historic-price contracts	Farmer Ground Flour; Valley Malt; Maine Grains
Pricing	Price premiums for growing location and practices	Farmer Ground Flour; Maine Grains

ference' in 2007 and the founding of the nonprofit Maine Grain Alliance in 2010. These initiatives provide technical assistance and convene bakers, millers, farmers, and other grain enthusiasts in workshops and discussions around local grain production, processing, and use. Observing the gap in local grain processing in Maine and seeing the potential for a flour mill to contribute to the community of Skowhegan's development, Amber Lambke, the Maine Grain Alliance's founding director, went on to co-found the gristmill Maine Grains in 2008 and launch the business in 2012. Lambke, originally a trained speech pathologist, continues to serve as the CEO of Maine Grains, whose other co-founder has since left. A certified organic facility, Maine Grains sources organic and untreated grain from farmers across the Northeast and sells its flour and grain products to bakeries, restaurants, breweries, grocers, co-ops, farm stores, and other retailers within the region.

Valley Malt and Ground Up Grain

Avid home brewers Andrea and Christian Stanley were inspired to explore local sourcing for their beer-making hobby when they learned that their favorite bakery down the street was attempting to grow its own wheat for flour. Inspired, the couple began looking for local ingredients to use in their

beer, but soon realized there was a missing link in the regional beer supply chain: malt. Quickly studying everything they could find about craft malting, the Stanleys, a vocational rehabilitation counselor and a mechanical engineer, set up their own malting operation in their basement and founded Valley Malt in 2009. Almost 10 years later, already having worked closely with Northeast farmers for almost a decade to source grain for their malthouse, the Stanleys were approached by the same local bakery about milling flour for its bread. The couple agreed and founded Ground Up Grain in 2018, which shares much of the same sourcing, equipment, and staff as Valley Malt. In 2021, the Stanleys received a grant through the state of Massachusetts to establish a grain hub in Holyoke, Massachusetts, where the two sister companies operate. The malthouse sells malt and grain to breweries, distilleries, and bakeries, and the mill sells flour to bakeries, bagel shops, pizzerias, farm stores, co-ops, and grocers throughout the Northeast.

Grain Production and Quality

> That's the trade-off of using local grain; [it] still has to deal with the weather.
>
> —*Zack Robinson, co-founder of Short Path Distillery*

Growing grains in the Upper Northeast proves much more challenging than in "typical" grain-growing regions such as the Cornbelt states. Moisture and humidity from the short, wet growing season make achieving food- and malt-grade quality specifications even harder. Grains used for human consumption must meet high quality parameters; they are strict for grain used for flour and stricter yet for grain intended for conversion to malt. Preharvest sprouting and fusarium head blight are two common challenges farmers in the Upper Northeast experience, which affect the quality of the starch and the prevalence of the mycotoxin deoxynivalenol (DON), respectively, in the grain. Farmers face the mounting effects of climate change through wetter summers, changes to winter snowpack, and harsher temperature fluctuations, all of which threaten the quality of their grain and its safety for human consumption. Researchers are continuing to work collaboratively with farmers to identify old varieties and breed new varieties that grow well in the region to maintain and build growers' access to food and malt grain markets.

Partnership Strategies

Grain that does not meet certain quality parameters can be difficult (and even dangerous) to use in baking or brewing. When they first started purchasing from Maine Grains in the mill's early years, South Portland, Maine, bakery co-owner Allison Reid stated, "[If] anything was up with the flour, we could call them right away, or text them, and we'd get an answer. And I just love that, that team effort, so to speak. And it's kind of been that way ever since." More recently, farmers struggled in 2023 when a beautiful spring turned into an unusually rainy summer. One Vermont bakery owner explained that their longstanding partnership with a farmer allowed them to overcome the rain: "[As] bad as the weather was this summer, . . . our farmers had this commitment with us. And they said, 'You know, if we have grain that's good, we'll sell it to you.' And so, [there were] lower yields with one of our main farmers, but [there was] plenty to be able to supply us for the year. So, [we're] able to weather those ups and downs." This commitment between partners allows for flexibility in navigating challenges like the weather. As the regional grain network has matured over the last decade and a half, grain quality has improved. As bakery co-owner Senders put it, "We've all been working out the bugs in our system, like our mechanical bugs, and the bread's better, the grain is better, the flour is better, everything's better."

Maine Grains took the initiative to increase the economic opportunity of its farm partners while supporting production practices that improve grain quality by marketing 'Crop Rotation' beans. To encourage its farmers to implement soil-enriching leguminous crop rotations (which, in turn, improve grain quality), Maine Grains began cleaning and selling the beans its farm partners were growing. Labeling these beans under the brand 'Crop Rotation' educates consumers about the importance of rotating crops in a farming system to support soil health, while providing both an incentive and a market for farmers to implement this practice.

A common strategy for assessing a new grain crop's "bake-ability" is for a processor to partner with a bakery to conduct bake tests. In both research and business settings, these partnerships are important for ensuring that a certain grain variety or a particular harvest will be usable for bakery customers. Ground Up Grain works with a local professional baker to test its farmers' grain quality every year; Farmer Ground Flour partners with its down-the-street neighbor, Wide Awake Bakery (where Oechsner is a silent part-owner); and Maine Grains works with retired professional bakers in the Northeast. Working with the same baker partners over the years creates a consistent and direct feedback loop for quality control and for helping the processors understand the qualities their bakery customers are looking for in a grain product.

Post-Harvest Handling

> I think there [are] a lot of people [who] say, "Oh, we need more infrastructure," which, we do need more infrastructure, but in the end . . . it's got to be more lucrative [for the farmer] to build that infrastructure.
>
> —*Sean O'Donnell, Maine organic farmer*

In localized grain value chains, a key component of post-harvest handling is the infrastructure needed for grain cleaning, drying, and storage. While commodity grain producers require their own extensive infrastructure, smaller-scale grain growers in these VBSCs face more difficulty in learning and troubleshooting cleaning and storage arrangements that suit their operations' budget and scale. Acquiring scale-appropriate equipment can be a challenge when most grain equipment and infrastructure is designed for large-scale, commodity agriculture. The scale of equipment that existed over 100 years ago when grain was still produced on a local scale is long gone in the U.S. June Russell, the director of regional food programs specializing in grains and staples at the Glynwood Center for Regional Food and Farming in Cold Spring, New York, described the beginning of the local grain movement in the Northeast: "[We] saw a lot of old, used equipment, like pre-1950s combines and grain cleaners, come out of old barns and get put back into use. That's definitely still a barrier—having scale-appropriate equipment. Not everybody needs a big, giant combine." Luckily, over time, farmers in the region have acquired better cleaning equipment and have set up better storage, which has improved the overall quality of food-grade grain.

This equipment and infrastructure challenge is pronounced for organic grain farmers, who typically grow a wider variety of crops in their rotations. One organic crop farmer explained,

> The challenge for small and particularly organic growers is we have to have a rotation of crops to manage weeds and nutrients and all sorts of other things. So, . . . we are often awful equipment-heavy for the size of our operation. It's like, "No kidding," you know, "there's an awful lot of steel around here that's expensive." But it's like, I don't know how to run the operation without it because we have this diversity in our business, you know?

This diversity supports soil health and provides multiple income streams for the farm business. Lambke sees this establishment of organic grain infrastructure building slowly over time in the Northeast: "[Certified] organic growers are slowly expanding acreage. We don't want a farmer to take too many big risks and then lose their shirt. We want them to grow gradually and smartly in a farm plan that makes sense for them. … Well, [growing organic grains] takes infrastructure investment—seeders harvesters, storage bins, dryers. That's a lot of money. … [This] is a long, slow game of building organic infrastructure." This gradual accumulation of infrastructure must happen in tandem with farmers securing their footing in marketing and sales, as borrowing money for infrastructure is difficult without a contract or a track record of sales.

Partnership Strategies

For farmers, having basic grain drying and storage infrastructure is necessary to meet food-grade grain specifications. Andy Morrill, a dairy and grain farmer in New Hampshire, learned the hard way that he could not let his food grain crop dry in the field. He has since set up storage bins and a grain dryer and learned to harvest slightly earlier: "[With]

the ability to put [the grain] through the dryer, we're able to get it out of the field before we're fighting as [many] disease problems or preharvest sprout issues." Additionally, because he made the investment in drying and storage infrastructure a few years ago, he was "able to salvage about 25 tons of wheat that otherwise probably would have been left in the field" during an unusually wet season. This infrastructure supports farmers in being able to produce food-quality grain—capturing the higher value from a food sale versus animal feed or cover crop seed—and hedge the risk of the weather.

Supporting farmers in accessing appropriate infrastructure is an important role of organizations like the Maine Grain Alliance and the Northern Grain Growers Collaborative in Vermont. The Maine Grain Alliance created an equipment and infrastructure program that gives farmers a "lifetime lease" on a piece of equipment that the organization formally owns. This allows the equipment to support Maine grain farmers while staying in the local grain network once a farm no longer needs it. The organization also offers technical assistance "mini-grants" of US$250 to US$1,000 to grain-based business owners in Maine, which, in recent years, have often been used for post-harvest grainhandling equipment. Noyes elaborates on the organization's approach:

> [We've] tried to meet each farm that we've been partnering with where they're at. Every farm is sort of in a different evolution of what they're doing, [has] different focuses, different needs. … [Rather] than say, "Everybody gets this thing," we try to take a really individualized approach to understanding what's the one thing with the funds that we had available that they … needed to be able to go to the next step.

While the Maine Grain Alliance is a separate entity from the flour mill, Maine Grains, the mill can point potential farm partners to the Maine Grain Alliance for support in acquiring the equipment and infrastructure they need to be able to eventually sell to the mill. As Lambke put it, "The Maine Grain Alliance obviously has been a key partner for Maine Grains the mill because, while we engage in different work, we support each other's missions."

The loss of scale-appropriate equipment for food-grade grains is true at essentially every point in the supply chain, including for flour milling. One company has filled some of this equipment gap by producing flour mills in a range of sizes using locally quarried Vermont granite to stone-mill flour, a practice that largely disappeared with the advent of roller mills in the late 19th century. New American Stone Mills, owned and founded by millwright Andrew Heyn, has a small team that produces these stone mills that serve regional processors like Farmer Ground Flour and Ground Up Grain in the Northeast, as well as over 100 bakeries, farms, restaurants, and food producers around the world.

Supply Planning

> [Usually], much of [the supply planning] for grain farmers occurs in the middle, like by grain … buyers and dealers. And … in the local food movement, those people don't exist, really. And so, … people have tried to [facilitate all] that within their shops. Amber does it, Andrea does it, Thor does it. And they've gotten better at it. And they've built relationships—but it certainly has taken them a lot of time to do that. And there's still uncertainty for all of them.
>
> *—Dr. Heather Darby, Extension Professor and Agronomic Specialist at the University of Vermont Extension*

As intermediaries, grain processors need to work with their partners on either side of the supply chain to plan for adequate grain supply while ensuring demand from end-users. Because these processors are relying on a small number of specific farm partners in these short supply chains, this planning often happens well before seed has been planted. These supply chain partners tend to come to agreement on the acreage or quantity of grain, grain variety, grain quality parameters, price, storage arrangement, and timing of delivery to the mill

in advance of the growing season, reducing uncertainty to the extent possible.

Partnership Strategies

Clear and consistent communication allows regional grain processors to manage grain supply planning. Stanley clearly defines and reiterates with Valley Malt's farm partners "the amount [of grain we] need, the price that it would be, the quality that is necessary, and who's going to take it and when" several times throughout the year: before the crop gets planted, during the growing season, right before harvest, and again around harvest time. In addition to this, 10 years ago the Stanleys began arranging annual field days at each of their partners' farms in the summer before harvest. "That's been really wonderful for our relationships, and for us just understanding what's going on each farm, and just getting that face time with the farms that we work with and their staff and … families." This in-person connection where the Valley Malt employees are able to meet their farm partners and see the grain in the field strengthens the company's partnerships with its farm partners and educates its malting and milling staff about grain production.

Planning for grain supply also requires extensive notetaking and coordination. Lambke has planning conversations with farmers in the winter before their spring groundwork and planting, "a year ahead of what [Maine Grains needs]." Lambke described the "matchmaking role" the mill plays, which entails working with growers to figure out who can supply which grains, keeping track of the commitments she already has with various farmers, and considering how those add up to meet their demand:

> A farmer will tell me that 30 acres of something is getting to be too small. … Well, I can punt that grain that I need over to the 30-acre farmer that has 10 free acres this year. And so that's not too small for them. … So, there's a little bit of matchmaking there to sort of match scale with demand and popularity of your product and keep enough things in the mix that achieve the mission. … [We're] going for biodiversity, … climate-adapted varieties, … good baking [and] cooking quality.

Russo similarly explained, "[It's] definitely not rocket science; it's just kind of spreadsheets," he determines, "we are going to want X number of pounds for the following year, and [we call] farmers: 'Who wants to put this in the ground?'" This "matchmaking" takes into consideration each farmer's scale, farming system, and available acreage that year as it relates to the needs of the processor and what they are already committed to purchasing from other growers.

Processors may or may not plan with end-users, depending on their relationship and the scale of product needed. Now that these processors have been operating for over a decade and have secured partnerships with farmers, the availability and quality of regional flour and malt in the Northeast has become much more consistent. Referring to another malthouse in the region, Brewmaster Jason Perkins at Allagash Brewing Company in Portland, Maine, who used almost 2 million pounds (or 1,000 tons) of Maine-grown grain in 2023, explained, "[Because] of the quantities and the predictability we give them, they're more or less malting for us, in a way. When they do a batch of grain in their malthouse, it's an 'Allagash batch' of grain that they're trying to hit our specifications [for]." In another example, Kate Galassi, the previous operations manager of Sfoglini Pasta Company in Coxsackie, New York, coordinated with Russo at Farmer Ground Flour for the year ahead: "[When] Greg is getting ready to purchase grain for the year and set up contracts [with farmers], he usually asks me for an updated annual forecast. I run all of my numbers of how much whole-grain pasta we've made in the last year, adjust based on current ordering volume … and send him an overall number." She adds, "We're in such a good routine at this point that my expectation of what they'll have and their expectation of what I'll order is very dialed in." Zack Robinson, co-founder of Short Path Distillery in Everett, Massachusetts, similarly described working closely with Stanley on "the timing of our single malt whiskey. …We try to plan it out six months in advance. We say, 'this is our goal for how many tons of grain we need and the cadence that we'll need them at.'" End-users operating at a smaller scale do not need this level of planning to

secure grain, malt, or flour from these regional processors.

This planning is almost "integrated," as Stanley put it, for processors, growers, and end-users who have been working together for many years. Rodney Graham, a New York organic grain grower for Farmer Ground Flour, stated, "They know me well. They know my farm operation well enough. Pretty much year in, year out, I've grown 70 acres and will continue to do that. … I'm really fortunate that they're in the area here. It's been great. Great people to work with." Similarly, Senders, co-owner of Wide Awake Bakery, said, "Surprisingly, [our communication is] actually so loose. I don't know. We just make stuff and then we give it to them and they grow stuff and give it to each other and grind it up. There's nothing to it." Stanley described one of her longest-standing farm partnerships as "a pretty well-oiled machine, that relationship." These partners have come to know each other's businesses and needs intimately through years of collaboration.

Contracts and Agreements

> With Christian and Andrea, they always come through; it's never been an issue. Contract or no, formal contract or informal contract. They've always done what they've said.
>
> —*Jeffrey Trout, New York grain farmer*

Grower and processor partners in grain value chains make different types of commitments based on their individual preferences, their relationship, and the institutional practices of the processor. Written contracts formalize the commitment between a grower and a processor and make clear the expectations of both parties, while verbal agreements feel sufficient to some partners. In both cases, the relationship-basis of these commitments means that partners tend to honor their end of the agreement, an important distinction from how commodity chains often operate.

Partnership Strategies

These supply chains all use forward contracts with at least some, if not all, of their farm partners. Forward contracts, which are agreements made in advance to buy or sell a specific quantity of grain at a predetermined price and date, are generally seen as beneficial to both the grower and processor. They create a commitment from both partners and outline specific terms and expectations before the sale of grain, and potentially before the grain is even planted. Tyler Murray, an organic grain farmer in New Hampshire, calls this "grow-to-order farming." This type of contract also typically sets the terms and expectations for pricing. In these contracts, the processor typically outlines how the grain will be priced depending on certain quality specifications, like protein level, falling number, and DON (mycotoxin) content. Tom Molloy, extension sustainable agriculture professional with the University of Maine, explained, "Historic price protects the buyer and the seller. If there's … a huge production issue and the wheat goes up to [US]$20 a bushel, there would be a protection in there for the buyer that the grower would not be able to 'gouge' the buyer and vice versa; so, as a seller, you might not get that [US]$20 bushel … but it goes both ways." Setting these terms in advance protects both partners. Spot contracts, in contrast, do not create the same long-term commitment between partners and do not allow for an advance agreement, as they are negotiated at the time of sale.

Purchasing by acre rather than yield (an "acreage contract" rather than a "bushel contract") reflects another form of risk-sharing between the grower and processor. In the case of a bad weather and low yield year, the grower is not expected to source additional grain from other farms to make up for the diminished yield. New Hampshire farmer Morrill provided an example: "This is a year where I had a commitment from a malthouse to buy 40 acres worth of grain. That commitment is 40 acres worth; there was no [requirement] on the tonnage or the bushels. Well, that 40 acres this year did not produce like it did a year ago. And everybody's kind of just been understanding of it."

In some cases, the processor provides or pays for the seed up-front as part of the contract or agreement with the grower. This is a way for the processor to make an up-front investment in the crop and show their commitment to purchasing grain from that grower. Processors may be more

likely to provide seed to farmers if they are looking for a heritage, ancient, or otherwise specialty grain variety that is uncommon and difficult to source. New Hampshire farmer Murray explains, "[If] they want 2,000 pounds of grain at a dollar a pound, [US]$200 would be the seed money when I plant it. … Then, once harvest comes to fruition in July, they would know what they have, and if it didn't come in as a good yield, they would lose that [US]$200." In other cases, processors can leverage their capacity to buy in bulk for a discounted price and pass it on to their grower partners. Making this gesture at the beginning of the season strengthens the commitment and partnership between the grower and processor.

Processors may require formal, written contracts as a strategy to avoid miscommunication or complications with some farm partners. Stanley described growers in their first few years of food- or malt-grade grain production as "high-risk." For her, having written contracts with these growers is especially important so that the partnership terms and grain quality specifications are outlined clearly. Stanley explains that it comes down to not yet having established trust:

> When you're in a new relationship with somebody … there's not a lot of trust established, so having a paper contract really does help. I would say the highest risk usually are those newer growers that we're working with, because it's just unknown how they operate, unknown how things will [go]. What you might assume somebody understands, they might not. What they think you might have said, you don't remember saying. Just normal kind of human communication breakdown can happen all the time. … With newer partners, sometimes you really don't know each other very well at all. So, trying to get everything in writing makes a lot more sense.

From the other perspective, farmers may feel more trust when a contract is in place. When a farmer works with a buyer for the first time, they also want assurance that the buyer will uphold their end of the agreement. Working through misunderstandings and continuing to make commitments to each other year after year is what builds this valuable trust between grower and processor partners.

In many cases, a verbal agreement is sufficient when there is strong trust between a grower and processor. The experience of overcoming challenges together, like bad weather, grain quality issues, and global supply chain disruptions from COVID-19 and global political unrest reaffirm partners' commitments to each other and build confidence that they will be able to work through more challenges together in the future, or, as millwright Heyn put it, "[weather] the ups and downs." Stanley stated, "[If] you have trust established with a partner … you know how to work through [miscommunications] because you've probably worked through some [difficulties] previously and gotten through it." Navigating challenges together builds trust, which strengthens the partnerships that persist through difficulties.

Pricing

> One of the challenges … is figuring out how to price the grain at what a baker can pay and what a farmer needs to make. Those are kind of tricky conversations to have. But more and more people are figuring … out how to make the economics work for both sides.
>
> —*Andrew Heyn, millwright and owner of New American Stone Mills*

For processors, determining a price that pays farmers fairly, covers the cost of processing, and is not "alienating for customers," as bakery owner Kerry Hanney put it, is a major challenge. Farmers and processors in these VBSCs are typically both "price-negotiators," meaning they work with each other to determine an appropriate price for the farmer's grain. Often, the farmer will set the starting price they need to cover their cost of production. Processors must then calculate how much they can pay the farmer while covering their lowest value market, which is often selling through distributors. Selling direct retail tends to provide the processor with the largest sales margin. Importantly, in these models, the savings derived from the reduced shipping cost from selling within the region allows for more money to end up in farmers' pockets.

Generally, there is more transparency in these grain value chains than in commodity supply chains. Long-standing, trusting relationships allow partners to talk about each other's costs openly and figure out a price that feels fair for both parties. This process for Stanley and Valley Malt's farm partners "is relationship by relationship and situation by situation. It's not very standardized," Stanley said. In addition to the farmer's cost of production (per acre or bushel), factors like increasing diesel prices, needing to purchase or fix equipment, the other crops the farmer is growing, and the availability of the particular grain variety play into this price negotiation. Dr. Julie Dawson, associate professor of plant and agroecosystem sciences at the University of Wisconsin-Madison, explained how this situation is different from pricing in commodity supply chains:

> [In] local/regional value chains, people are a lot more transparent about what things cost. If a farmer takes grain to an elevator, they may get docked on the price without knowing why, and then the purchaser is blending grain from many sources anyway. Commodity buyers are not helping the farmers make money. With a regional mill … they want the farmers to stay in business. They want to work with them. They want that supply. They're also often farmers themselves. They can have a conversation about, "Okay, how much work does this take me? How much work does this take you? What's a fair price?"

This transparency and supportiveness come from an understanding that these partnerships are mutually beneficial. Darby expressed, "It's exciting that people are willing to come together around risk, and pricing, and the needs of each other and their businesses. I mean, that's what makes this special."

Farmers who are more accustomed to selling through commodity or traditional markets may not transition seamlessly to selling through VBSCs. When grain prices spiked during COVID-19 and the beginning of the war in Ukraine, for example, Russo explained, "[We had to get] farmers to understand, like, 'Okay, yes, the market price is higher, a tiny bit higher than ours this year, but for the last 10 years, *our* price has been way higher. So, if you want to stick with us [Farmer Ground Flour] and have that stability in that relationship, that's up to you.'" Darby emphasized the importance of a "real commitment on both sides" to overcome the ups and downs in the broader market. She acknowledged that "a local food system [can] protect [partners] and provide them the resiliency, the ease in those hard times … but it would really take committed people that trust each other and believe in each other. Which, I think … happens over time." However, she continued, "A lot of that trust still hasn't been built for a lot of the farmers that we want to grow or could grow [food grains]. [Farmers] don't trust just anybody, so the real relationship [between partners] has to be built first."

End-users expressed a desire to maintain prices that are accessible to their customers. Baker Tim Gosnell of Standard Baking Company expressed that they "don't want [the bakery] to become so boutique-y that you have to be rich to buy bread. … We also want the farmers and Amber and everybody involved to get paid a fair price, too." While many end-users described the need to find this middle ground of pricing their products below a "boutique-y" rate but above the market rate to cover the cost of the added value, another baker felt strongly that the sustainability of the supply chain requires pricing to be comparable to any other similar product. Randy George, owner and baker at Red Hen Baking Co., conveyed,

> It's important to me that the pricing works for our business. We're not doing any farmers any favors if we can't operate a sustainable business that's going to stay in business and be able to continue to support them. That does mean that we have to be able to buy grain that is about the same price as what we could get from anywhere else (other organic sources). … We're in the same world as all the rest of the bakers and other food producers out there. If our bread has to be a few dollars more just because it's local, I feel strongly that it's not going to work out. … I really think that that's actually part of the sustainability equation in all of this.

JC Tetreault, co-founder and co-owner of Trillium Brewing Company, echoed this sentiment: "[You] can have your ideology, and … you can use an ingredient, but … the laws of supply and demand and price elasticity, those things all [still] apply." These businesses still operate within the conditions of the broader economy and need to attract customers and be profitable in order to function within these VBSCs.

The end-users' desire to maintain closer to market-based pricing directly conflicts with several farmers' opinion that the necessary price increase for their grain should be passed on to the customer. As one organic farmer put it, "to make a good product, it is a little more costly. So, I think [the processor] needs … to up their price a little bit. And if they're really offering a quality product, maybe the end user really would be willing to pay a little bit more." Reconciling a fair price for farmers with affordability for customers remains a challenge for some partners.

Partnership Strategies

Processors can show a commitment to local or in-state growers and to growers using certain production practices by providing price premiums. Seth Kroeck, farm manager of Crystal Spring Farm in Maine, explained that a malthouse in the state would give him a premium for his grain as long as it met the malt-grade specifications: "If we have a quality that's usable, then we'll talk about what it is he feels like he can afford. [The maltster] said, that said, he's happy to pay me a premium because … we're organic, we're [in-state], we're willing to tell our story." Offering price premiums supports these smaller-scale grain growers who struggle to achieve economies of scale.

End-users seemed overall comfortable as "price-takers," accepting the price of malt or flour that the processors set. Jonathan Stevens, co-owner and head baker at The Hungry Ghost Bread, shared, "I don't argue with [Andrea] about [pricing] because, first of all," he said in jest, "she's tough and she'll win. Second of all, I just need to trust her judgment. She does her job; I do my job." Robinson, co-founder of Short Path Distillery, similarly stated, "Well, she sets the price, and we pay it. How she arrives at [that] pricing is—she's transparent about it." For end-users, choosing to purchase the value-added and differentiated products through these VBSCs is a decision that represents their social, environmental, and economic values. Allison Reid, co-owner of Scratch Bakery in South Portland, Maine, explained, "There's so much more than price going into that bag [of flour] for us to decide to use that product. You know, it's education for our customers … it's education for our team. It's supporting a local company [Maine Grains], and a lot of local people that work there. So, it goes beyond the price. And I think that's the kind of stuff that you can't put a price on." Providing education and communication around the values embedded in their products is a critical step in selling these products to customers and justifying their higher price.

Discussion

Our study demonstrates how partnerships between VBSC actors develop into committed and often interdependent farmer-miller-baker and farmer-maltster-brewer relationships, and how the close nature of these partnerships is crucial to overcoming supply chain challenges and sustainably functioning as grain value chains. Interorganizational trust has been noted as a key component of successful VBSCs, which is "generated and maintained [by] reliability, fairness, competence, goodwill, loyalty, and respect for the risks and vulnerabilities associated with business models based on interdependence" (see Stevenson & Pirog, 2008, p. 125). Our study demonstrates that a high level of trust and interdependence is essential for overcoming the many barriers faced by grain value chain participants. Partners build trust by following through on their commitments to one another and collaboratively working through unexpected challenges with the understanding that their individual success is largely dependent upon the success of their partners.

Through years of collaboration, many supply chain partners became not only professionally, but personally, invested in each other's businesses. They described how their professional relationships often evolved into close personal friendships, and these friendships contributed to their trust in and commitment to one another. The personal

closeness of these relationships mirrors Saulters et al.'s (2018) finding of "fairness as relationships," or fairness in the supply chain being viewed and exercised as the way processors have developed and maintained relationships with their partners over time. These relationships were more collaborative and reciprocal in nature rather than transactional as in commodity supply chains, allowing farmers some amount of negotiating power.

Despite working closely with the same partners year after year, our study shows that these grain value chains are not linear, but rather dynamic and complex, making up a broader regional grain network. Previous research has reflected this finding that, rather than operating as distinct, linear supply chains, VBSCs resemble more of a network (Feenstra & Hardesty, 2016; Feenstra et al., 2011; Hardesty et al., 2014). In this regional grain network, many farmers sell to multiple regional processors, some farmers sell directly to end-users like bakeries and breweries, and other farmers directly retail their own grain or flour. Regional processors may even occasionally purchase grain from each other. Lambke emphasized the ways her vision was counter to the idea of a linear supply chain: "I've been more vocal about my recoil around the terms like 'supply chain' and 'value chain.' It implies linear. That, I don't think, is helpful. … I think, thinking of grain systems as clusters of relationships is helpful. And then you'll find you're welcoming in new people that you didn't think you'd be welcoming in." Our study of these partnerships illustrates how the complex, dynamic, and relationship-based nature of VBSCs is critical to their effectiveness, in contrast with the more linear structure and transactional nature of conventional commodity supply chains.

A key aspect of this network is the role of value chain coordinators. Throughout the study's interviews, the owners of the three grain processing companies were praised for their level of initiative, which went far beyond running their own businesses. The Wallace Center at Winrock International defines value chain coordination (VCC) as "a set of roles that foster soft infrastructure development … in the form of skills, competencies and relationships" (2019, p. 1). As detailed in the Wallace Center's "Value Chain Coordination Quicksheet," these individuals played many of the "primary" and "enabling" VCC roles, such as providing technical assistance, playing market-matchmaking, and organizing convenings and events, to support the VBSC as a whole. Without this level of investment in their partners' success, the grain processing businesses would not have been sustainable. Additionally, university Cooperative Extension, researchers, and nonprofit organizations (like GrowNYC, the Maine Grain Alliance, the Northern Grain Growers Collaborative, and the Northeast Grainshed Alliance) were critical in supporting the development and functioning of the regional grain network, especially in hosting events for knowledge-sharing and networking where individuals at different points in the supply chain could meet and form new partnerships. This study further demonstrates that developing social connections (the "soft infrastructure") is essential to the functioning of VBSCs and their ability to take risks, develop novel strategies, and work through challenges.

Current Related Work and Policy and Program Implications

These examples of partnership strategies could offer guidance for VBSC development in other sectors or places. They have already inspired similar models in other parts of the U.S. Northeast and Midwest, including grower-owned mills, a farmer-initiated grain center, and craft malthouses. There are currently over 60 craft malthouses and about as many artisan flour mills in the U.S., most of which were established in the time since the formation of the three grain value chains in this study.

Nonprofit organizations and university extension groups are developing technical assistance reports on topics like food-grade grain production (Cornell College of Agriculture and Life Sciences, n.d.; Hallweaver, 2017; Williams et al., 2023) and post-harvest grain handling (Artisan Grain Collaborative, n.d.-b; Noyes, 2020), and are bringing stakeholders together to support partnership development. The Artisan Grain Collaborative even created a documentary series called *Grain Chain Connections*, which demonstrates what some of these collaborative partnerships look like. It asserts, "Trusting relationships form the base of a

thriving regional grainshed" (Artisan Grain Collaborative, n.d.-a, para. 1).

Support for VCC is critical for the development of VBSCs and regional food systems. One example of how this work is being supported is through the Resilient Food Systems Infrastructure (RFSI) program, a U.S. Department of Agriculture (USDA) program that invests in equipment and infrastructure for the middle of the food supply chain. Through RFSI, the participating 56 states and territories could allocate a portion of their RFSI grant funds specifically to advance VCC efforts. This option represents the USDA's recognition of the importance of developing the "soft infrastructure" in these supply chains and networks. The Local Farms and Food Act, a bill introduced in both the House and Senate in April 2023, would further institutionalize USDA support for this coordination work to "meet critical and under-supported needs for local food system equipment, value-chain coordination, and business technical assistance" (Zaks, 2023, para. 4). Future USDA and state programs should similarly invest in VCC activities in tandem with providing equipment, infrastructure, marketing, and other support to farmers and food producers.

Conclusion

Our findings from this multiple-case study of three grain value chains in the Upper Northeast offer insights into the nature of VBSC partnerships and the ways in which partners work together to overcome challenges. While the structural challenges and opportunities the three grain value chains face are the same (or very similar), the relationships and the partnership strategies they employ vary. This research shows how relational factors, such as shared values, fairness, and trust, intertwine with structural factors like infrastructure, contracts, and pricing, and how the intertwining of these factors is likely vital to the functioning of VBSCs. This creates resiliency that helps these partnerships adapt to the challenges inherent to grain value chains and promotes the kind of systemic food system change these partners are working toward. Overall, developing committed, trusting, and interdependent partnerships that see value in one another's success is key to overcoming the challenges facing grain value chains.

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References

Artisan Grain Collaborative. (n.d.-a). *Grain chain connections*. Retrieved January 21, 2025, from https://www.graincollaborative.com/grainchainconnections

Artisan Grain Collaborative. (n.d.-b). *Post-harvest handling*. Retrieved January 21, 2025, from https://www.graincollaborative.com/post-harvest

Baker, B. P., & Russell, J. A. (2017). Capturing a value-added niche market: Articulation of local organic grain. *American Journal of Agricultural Economics*, *99*(2), 532–545. https://doi.org/10.1093/ajae/aaw100

Blair, H. R., & Dimitri, C. (2017). Bridging crop diversity and market development in the Northeast grain renaissance. *Journal of Agriculture, Food Systems, and Community Development*, *7*(4), 51–60. https://doi.org/10.5304/jafscd.2017.074.015

Brouwer, B. O., Murphy, K. M., & Jones, S. S. (2016). Plant breeding for local food systems: A contextual review of end-use selection for small grains and dry beans in Western Washington. *Renewable Agriculture and Food Systems*, *31*(2), 172–184. https://doi.org/10.1017/S1742170515000198

Choi, T. Y. (2023). *The nature of supply networks*. Oxford University Press.

Clark, J. K., Jablonski, B. B. R., Inwood, S., Irish, A., & Freedgood, J. (2021). A contemporary concept of the value(s)-added food and agriculture sector and rural development. *Community Development*, *52*(2), 186–204. https://doi.org/10.1080/15575330.2020.1854804

Cornell College of Agriculture and Life Sciences. (n.d.). *Small grains*. Retrieved January 21, 2025, from https://cals.cornell.edu/field-crops/small-grains

Craft Maltsters Guild. (n.d.). *History*. Retrieved April 5, 2024, from https://craftmalting.com/history/

Craft Millers Guild. (n.d.). *About the guild*. Retrieved April 5, 2024, from https://www.craftmillersguild.com

Dimitri, C., & Gardner, K. (2019). Farmer use of intermediated market channels: A review. *Renewable Agriculture and Food Systems*, *34*(3), 181–197. https://doi.org/10.1017/S1742170518000182

Donahue, B., Burke, J., Anderson, M., Beal, A., Kelly, T., Lapping, M., Ramer, H., Libby, R., & Berlin, L. (2014). *A New England food vision: Healthy food for all, sustainable farming and fishing, thriving communities*. Food Solutions New England. https://harvardforest1.fas.harvard.edu/publications/pdfs/Donahue_NewEnglandFoodVision_2014.pdf

Fedco Seeds. (n.d.). *Packer's Lima: A seed without a price*. Retrieved May 30, 2023, from https://fedcoseeds.com/seeds/seed-without-a-price.htm

Feenstra, G., & Hardesty, S. (2016). Values-based supply chains as a strategy for supporting small and mid-scale producers in the United States. *Agriculture*, *6*(3), Article 39. https://doi.org/10.3390/agriculture6030039

Feenstra, G., Visher, D., & Hardesty, S. (2011). *Developing values based distribution networks to enhance the prosperity of small and medium sized producers: Full study*. Sustainable Agriculture Research and Education Program, Agricultural Sustainability Institute, University of California Davis. https://sarep.ucdavis.edu/sites/g/files/dgvnsk5751/files/inline-files/DevelopingValuesBasedDistributionNetworksFullStudy_2011.pdf

Forrest, N., & Wiek, A. (2021). Growing a sustainable local grain economy in Arizona: A multidimensional analytical case study of an alternative food network. *Journal of Agriculture, Food Systems, and Community Development*, *10*(2), 507–528. https://doi.org/10.5304/jafscd.2021.102.031

Griffin, T., Conrad, Z., Peters, C., Ridberg, R., & Tyler, E. P. (2015). Regional self-reliance of the Northeast food system. *Renewable Agriculture and Food Systems*, *30*(4), 349–363. https://doi.org/10.1017/S1742170514000027

Griffin, T., Peters, C., Fleisher, D., Conard, M., Conrad, Z., Tichenor, N., McCarthy, A., Piltch, E., Resop, J., & Saberi, H. (2018). Baselines, trajectories, and scenarios: Exploring agricultural production in the Northeast U.S. *Journal of Agriculture, Food Systems, and Community Development*, *8*(2), 23–37. https://doi.org/10.5304/jafscd.2018.082.015

GrowNYC & Organic Growers' Research and Information-Sharing Network [OGRIN]. (2016). *Marketing local grains in the Northeast*. https://www.grownyc.org/files/gmkt/Grains/marketing_v7_web.pdf

Halloran, A. (2015). *The new bread basket: How the new crop of grain growers, plant breeders, millers, maltsters, bakers, brewers, and local food activists are redefining our daily loaf*. Chelsea Green Publishing.

Hallweaver, C. (2017). *Scaling organic grain production in Aroostook County: Report to Maine Technology Institute*. Maine Grain Alliance. [Electronic version in possession of the lead author]

Hardesty, S., Feenstra, G., Visher, D., Lerman, T., Thilmany-McFadden, D., Bauman, A., Gillpatrick, T., & Rainbolt, G. N. (2014). Values-based supply chains: Supporting regional food and farms. *Economic Development Quarterly*, *28*(1), 17–27. https://doi.org/10.1177/0891242413507103

Heffernan, W., Hendrickson, M., & Gronski, R. (1999). *Report to the National Farmers Union: Consolidation in the food and agriculture system*. Department of Rural Sociology, University of Missouri. Retrieved from the Institute for Agriculture & Trade Policy [IATP] website: https://www.iatp.org/documents/report-to-the-national-farmers-union-consolidation-in-the-food-and-agriculture-system-0208

Hergesheimer, C., & Wittman, H. (2012). Weaving chains of grain: Alternative grain networks and social value in British Columbia. *Food, Culture & Society*, *15*(3), 375–393. https://doi.org/10.2752/175174412X13276629245803

Hills, K. M., Goldberger, J. R., & Jones, S. S. (2013a). Commercial bakers and the relocalization of wheat in western Washington State. *Agriculture and Human Values*, *30*, 365–378. https://doi.org/10.1007/s10460-012-9403-9

Hills, K. M., Goldberger, J. R., & Jones, S. S. (2013b). Commercial bakers' view on the meaning of "local" wheat and flour in western Washington State. *Journal of Agriculture, Food Systems, and Community Development*, *3*(4), 13–32. https://doi.org/10.5304/jafscd.2013.033.022

Jones, E., & Harvey, D. C. (2017). Ethical brews: New England, networked ecologies, and a new craft beer movement. In N. G. Chapman, J. S. Lellock, & C. D. Lippard (Eds.), *Untapped: Exploring the cultural dimensions of craft beer* (pp. 1–13). West Virginia University Press. https://www.academia.edu/27343251/Ethical_Brews_New_England_Networked_Ecologies_and_a_New_Craft_Beer_Movement

Jones, S. S., & Econopouly, B. F. (2018). Breeding away from all purpose. *Agroecology and Sustainable Food Systems*, *42*(6), 712–721. https://doi.org/10.1080/21683565.2018.1426672

Kissing Kucek, L., Dyck, E., Russell, J., Clark, L., Hamelman, J., Burns-Leader, S., Senders, S., Jones, J., Benscher, D., Davis, M., Roth, G., Zwinger, S., Sorrells, M. E., & Dawson, J. C. (2017). Evaluation of wheat and emmer varieties for artisanal baking, pasta making, and sensory quality. *Journal of Cereal Science*, *74*, 19–27. https://doi.org/10.1016/j.jcs.2016.12.010

Lev, L., & Stevenson, G. W. (2013a). *Values-based food supply chains: An introduction to nine case studies*. The National Initiative on Agriculture of the Middle and The Center for Integrated Agricultural Systems. https://cias.wisc.edu/wp-content/uploads/sites/194/2013/04/introsectionfinal0725131.pdf

Lev, L., & Stevenson, G. W. (2013b). *Values-based food supply chains: Shepherd's Grain*. National Initiative of Agriculture of the Middle, Center for Integrated Agricultural Systems. https://cias.wisc.edu/wp-content/uploads/sites/194/2013/06/shepherdsgrainfinal0716131.pdf

Lindell, P. (2023, March 24). Payment for the past: Recognizing Indigenous seed stewardship. *Modern Farmer*. https://modernfarmer.com/2023/03/payment-for-the-past-recognizing-indigenous-seed-stewardship/

Murphy, S., Burch, D., & Clapp, J. (2012). *Cereal secrets: The world's largest grain traders and global agriculture*. Oxfam. https://www.oxfam.org/en/research/cereal-secrets-worlds-largest-grain-traders-and-global-agriculture

Neidecker, E. (2024). *From seed to sourdough and barley to beer: Values-based grain supply chain models to support mid-scale farm viability in the Upper Northeast* [Master's thesis, University of New Hampshire]. University of New Hampshire Scholars Repository. https://scholars.unh.edu/thesis/1892

Northeast Grainshed Alliance. (2022). *Raising the grain: A Northeast Grainshed Alliance action plan*. https://northeastgrainshed.com/wp-content/uploads/2022/11/Northeast-Grainshed-Alliance-Action-Plan-2022-.pdf [Website not accessible as of September 26, 2025]

Noyes, T. (2020). *Adding value to Maine grown grains through enhanced cleaning, drying, and storing solutions: Postharvest Grain Handling Project report*. Maine Grain Alliance. https://heritagegrain.net/wp-content/uploads/2024/04/Postharvest-Grain-Handling-Final-report-copy44.pdf

Peters, C. J., Barley, L., Borges-Mendez, R., Donahue, B., McCarthy, A. C., Schumann, S., Stoll, J., & von Wettberg, E. (2023). *A regional approach to food system resilience: Volume 2: Estimating production for 30% regional self-reliance*. https://nefoodsystemplanners.org/wp-content/uploads/NEFNE_Volume-2_Estimating-Production-for-30_-Regional-Self-Reliance.pdf

Rosol, M., & Barbosa, R., Jr. (2021). Moving beyond direct marketing with new mediated models: Evolution *of* or departure *from* alternative food networks? *Agriculture and Human Values*, *38*, 1021–1039. https://doi.org/10.1007/s10460-021-10210-4

Ruhf, K. Z., & Clancy, K. (2022). *A regional imperative: The case for regional food systems*. Thomas A. Lyson Center for Civic Agriculture and Food Systems. https://doi.org/10.5304/lyson.2022.001

Saldaña, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). SAGE.

Sandro, P., Kucek, L. K., Sorrells, M. E., Dawson, J. C., & Gutierrez, L. (2022). Developing high-quality value-added cereals for organic systems in the US Upper Midwest: Hard red winter wheat (*Triticum aestivum* L.) breeding. *Theoretical and Applied Genetics*, *135*, 4005–4027. https://doi.org/10.1007/s00122-022-04112-0

Saulters, M. M., Hendrickson, M. K., & Chaddad, F. (2018). Fairness in alternative food networks: An exploration with midwestern social entrepreneurs. *Agriculture and Human Values*, *35*, 611–621. https://doi.org/10.1007/s10460-018-9852-x

Simpson, S., & McLeod, H. (2013). *Uprisings: A hands-on guide to the community grain revolution*. New Society Publishers.

Stevenson, G. W., Clancy, K., King, R., Lev, L., Ostrom, M., & Smith, S. (2011). Midscale food value chains: An introduction. *Journal of Agriculture, Food Systems, and Community Development*, *1*(4), 27–34. https://doi.org/10.5304/jafscd.2011.014.007

Stevenson, G. W., Clancy, K., Kirschenmann, F., & Ruhf, K. (2014). Agriculture of the middle. In P. Thompson & D. Kaplan (Eds.), *Encyclopedia of food and agricultural ethics* (pp. 94–101). Springer Science + Business Media.

Stevenson, G. W., & Pirog, R. (2008). Values-based supply chains: Strategies for agrifood enterprises of the middle. In T. A. Lyson, G. W. Stevenson, & R. Welsh (Eds.), *Food and the mid-level farm: Renewing an agriculture of the middle* (pp. 119–144). The MIT Press. https://doi.org/10.7551/mitpress/9780262122993.003.0007

Stevenson, G. W., & Pirog, R. (2013). *Values-based food supply chains: Strategies for agri-food enterprises-of-the-middle*. The National Initiative on Agriculture of the Middle & The Center for Integrated Agricultural Systems. https://cias.wisc.edu/wp-content/uploads/sites/194/2013/04/valuechainstrategiesfinal0725131.pdf

Thilmany, D., Canales, E., Low, S. A., & Boys, K. (2021). Local food supply chain dynamics and resilience during COVID-19. *Applied Economic Perspectives and Policy*, *43*(1), 86–104. https://doi.org/10.1002/aepp.13121

Ulmet, M. (2021). *Building a resilient local grain chain: Perspectives from Colorado's farmers, millers, and artisan bakers* (Term paper, master of professional studies, Cornell University). https://hdl.handle.net/1813/111089

Wall Kimmerer, R. (2018, October 31). Corn tastes better on the honor system. *Emergence Magazine*. https://emergencemagazine.org/feature/corn-tastes-better/

Wallace Center at Winrock International. (2019). *Value chain coordination quicksheet: Roles of value chain coordination*. https://wallacecenter.org/wp-content/uploads/2020/07/Quicksheet_RolesofValueChainCoordination.pdf

Wang, J., Chatzidimitriou, E., Wood, L., Hasanalieva, G., Markellou, E., Iversen, P. O., Seal, C., Baranski, M., Vigar, V., Ernst, L., Willson, A., Thapa, M., Barkla, B. J., Leifert, C., & Rempelos, L. (2020). Effect of wheat species (*Triticum aestivum* vs *T. spelta*), farming system (organic vs conventional) and flour type (wholegrain vs white) on composition of wheat flour – Results of a retail survey in the UK and Germany – 2. Antioxidant activity, and phenolic and mineral content. *Food Chemistry: X*, *6*, Article 100091. https://doi.org/10.1016/j.fochx.2020.100091

Williams, K., Tautges, N., Mirsky, S., Hartman, A., & Dawson, J. C. (2023). *The new growers' guide to producing organic food-grade grains in the Upper Midwest*. UW Madison Extension Emerging Crops Initiative, Organic Grain Resources and Information Network, Michael Fields Agricultural Institute, & Artisan Grain Collaborative. https://cdn.prod.website-files.com/63e3d9a0146ea26d60fe357f/65d51e75a0eb32590b67ad2c_Food%20Grade%20Grains%20Guide%20Final%2002.08.2024.pdf

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE. http://study.sagepub.com/yin6e

Zaks, L. (2023, April 19). *Release: Local Farms and Food Act introduced in both houses* [Press release]. National Sustainable Agriculture Coalition. https://sustainableagriculture.net/blog/release-local-farms-and-food-act-introduced-in-both-houses/

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Local food system resilience in discourse and community practice: Findings from southern Wisconsin

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Abstract

This paper examines the discourse and practice of food system resilience through a community-based case study in southern Wisconsin. In response to COVID-19 disruptions, a farm-to-table restaurant collaborated with farmers, community members, and university researchers to launch the Brix Project, supported by USDA Local Food Promotion Program funding. Using community-based research methods and grounded in a political ecology framework, this study analyzes how resilience was defined, operationalized, and politicized by project collaborators. Although the project's grant framing emphasized market-based economic resilience, community actors envisioned a relational and transformative form of resilience rooted in abundance, flexibility, and stability. The study highlights how grassroots efforts tactically engaged with dominant resilience discourse to access resources,

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Statement on Any Previous Reporting of Data

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Author's Note

The author has a personal and professional relationship with the owners and employees at Brix Cider, LLC, that may be perceived as possible conflict of interest, including part-time employment during the course of the research project. The author also received a Graduate Research Assistantship through the USDA Local Food Promotion Program Grant to conduct Brix Project program activities. The author has pursued methods for maintaining the transparency and integrity of this research to the fullest extent of her ability.

while simultaneously advancing more integrated and politically conscious food system transformation. This work contributes to scholarship on transformative resilience by demonstrating how relational autonomy and community-rooted definitions of resilience can contest and reconfigure conventional food system structures.

Keywords
community-based research, food system resilience, relational autonomy, political ecology, Wisconsin, transformative change

Introduction

In March 2020, just one year after opening a farm-to-table restaurant and cidery in southern Wisconsin, USA, Matt and Marie Raboin closed their doors to protect staff and community at the onset of the global COVID-19 pandemic. Amid extraordinary uncertainty for the industry, the Raboins transformed their restaurant overnight into a community grocery delivery operation. They developed an online grocery platform to sell the food products that would otherwise have stocked their restaurant kitchen. They paid employees to process, pack, and deliver online orders and continued purchasing from local producers. Then, with no end in sight to the lockdown, the Raboins applied for a U.S. Department of Agriculture Agricultural Marketing Service (USDA AMS) Local Food Promotion Program (LFPP) grant. LFPP grants fund projects that "support the development, coordination, and expansion of local and regional food business enterprises that engage as intermediaries in indirect producer-to-consumer marketing" (USDA, 2025, p. 4), increasing accessibility of local foods as well as market development, and are awarded in amounts of US$25,000–US$750,000 depending on project type. The Raboins requested a grant to support their own restaurant business, and to develop growth in a regional food economy and build a more resilient food system.

This framing of the application highlights a growing trend in public discourse, policy, and agri-food scholarship that elevates resilience as a principle goal for food system interventions (Boyacı-Gündüz et al., 2021; Jones et al., 2022; Karniouchina et al., 2022; Kubatko et al., 2023; Worstell, 2020). The pandemic, by exposing fragile supply chains, poor working conditions, and disparate access to healthy food along class lines (Anderson, 2020), has amplified these calls. Generally defined as the capacity to respond to change through adaptation and/or transformation (Wood et al., 2023), resilience influences how we think about, interact with, and fund projects to shape a world that is fundamentally uncertain and dynamic (Zimmerer, 1994). These political and material consequences make it worthwhile to investigate how the concept is perceived and enacted—particularly from the communities and grassroots organizers that resilience scholarship and funding is intended to support (Beckwith, 2022).

In fall 2020, in partnership with a team of collaborators that included small-scale farmers, business owners, and university researchers, the Raboins were awarded a USDA AMS LFPP grant for the Brix Local Food Community Hub Project (the Brix Project), which proposed to strengthen both value chain and social connections within the regional food system. These connections would be intermediated by Brix Cider as a local food community hub; that is, the aggregator, processor, and distributor of local food, and the physical space for community to gather. A more connected regional food economy arguably would better withstand shocks and more easily adapt in the face of disruption. In other words, the food system would be more resilient.

This regional food system in southern Wisconsin is a diverse configuration of multigenerational family-owned dairy farms, diversified cropping systems, corn and soy farms, and both industrial and direct market-oriented operations. Farms follow national agro-economic trends of consolidation and corporate control, with the average dairy herd size increasing steadily alongside overall farm loss (D'Andrea, 2024). Although small-scale farmers have carved out niches in local and direct-to-consumer markets, pathways of food production and consumption are highly complex and traverse a local/national divide. For example, as a farm-to-table restaurant Brix Cider sources more than half of its food directly from local producers (Reynolds, 2023), nevertheless the restaurant is embedded in a

national service industry and economy that was vulnerable to the market and labor disruptions of the pandemic. Climate vulnerabilities are also more likely to impact small-scale producers, affecting the supply chain to Brix Cider.

If resilience is ultimately about how we interact with a world characterized by uncertainty and change, to orient toward resilience we must consider how producers and consumers within complex systems envision and enact their interaction. The Brix Project, with its use of resilience to frame food system interventions, provides a useful case study to explore these responses. Though specific to the food system of southern Wisconsin and its community of eaters, growers, and researchers, this case study contributes to broader ongoing discussions about food system resilience in the face of certain uncertainty and inevitable change.

Literature Review: Defining and Critiquing Food System Resilience

Today resilience animates broad-ranging analyses of social, economic, political, and environmental systems. It is not just a buzzword but a powerful discursive tool that shapes policy, research, and action in human-environment interactions. Nevertheless, as we have seen with sustainability and regenerative agriculture, this widespread usage has blurred the definition of the term. Broadly defined as the capacity to adjust and adapt to disturbance while retaining the core functionality of the system (Holling, 1973), resilience has been described by scholars as a fuzzy concept (Brand & Jax, 2007) and a "loosely organized cluster of concepts" (Carpenter & Brock, 2008, p. 40). Though some find this vagueness useful (Strunz, 2012), others argue that the looseness weakens the term's capacity for analyzing change (Cretney, 2014; Davidson et al., 2016).

Definitional ambiguity leads to a vague politics of resilience. As an ecological framework applied to social systems, resilience does not intrinsically incorporate social characteristics such as agency (Davidson, 2010), values (Côte & Nightingale, 2012), and power (MacKinnon & Derickson, 2013). Without clear calls for political analysis, resilience risks reinforcing the neoliberal paradigm of individual responsibility, naturalization of crises and vulnerability, and maintenance of a dominant status quo (Anderson, 2015; Grove, 2013; Joseph, 2013; Pugh, 2014; Walker & Cooper, 2011). For example, while initially theorized as the adaptive shift forward from disturbance and change, in practice resilience is most often articulated as "bouncing back" to a preexisting state (Davidson et al., 2016; Harris & Spiegel, 2019), suggesting—and affirming—maintenance of the current system.

Centering *transformative* resilience, when systems both reorganize and innovate in response to disruption, offers a pathway to a political analysis (Folke et al., 2010; Gotham & Campanella, 2010; Lyon, 2014). Transformative framing shifts resilience from persistence to intentional, fundamental system change. Few empirical studies, however, show transformative resilience in action. Furthermore, recommendations for food system transformation often ignore power asymmetries and fall short of addressing root causes of systemic problems (Slater et al., 2022). Regional food systems that are characterized by seasonal production, relatively few intermediaries (Marusak et al. 2021), and meaningful engagement with producer, food, and land (Sanderson Bellamy et al., 2021; Trauger & Passidomo, 2012), directly challenge the root assumptions of the industrial food system, and therefore provide a starting place for understanding and implementing transformative resilience.

Food System Resilience

Tendall et al. (2015) define the food system as the multi-scalar ecological, social, economic, and political relationships and processes involved at all levels of food production, processing, distribution, and consumption; food system resilience, then, is the **"**capacity over time of a food system and its units at multiple levels, to provide sufficient, appropriate and accessible food to all, in the face of various and even unforeseen disturbances" (p. 19). Though this definition depicts the *what* of food system resilience, it does not necessarily address the *how* (Jones et al., 2022), nor a politics of change. Small-scale farmers participating in the global food economy experience economic vulnerabilities due to fluctuations in prices, unreliable demand, and market shocks (Valencia et al., 2019), as well as ecological vulnerability from extreme climate events and bio-

diversity threats (Ericksen, 2008). These vulnerabilities create the political landscape within which possibilities for resilience are shaped and enacted.

The field of political ecology (PE) recognizes that socio-ecological change occurs within political, economic, and cultural contexts and differentially impacts vulnerable populations (Blaikie & Brookfield, 1987; Forsyth, 2003; O'Brien et al., 2007; Peet & Watts, 2004). This commitment to contextual political analysis can enrich resilience efforts with greater equity and fairness (Cutter, 2016). Additionally, the place-based analysis PE offers can help ground resilience within lived experiences and grassroots action (Beckwith, 2022; Brown, 2015). As Hedberg (2021) suggests, empirical analyses of specific places and processes, coupled with analyses of vulnerability and justice, will create a more robust understanding of food system resilience. For example, Cretney and Bond (2014) illustrated how grassroots groups employed resilience to access funding for community projects that created transformative alternatives to capitalism, ultimately re-negotiating the power relations embedded in resilience frameworks. More recently, Ladyka et al. (2022) examine the impacts of the pandemic on small, direct-market farms, arguing that farmer experiences of struggle, vulnerability, and resilience were more nuanced than common pandemic narratives would suggest. These studies illuminate how investigating actions involving resilience, in conversation with power and vulnerability, would do much to resist the term's apolitical trap.

Methods

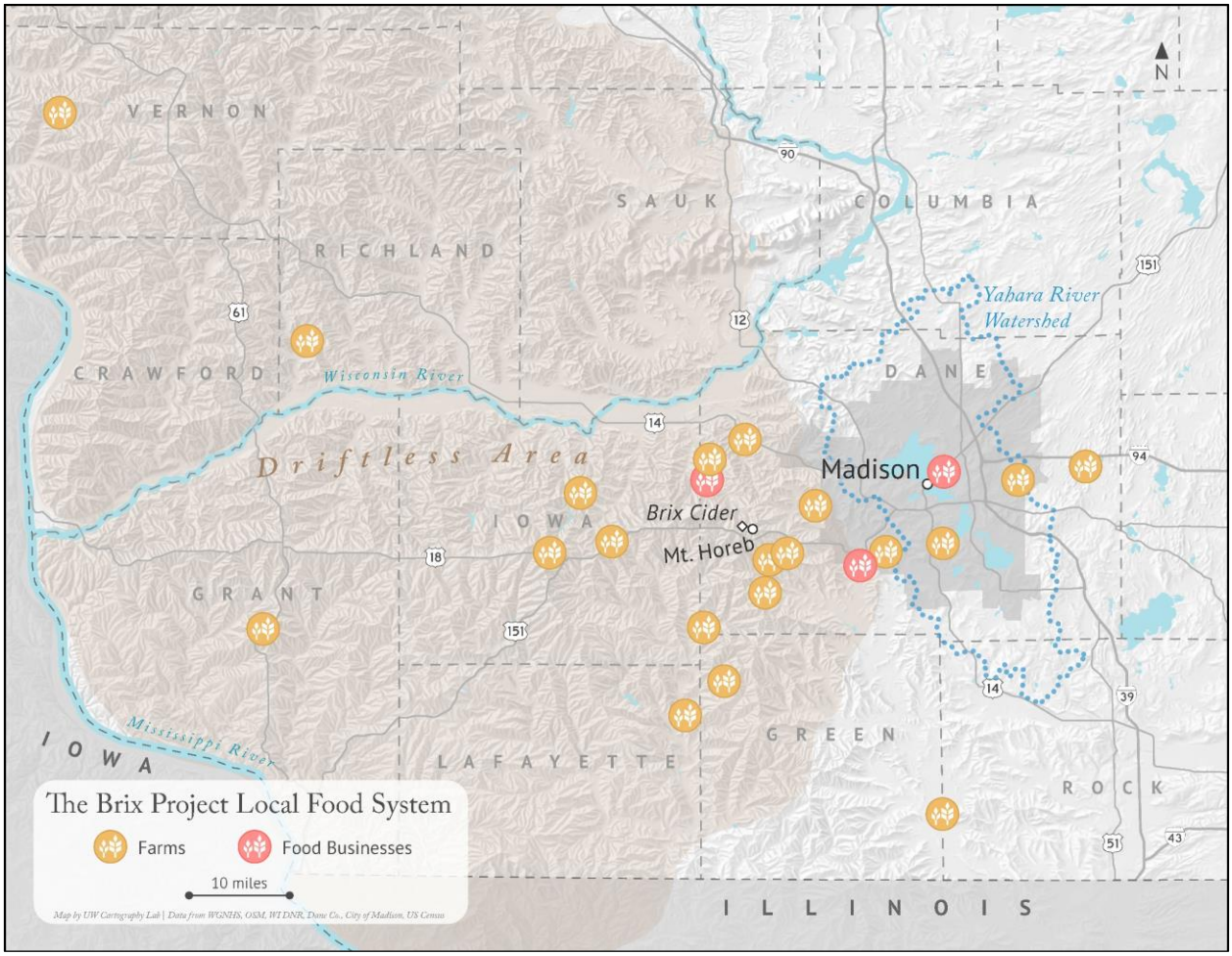
This community-based research (CBR) recognizes the value of in-depth, place-based investigation (Beckwith, 2022; Flyvbjerg, 2006) that connects, rather than generalizes, to other studies. CBR broadly describes research in collaboration with community partners on community-identified problems directed toward goals of societal change (Boyer, 1990). I situate this research under CBR rather than participatory action research, because, although the study was shaped by community processes, the research was supplementary to other community goals.

The case study developed from pre-existing relations including my part-time employment at Brix Cider and the Raboins' relationships with faculty at the University of Wisconsin-Madison. The latter enabled this CBR to take shape with both agility and longevity following the early pandemic disruptions. The research was shaped by the collaborating team, and I conducted the majority of data collection and analysis. I occupied multiple identities throughout this process —researcher, Brix Project coordinator, Brix Cider employee, and community member—which provided different opportunities and challenges. As a Brix Cider employee, I was privy to certain conversations and physical spaces (e.g., the restaurant kitchen). My role as university researcher granted a degree of legitimacy but also generated distance (e.g., when I used a recording device). Ongoing reflection and consistent, transparent communication provided crucial guideposts for navigating partnerships with reciprocity and trust. For example, I discussed these various identities with interviewees and confirmed when informal conversations would be appropriate to include as data.

In this study, I use the definitions of *community* and *local* that coalesced from Brix Project collaborators. *Community* encapsulated project organizers, including the Raboins and food producers who supplied to Brix Cider and developed personal narratives of community engagement. *Community* also captured the network of producers and eaters who attended events, participated in conversations, and connected through shared values about food and sustainability to support Brix Project efforts. The Raboins used *local* to describe the food system of the Brix Project, which incorporated a regional geography of producers and supply chains spanning multiple municipalities and counties that centered in Dane County (Figure 1). Local and community were often entangled together, the two informing and co-creating each other. I note the dangers of conflating local with a "purified category" (DuPuis & Goodman, 2005, p. 386) of food/community or inferring scale as a solution for social, environmental, or economic interventions (Born & Purcell, 2006). In this case study, "local" was not so much the goal as the rough terrain through which visions of resilience were navigated.

Recognizing multiple forms of community

Figure 1. The Food System of the Brix Project in Southern Wisconsin



Map by Will McAllister.

knowledge (Park, 2006), this research drew from the grant documents, grassroots activities, informal conversations, and guiding ideas that emerged from the Brix Project. I organized data around two broad questions: (1) How do people conceptualize/define resilience? and (2) How is resilience enacted in the community? Using inductive methods, I developed a baseline framework for defining resilience from the LFPP grant documents. I then conducted interviews with the Brix Project core team (N = 3) to explore explicit definitions of resilience alongside how the team contextualized the project within broader food system challenges and visions for change. I conducted ten formal interviews with Brix Project collaborators (Brix Cider employees and producers) exploring the same themes. Participants were selected based on participation in project activities and design. Data from these formal interviews were used to refine definitions of resilience and visions for transformation.

After formalizing research themes and questions, subsequent follow-up interviews, community surveys, and community conversation supported iterative processes of refining questions and analysis. Two early canvassing surveys of Mount Horeb community members provided baseline information on perceived strengths and challenges within the food system. Monthly project meetings over four years structured ongoing discussion with the core team about definitions of resilience. Informal conversations with collaborators and community members also developed organically during events.

(As Swain & King (2022) point out, informal conversations—which informants participated in with the understanding of my role-as-researcher, but without the constraints of a recorder and formal questions—often result in the richest and most authentic data.) Extensive field notes captured the topics, language, and tone of these conversations.

To address the second question, on the *enactment* of resilience and transformation, I drew from Brix Project films, events, and community-based conversation. I coded transcripts from films to identify producer narratives and relations. Project events, such as film screenings and panel discussions with the farmers featured in the films, served multiple purposes: to advance awareness of producer practices and experiences, to foster conversations and relationships within the community, to provide opportunities to experience local, seasonal food, and to build a sense of community that engages with the food system. Through the four-year project, the core team experimented with a variety of formats, locations, and audiences. Over two hundred surveys, solicited through event programming, offered data on community impacts of programming. Events also fostered community dialogue and iterative analysis, through which specific themes, questions, and reflections inductively materialized over time. I shared these emergent themes with collaborators, and their feedback supported community-driven analysis of local food system experiences.

Results

Resilience Defined in the LFPP Grant

The Raboins developed their definition of food system resilience for the LFPP grant within a complex personal and political landscape: (1) as small business owners during a period of unforeseen economic uncertainty due to the pandemic; (2) as farm-to-table restaurant owners perceiving widespread ruptures of national and global food supply chains; (3) as concerned community members, employers, and friends of producers in Wisconsin; and (4) with the goal of achieving funding through USDA AMS. With no specific verbiage or recommendations around resilience in the call for proposals, the fact that 10 of the 44 LFPP grants awarded in 2020 explicitly referenced resilience in project titles or description (USDA, 2020) reflects the prevailing rhetoric of the era.

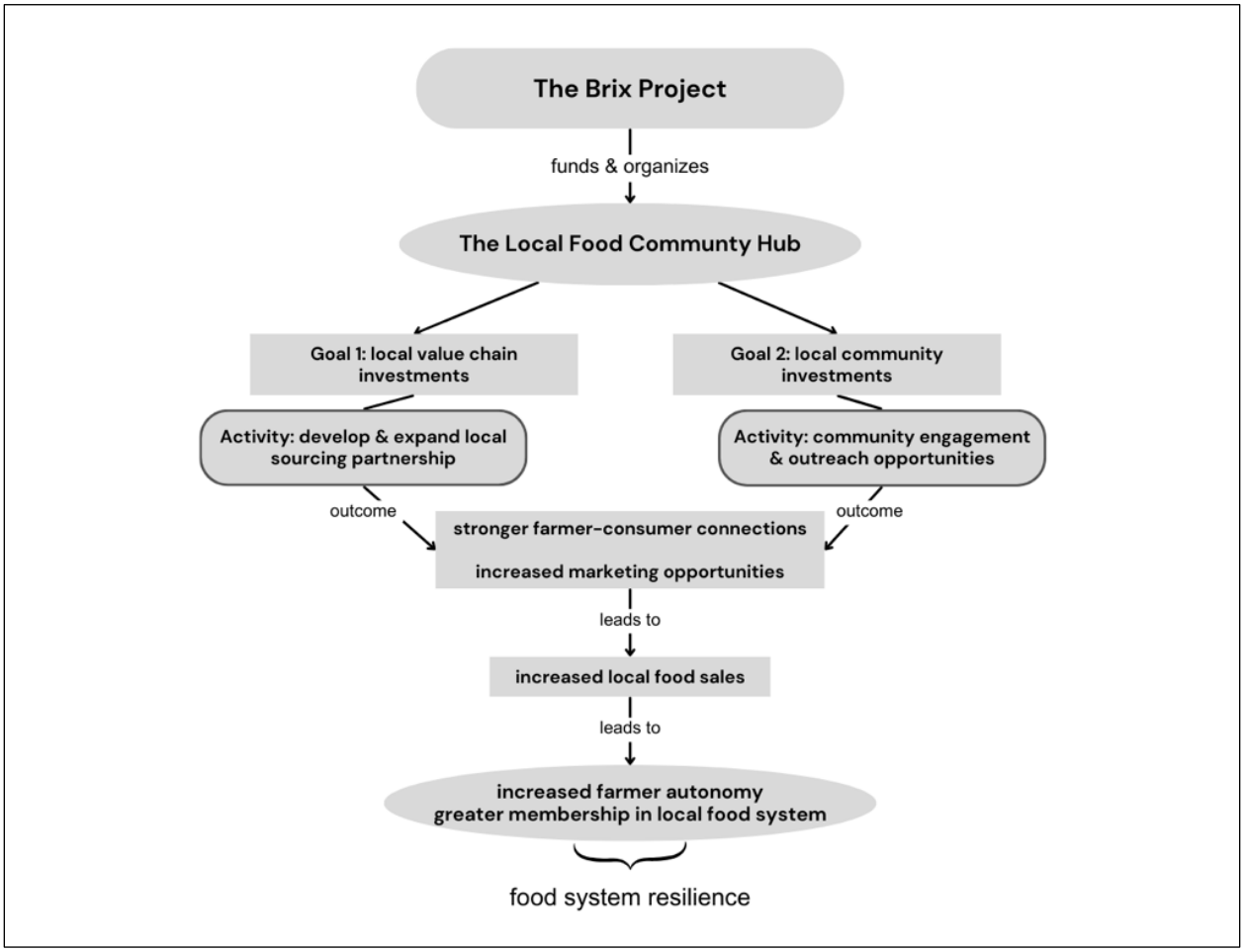
The following passage from the 2020 grant application narrative presents the guiding concept of change for the Brix Project, asserting that a food system based on weak links between producer and consumer could be made more resilient by strengthening these connections:

> We need to develop new business models that can better withstand shocks and connect local farmers to local consumers. Through this project, we will advance a "local food community hub" as a model of resilience. A local food community hub, as we are defining it here, is similar to a traditional food hub, in that it aggregates, processes, and distributes local food from multiple producers through relatively short supply chains. As the name implies, the key difference is that a local food community hub is structured around a core concept of community.

Note the pairing of classic resilience framing rhetoric ("withstand shocks") with the vision of connection. The proposal outlined two key strategies to support the theory of change (Figure 2): supply chain investments to increase market connections, and enhancing customer education through events, storytelling, and other strategies to build social connections. While these connections would be enacted through market channels (specifically, Brix Cider), the second strategy implied broader, community-based approach to change. In the grant, *community* referred to the farmers, processors, marketers, and consumers who share values around food, particularly the understanding that food is more than a simple commodity.

The proposal argues that typical food hubs are often constrained by distribution and marketing structures, but that a local food community hub would create broader community participation that would ripple beyond the Brix Cider market channels, contributing to greater farmer autonomy and deeper economic growth. Thus, the Brix Project's unique approach to resilience was in building understanding and relationships around food beyond market channels.

Figure 2. Schematic of the Brix Project Activities



Collaborator Definitions

Brix Project collaborators, who included employees and partnering producers involved with designing and implementing Brix Project programming, tended to characterize resilience through three main characteristics: *abundance, flexibility,* and *stability*. More specifically, it was the relationship between flexibility and stability from a place of abundance that created the experience and vision of a strong, resilient regional food system. Underlying this conceptualization was commitment to, and respect for, small-scale producer decision-making (e.g., to pursue diverse market opportunities or on-farm conservation goals) within the context of a rigid conventional food system.

Abundance as a characteristic referred to the many farms, markets, businesses, and other organizations supporting regional food economies. Collaborators identified abundance as either an important component of, or a precursor to, resilience. Results from the community canvassing surveys indicated that community members perceived abundance as a core strength of Mount Horeb and the surrounding region. Members of the Brix Project core team suggested that producer abundance enabled greater flexibility and adaptability in market relations. Matt explained: "We're a lucky place here in southwest Wisconsin, where there are a lot of farms and small farmers. And if [Farm] was like, we just want to focus on the CSA and we're not going to do [Brix's] veggies this year, there's twenty other veggie farmers we could talk to." Abundance was important for navigating ecological disruption in the food system as well. For

example, a Brix Project employee indicated a strawberry crop ruined by a surge of pests in the region. Brix Cider, she explained, had to purchase from a different producer: "There are certain things you just can't adapt to when it comes to climate change. I mean, things [crops] are just going to get lost, or unexpected occurrences are going to happen…So having resiliency is having a number of backups."

Abundance enabled flexibility but alone did not define resilience. A farmer collaborator stated:

> I feel like we're almost there. Like, the backbone [for resilience] is there. When you Google Map zoom out on what farms are around here, it's insane. There are so many farms—very established, well-known, successful farms in addition to all of these little ones that are popping up. So the resources are there. The closed cycle is not quite there. The continuum is not quite there. The tapping into all of those markets [by the community], that's not there yet. But the potential is definitely there.

For this farmer, abundance helped provide the "backbone" of resilience. However, it was not just the quantity of farms or opportunities available but how these farms integrated into a community-driven circular economy that formed the real metric of resilience.

If abundance helped answer the *what* of resilience, then flexibility helped to answer the question of *how*. For Brix Project collaborators, flexibility, like adaptability, meant the capacity to navigate a food landscape characterized by fluctuation and change. Flexibility was often specifically identified as a response or solution to the central problem of a rigid contemporary food system. For example, Matt framed his definition of resilience by first describing that problem:

> Just to compare [Brix Cider] to a typical food hub, I think that's the challenge that a lot of food hubs run into. You create a rigid structure that the farms need to build themselves around. And then you're just stuck with whatever the market is through that structure. It's just kind of rigid and you can get stuck, and a farm can't change without changing the bigger system. … I feel like [resilience is] having a looser model with individuality. just gives people freedom to do their own thing and use [Brix Cider] when it makes sense, but not when it doesn't make sense.

Another core team member and farmer described flexibility as embedded in resilient market relations:

> [Brix Cider is] flexible and calm enough to work with the producers as their product availability ebbs and flows. If they [the producers] have a huge amount of product they need to move, Brix trusts the kitchen staff to adapt to that. So it's really like a looseness and a confidence that I just don't see that often in restaurants where there seems to be such a grip on planning. But this is nature. And this is weather. And this is food that we're dealing with, which are not static things. … And so by being flexible, and being a natural organism as well, Brix is able to really mix with what seasons have and what seasons do to farmers.

Flexible purchasing practices, which reflect the dynamic characteristics of a regional food system, allowed the Brix Cider supply chain to adjust to seasonality, unexpected weather events, disruptions to farm management, and the pandemic, all the while maintaining strong relationships with producers. As understood by collaborators, flexibility is a characteristic imbued with trust, care, and the recognition that food system actors are people with a broad set of needs and desires, which the rigidity of the conventional food system does not support.

A fuller portrait of resilience emerges when flexibility is enacted in tandem with stability. To the collaborator above describing resilient market relations, it was not just flexibility but the capacity to be "calm" and confident through change that enabled strong market connections. The dynamism of flexibility was important insofar as market movement was paired with support: "I think it [resilience] looks like two things, it looks like being able to be flexible, but also being able to be solid. And combining those two—it's like

moving. It's a constantly moving target." Another core team member explained, "You can still have structure in resilience. Not to say that structure is always bad." The intended structure here was not that of a rigid or fixed system, but of trust, accountability, and security in the strength of relations along the supply chain. Perhaps most importantly, as depicted in the interviews, resilience was not a predefined state to achieve but a process, or that "constantly moving target" that is enacted through relations.

Core team leaders understood that ensuring market stability allowed small-scale producers to better navigate agroecological decisions, such as what to plant and how often, based on their specific farm conditions. Decisions could be directed toward improving soil health or crop diversity (or, as one farmer noted, out of personal curiosity) rather than dictated by external market demands. In this way, market stability and flexibility correlated with agroecological stability and flexibility, although the former was not structurally guaranteed. In an interview toward the end of the Brix Project, Matt reflected that purchasing was at the discretion of Brix Cider, not the farmer. The Raboins still need to consider price, convenience, and product consistency when purchasing ingredients for their restaurant. Though maintaining stable relationships is a priority, these decisions are still influenced by profit margins and restaurant operations.

For collaborators, resilience was not necessarily the desired goal of Brix Project interventions. When describing their visions for a healthy food system, collaborators mentioned sustainability education, community health, inclusivity for dietary diversity, and protection of ecological biodiversity. Participants used the language of resilience to weave together connections between these diverse elements of agri-food systems. One farmer considered such systems-level thinking to be an important outcome of Brix Project programming: "I think it puts stuff into perspective for folks who are like, Oh, I'm hungry, if I go to Brix and buy this— as opposed to Culver's—that support those guys [Brix] *and* these guys [Farm]. … It's just interconnected. It's community in action."

Demonstrations of Resilience Throughout the Brix Project

Drawing from the above discussions, a community-based definition of resilience begins to crystallize as the capacity to be flexible yet stable within a context of abundant, community-oriented relations. This definition holds little traction, however, if it is not consistent with or support the perspectives and behaviors of the broader set of food system actors (producers, business owners, consumers) within the Brix Project network. Attending to the processes of resilience ("how it works") rather than simply cataloging its elements ("what is there") shifts resilience from persistence to transformation (Jones et al., 2022). Therefore it is crucial to recognize resilience-in-action, what Pugh calls "adapting and navigating our way through the precarious nature of complex life" (2014, p. 318). The following vignettes describe several beliefs and practices of food system actors as they navigate the precarities and politics of the regional food system. These actions occurred and/or were documented through Brix Project interventions.

Reorganization of Brix Cider through the Brix Project

Just days after closing their restaurant doors in March 2020, the Raboins created an online platform where community members could order the food items that would have been produced in the Brix kitchen. Employees organized and packaged these orders and delivered them to households in a no-contact delivery service. Most obviously, this strategic shift created a pathway for revenue as local food economies navigated turbulent times. The Raboins also wanted to maintain market outlets on which their local producers depended and provide employment for their staff. In the following weeks, the Raboins assembled a multi-organizational team to shape ideas around developing resilience and applying for the LFPP grant.

Though the application was clearly an immediate response to the pandemic, it also represented strategic positioning to face long-term uncertainty. The proposed project would not be funded (or denied) for months down the road. The process of assembling the grant proposal included reaching out to potential community partners, identifying

mutual needs, conversing about the possibilities of a multi-year project, and writing a complex grant application. Establishing the university collaboration itself required navigating an entire subset of meetings, bureaucratic procedures, and subaward agreements. Although the process relied on pre-existing relationships, grant writing skills, and knowledge of government funding, it required an intensive investment of time and energy. These processes were implemented without the immediate guarantee of reward or financial respite from the disturbances at hand.

Responding to climate variability: Brix Cider purchases apples for cider production from a variety of small orchards, often five acres or less, many planted by settlers in the late 19th century when southern Wisconsin agriculture shifted from grain production to more diversified systems. In 2021, a late spring frost destroyed apple blossoms around the state and devastated the fall harvest. The small-scale family-owned orchards on which Brix Cider relied were not equipped with technology like frost fans to mitigate the unexpected weather event. As Matt recounted:

> [Brix was] so understaffed all summer, I was just working really hard and not thinking about apples. And then apple season came, and I started calling and emailing, and orchard after orchard after orchard just said, we don't have a good crop for you. As a cider maker, it just means we [need] to do something different. It means another pivot. I mean, we're tired. We're tired of pivoting.

In this pivot, Matt called a hermitage to which he had donated an old apple press that Brix Cider no longer used. He explained that earlier in the year, "They wanted a press so we just donated it to them on kind of a good-faith idea that they'll then use it to press juice for us. … We had no idea at the time we were going to have a crappy apple year." Without firm purchasing arrangements, Matt did not know how much apple juice the hermitage could offer. Matt continued, "Getting into November, we were still a couple thousand gallons short of where we needed to be. I just kept waiting and waiting on the hermitage—and they followed through. … You give something to the community and the community gives something back." The hermitage pressed enough apple juice for Brix to meet their quota for cider production.

This vignette reflects the interconnectedness of multiple disruptions within a local food system: ecological/climate (late spring freeze at small-scale orchards); socio-political (labor disruptions within the restaurant industry); and market (value chain disruptions between producer and restaurant/distributor). For Matt, the experience demonstrated how disruptions could create new connections and opportunities: "And in some ways, having to scramble a bit, identifying these new orchards and working with them—I think sets us up well for the future. … You learn stuff when you do things different."

Food System Collaborations

Brix Project programming included crafting short films to capture farmer stories, and fostering community conversations to explore these narratives through film screenings and panel discussions. In one event, two business owners (of a bakery and a tortillería) sat alongside two producers (beef and grain), in front of a crowd of about forty, to discuss their experiences with and perspectives on the regional food system. Though none of these panelists were Brix Project collaborators or were interviewed for this study, their reflections aligned closely with collaborator perspectives on resilience.

The owner of the bakery Origin Breads, which purchases regionally grown grain, stated that the experience of food system abundance was a factor in committing his business to the Madison area: "I had lived here 12 years prior and I just knew it was a food-friendly town, and I knew the market scene was pretty vibrant…The fact that there was a local mill here, and there [are] farmers growing grains all around brought the puzzle pieces together." For him, as with the grain farmer panelist who described the many small markets he sold to on a weekly basis, abundance was a central pillar of a strong food system.

In the abundant food scene, many producers sell similar products at local markets. The owner of Origin Breads participated in a nearby farmers market, where multiple local bakeries offer freshly

baked goods Saturday morning: "Technically we're in competition with each other, when there are people coming to the market who are either going to spend their money on your stand or on someone else's stand." However, he reflected that the idea of competition is a story told by the industrial food complex—one that is not true to his experience. To his mind, if a customer goes to a different bakery, there is still a positive outcome for the community and the regional food system. This sentiment was echoed by an orchardist featured in one of the Brix Project films: "Having a [cider] product that is made from our fruit, by friends nearby, is just fantastic. We're boosting each other. So we're lifting everybody up by having these kinds of partnerships."

Like many other farms that supply to Brix Cider, Seven Seeds Farm is located in the undulating ridges and valleys of the Driftless Region of southwest Wisconsin. The farm sells grassfed beef, pork, and chickens. To manage soil health on the highly erodible hillsides and provide shade and food to their livestock, the farmers planted over one hundred acres of perennial fruit and nut trees. For these farmers, the market relationship with Brix Cider provides an invaluable outlet for their products:

> Brix is great to work with because they're so flexible and easy going. They're not always needing one cut [from the animal] and they're really receptive to change on the menu. As a farmer, as a producer that's selling whole animals or pieces of whole animals, it's so nice to work with people like Matt and Marie who know the struggles we have and know how to use the whole animal.

Cooking with lesser-desired cuts of meat, such as beef hearts, often takes more creativity and education for chefs in the Brix Cider kitchen. In a community conversation, Marie Raboin acknowledged that this practice requires more education to consumers to explain why chicken breast or bacon does not always appear on the menu: "If I raise my hogs to two hundred pounds, and from that maybe only get twenty pounds of bacon, there's still a lot of pork left to do something with." This practice elevates the understanding that farmers do not just produce bacon or chicken breast for purchase but are raising whole animals that are an essential part of a healthy ecosystem.

Discussion

Resilience has been critiqued for its "fuzziness," for its lack of political acuity, and for implying support for preserving the status quo. While these critiques are crucial for highlighting potential consequences of resilience discourse and policy, the results of this study demonstrate community definitions and enactments of resilience that are useful in their fluidity, maintain political motivations, and fundamentally orient toward transformation. When writing the grant application, the Raboins utilized resilience to situate their project within the post-pandemic rhetoric and thus gained access to financial resources. The market emphasis within the LFPP grant application, and the related prominence of economic resilience, is understandable given the USDA program requirements to fund local food businesses and market development. Nevertheless, in nodding to a broader vision of food system change, this definition was still malleable enough to satisfy LFPP grant objectives while creating opportunity for broader conversations and interventions. The acknowledgement that food is "more than a commodity" firmly placed the Brix Project within a food system politics, motivated to transform the underlying dynamics of the industrial food system.

Furthermore, the Raboins's decision to apply for the LFPP grant demonstrates reorganization of resources and relations in response to change. The application process prompted the core team to organize within Brix Cider's network, exchange ideas, envision change goals and mechanisms, and identify community resources. The LFPP grant proposal was submitted in the spring of 2020; the award was not confirmed or received until the fall. Though an immediate response to the pandemic lockdown, the grant application was more realistically a long-term strategy for mobilizing change within the community. This process presents an empirical demonstration of transformative resilience, illuminating the capacity for renewal, regeneration, and re-organization of a system

(Gotham & Campanella, 2021) rather than "bouncing back" to a previous state.

Interviews clarified and situated this vision for transformation within a specific politics of resilience. Brix Project collaborators contrasted resilience with an industrial food system characterized by commodified food, rigid market structures, consolidation, and competition. They conceptualized flexible yet stable market relations which functioned within the inherent dynamism of the food system. They also prioritized cooperation through abundance. It is worth noting that as a farm-to-table restaurant Brix Cider is uniquely both flexible and stable. As producers themselves, the Raboins' possess deep knowledge of farming and the fluctuations of production within southern Wisconsin. They know their partnering farmers and view their business as contributing to positive change. Their knowledge and values shape their interactions with producers—such as purchasing lesser-desired cuts of meats—which enable farmers to center their own needs rather than the demands of a monolithic food economy. It is Brix Cider's specific positionality within southern Wisconsin's abundant food system that creates this pathway for transformative resilience.

The importance of flexibility, diversity, and autonomy are consistent with other post-pandemic examinations of agroecological and food system resilience (Jones et al., 2022; Ladyka et al., 2022; Perrin et al., 2020). For example, in their study of the experience of small farms in Washington, Ladyka et al., (2022) find that flexibility and autonomy were important attributes of resilience, and that farmers with greater operational flexibility also reported higher levels of autonomy within market channels. Jones et al. (2022) reported flexibility and social capital—related to the concept of social connection in the Brix Project—to be key characteristics of local food system resilience following the pandemic. However, diversity rather than abundance is often named in this literature. While collaborators of the Brix Project certainly referred to diversity, it was usually within the context of abundance. In other words, the *quantity* of producers, market channels, or food businesses and organizations was more often considered the crucial precursor to resilience rather than *variety*.

A core thread throughout the grant proposal, interviews, and community conversations and actions was the importance of elevating farmer autonomy through food system intervention. Although emphasizing autonomy would seem to perpetuate an individualistic ideology based on neoliberal values, participants repeatedly positioned autonomy, or, as one collaborator defined it, "freedom to do your own thing," within the context of acting within an integrated web of community. These findings align with the notion of relational autonomy (Mackenzie, 2008, 2019), the capacity to act *within* networks of interdependencies. In a Netherlands case study of local food networks, Goris et al. (2025) demonstrate that increased local market opportunities boosted relational autonomy for both farmers and consumers, although it is still shaped by the institutional and regulatory limitations of a multi-scalar food economy. Autonomy, then, can be experienced at the same time as vulnerability.

Autonomy is increasingly recognized as a core component of resilience within a politics of food production (Ladyka et al., 2022; Schneider & Niederle, 2010; Valencia et al., 2019). Schneider and Niederle (2010) describe autonomy as the broad capacity to act, both materially and symbolically, within a landscape of possibilities. They outline strategies for farmer resistance in Brazil to shape autonomy through livelihood diversification. Building on this work, Valencia et al. (2019) demonstrate how farmers develop autonomy through increased reliance on internal resources such as land and knowledge, and thus can shield themselves from market shocks and uncertainties. They find that stronger farmer autonomy in Brazil builds agro-ecological resilience through farm diversification strategies, a correlation explicitly identified by Brix Project farmers as well. For them, as for the Brazil farmers, the drive for autonomy reflects local struggle within the rigid political economy in which farmers and restaurants are situated: a system which has "trapped" farmers and rendered small-scale businesses vulnerable. Highlighting autonomy illuminates flows of power and the desire to create new structures within the food system. Relational autonomy moves resilience into the realm of transformation.

This case study has grounded transformative resilience in lived experiences and community processes, though such grounding should not suspend critical investigation of transformation. As with resilience, transformative processes should be examined for (a)political traps and attended to for vulnerabilities, equity, and justice issues. Davis et al. (2022) caution against reallocating vulnerabilities within the food system onto the rural poor in our haste to restructure and transform. Kokorsch (2022) questions transformative resilience for lacking an exit strategy, or the end point at which a system or community no longer needs to be resilient. This critical scholarship offers imperative guideposts for inquiry into transformative resilience in food systems, and suggests that critical transformation must involve community inclusion when identifying transformation agendas and goals.

Although this study has focused on the discourse around food system resilience in the wake of the pandemic, calls for other types of resilience—for example, ecological resilience through soil carbon sequestration—also pervade agricultural research and policy. For food producers embedded in the food economy, whether local or not, efforts for resilience must be supported by suitable market structures. It would be shortsighted, however, to suggest that resilient market relations, such as the connections that facilitated stability through the pandemic, always lead to other types of resilience. It is the context and scale at which we assess resilience that matters. Producers and business owners experienced disruption and vulnerability variably across the four-year Brix Project, such as contending with industry-wide labor shortages or extreme climate events. Interventions that focus on market relations and supply chains within short timelines might interpret Brix Cider's flexible, abundant, and stable farmer relationships as a complete picture of resilience. Yet these frameworks may not take into account the interconnected struggles within the food system that extend into longer timeframes or broader economic contexts. This study highlights the need for long-term, place-based research providing empirically driven analyses of relational autonomy within food system transformation.

Conclusion

This paper explored the discourse and practices of resilience within the connected food system of the grassroots food system initiative, the Brix Project, in southern Wisconsin. Common critiques of resilience point to its definitional and theoretical ambiguity and the apolitical bedrock of the term. However, as demonstrated by this qualitative case study, the very ambiguity of resilience proved valuable for the grassroots organizers of the Brix Project. These organizers leveraged the post-pandemic rhetoric of resilience to gain access to resources from the USDA. While framing their funding goals loosely around market interventions, they also imbued the grant narrative with a broader vision for change that was firmly situated within a political critique of the conventional food system. Interviews with Brix Project collaborators, combined with conversations among and actions by food system actors within the Brix Project network, built on this vision to reveal a politically driven understanding of resilience based in flexible yet stable relations within a context of abundance, relational autonomy, and collaborative community. These results indicate that resilience, when grounded in the grassroots food system organizing of the Brix Project, ultimately supported transformative change. This case study also illuminates the specific characteristics of resilience that emerged from the particularities of the Brix Project food system. The ambiguity of resilience is valuable only insofar as there is room for context-specific definitions and interventions to emerge, which should ultimately build a food system embedded in place.

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References

Anderson, B. (2015). What kind of thing is resilience? *Politics*, *35*(1), 60–66. https://doi.org/10.1111/1467-9256.12079

Anderson, M. D. (2020). Pandemic shows deep vulnerabilities [Rapid Response Opinion]. *Agriculture and Human Values*, *37*(3), 559–560. https://doi.org/10.1007/s10460-020-10108-7

Beckwith, L. (2022). No room to manoeuvre: Bringing together political ecology and resilience to understand community-based adaptation decision making. *Climate and Development*, *14*(2), 184–195. https://doi.org/10.1080/17565529.2021.1904811

Blaikie, P., & Brookfield, H. (Eds.) (1987). *Land degradation and society*. Routledge. https://doi.org/10.4324/9781315685366

Born, B., & Purcell, M. (2006). Avoiding the local trap: Scale and food systems in planning research. *Journal of Planning Education and Research*, *26*(2), 195–207. https://doi.org/10.1177/0739456X06291389

Boyacı-Gündüz, C. P., Ibrahim, S. A., Wei, O. C., & Galanakis, C. M. (2021). Transformation of the food sector: Security and resilience during the COVID-19 pandemic. *Foods*, *10*(3), Article 497. https://doi.org/10.3390/foods10030497

Boyer, E. L. (1990). *Scholarship reconsidered: Priorities of the professoriate*. The Carnegie Foundation for the Advancement of Teaching. https://files.eric.ed.gov/fulltext/ED326149.pdf

Brand, F. S., & Jax, K. (2007). Focusing the meaning(s) of resilience: Resilience as a descriptive concept and a boundary object. *Ecology and Society*, *12*(1), Article 23. https://www.jstor.org/stable/26267855

Brown, K. (2015). *Resilience, development and global change*. Routledge. https://doi.org/10.4324/9780203498095

Carpenter, S. R., & Brock, W. A. (2008). Adaptive capacity and traps. *Ecology and Society*, *13*(2), Article 40. https://www.jstor.org/stable/26267995

Côte, M., & Nightingale, A. (2012). Resilience thinking meets social theory: Situating social change in socio-ecological systems (SES) research. *Progress in Human Geography*, *36*(4), 475–489. https://doi.org/10.1177/0309132511425708

Cretney, R. (2014). Resilience for whom? Emerging critical geographies of socio-ecological resilience. *Geography Compass*, *8*(9), 627–640. https://doi.org/10.1111/gec3.12154

Cretney, R., & Bond, S. (2014). "Bouncing back" to capitalism? Grass-roots autonomous activism in shaping discourses of resilience and transformation following disaster. *Resilience*, *2*(1), 18–31. https://doi.org/10.1080/21693293.2013.872449

Cutter, S. L. (2016). Resilience to what? Resilience for whom? *The Geographical Journal*, *182*(2), 110–113. https://doi.org/10.1111/geoj.12174

D'Andrea, R. (2024, February 19). Wisconsin has lost 10 percent of its farms since 2017. Wisconsin had 58,521 farms in 2022, and has lost 30 percent of its dairies. *Wisconsin Public Radio*. https://www.wpr.org/agriculture/wisconsin-lost-10-percent-farms-since-2017

Davidson, D. J. (2010). The applicability of the concept of resilience to social systems: Some sources of optimism and nagging doubts. *Society & Natural Resources*, *23*(12), 1135–1149. https://doi.org/10.1080/08941921003652940

Davidson, J. L., Jacobson, C., Lyth, A., Dedekorkut-Howes, A., Baldwin, C. L., Ellison, J. C., Holbrook, N. J., Howes, M. J., Serrao-Neumann, S., Singh-Peterson, L., & Smith, T. F. (2016). Interrogating resilience: Toward a typology to improve its operationalization. *Ecology and Society*, *21*(2), Article 27. https://www.jstor.org/stable/26270410

Davis, B., Lipper, L., & Winters, P. (2022). Do not transform food systems on the backs of the rural poor. *Food Security*, *14*(3), 729–740. https://doi.org/10.1007/s12571-021-01214-3

DuPuis, E. M., & Goodman, D. (2005). Should we go "home" to eat?: Toward a reflexive politics of localism. *Journal of Rural Studies*, *21*(3), 359–371. https://doi.org/10.1016/j.jrurstud.2005.05.011

Ericksen, P. J. (2008). What is the vulnerability of a food system to global environmental change? *Ecology and Society*, *13*(2), Article 14. https://www.jstor.org/stable/26268000

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry*, *12*(2), 219–245. https://doi.org/10.1177/1077800405284363

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society*, *15*(4), Article 20. https://www.jstor.org/stable/26268226

Forsyth, T. (2003). *Critical political ecology: The politics of environmental science*. Routledge. https://doi.org/10.4324/9780203017562

Goris, M., Schoop, D., Roep, D., & Hassink, J. (2025). Relational autonomy highlights how interdependencies shift in the transformation of food provisioning. *Journal of Agriculture, Food Systems, and Community Development*, *14*(2), 79–99. https://doi.org/10.5304/jafscd.2025.142.009

Gotham, K. F., & Campanella, R. (2010). Toward a research agenda on transformative resilience: Challenges and opportunities for post-trauma urban ecosystems. *Critical Planning Journal*, *17*(Summer 2010), 9–23. https://richcampanella.com/wp-content/uploads/2020/02/article_Gotham%20Campanella%20Critical%20Planning-resilience%20of%20New%20Orleans.pdf

Grove, K. (2013). On resilience politics: From transformation to subversion. *Resilience: International Policies, Practices and Discourses*, *1*(2), 146–153. https://doi.org/10.1080/21693293.2013.804661

Harris, J., & Spiegel, E. J. (2019). *Food systems resilience: Concepts & policy approaches*. Center for Agriculture and Food Systems, Vermont Law School. https://vermontlaw.b-cdn.net/wp-content/uploads/2024/05/Food-Systems-Resilience_Concepts-Policy-Approaches.pdf

Hedberg, R. C. (2021). An instrumental-reflexive approach to assessing and building food system resilience. *Geography Compass*, *15*(7), Article e12581. https://doi.org/10.1111/gec3.12581

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology, Evolution, and Systematics*, *4*, 1–23. https://doi.org/10.1146/annurev.es.04.110173.000245

Jones, S., Krzywoszynska, A., & Maye, D. (2022). Resilience and transformation: Lessons from the UK local food sector in the COVID-19 pandemic. *The Geographical Journal*, *188*(2), 209–222. https://doi.org/10.1111/geoj.12428

Joseph, J. (2013). Resilience as embedded neoliberalism: A governmentality approach. *Resilience*, *1*(1), 38–52. https://doi.org/10.1080/21693293.2013.765741

Karniouchina, K., Sarangee, K., Theokary, C., & Kübler, R. (2022). The impact of the COVID-19 pandemic on restaurant resilience: Lessons, generalizations, and ideas for future research. *Service Science*, *14*(2), 121–138. https://doi.org/10.1287/serv.2021.0293

Kokorsch, M. (2022). Community resilience: A useful concept for declining Icelandic communities? *Fennia–International Journal of Geography*, *200*(2), 245–250. https://doi.org/10.11143/fennia.122522

Kubatko, O., Merritt, R., Duane, S., & Piven, V. (2023). The impact of the COVID-19 pandemic on global food system resilience. *Mechanism of an Economic Regulation*, *99*(1), 144–148. https://essuir.sumdu.edu.ua/bitstream-download/123456789/91371/3/Kubatko_mer_1_2023.pdf

Ladyka, D., Sipos, Y., Spiker, M. L., & Collier, S. M. (2022). A qualitative investigation of resilience among small farms in western Washington State: Experiences during the first growing season of COVID-19. *Journal of Agriculture, Food Systems, and Community Development*, *11*(4), 35–59. https://doi.org/10.5304/jafscd.2022.114.007

Lyon, C. (2014). Place systems and social resilience: A framework for understanding place in social adaptation, resilience, and transformation. *Society & Natural Resources*, *27*(10), 1009–1023. https://doi.org/10.1080/08941920.2014.918228

Mackenzie, C. (2008). Relational autonomy, normative authority and perfectionism. *Journal of Social Philosophy*, *39*(4), 512–533. https://doi.org/10.1111/j.1467-9833.2008.00440.x

Mackenzie, C. (2019). Feminist innovation in philosophy: Relational autonomy and social justice. *Women's Studies International Forum*, *72*, 144–151. https://doi.org/10.1016/j.wsif.2018.05.003

MacKinnon, D., & Derickson, K. D. (2013). From resilience to resourcefulness: A critique of resilience policy and activism. *Progress in Human Geography*, *37*(2), 253–270. https://doi.org/10.1177/0309132512454775

O'Brien, K., Eriksen, S., Nygaard, L. P., & Schjolden, A. (2007). Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy*, *7*(1), 73–88. https://doi.org/10.1080/14693062.2007.9685639

Park, P. (2006). Knowledge and participatory research. In P. Reason & H. Bradbury (Eds.), *Handbook of action research: Concise paperback edition* (pp. 83–93). SAGE.

Peet, R., & Watts, M. (Eds.) (2004). *Liberation ecologies: Environment, development, social movements* (2nd ed.). Routledge. https://www.routledge.com/Liberation-Ecologies/Peet-Watts/p/book/9780415312363

Perrin, A., Milestad, R., & Martin, G. (2020). Resilience applied to farming: Organic farmers' perspectives. *Ecology and Society*, *25*(4), Article 5. https://doi.org/10.5751/ES-11897-250405

Pugh, J. (2014). Resilience, complexity and post-liberalism. *Area*, *46*(3), 313–319. https://doi.org/10.1111/area.12118

Reynolds, J. M. (2023, July 17). *Putting the farm back in "farm-to-table"* [Guest Post]. Brix Cider. https://brixcider.com/blog/2021/5/4/putting-the-farm-back-in-farm-to-table

Reynolds, J. M. (2024). *Farm-to-place: Community engagement, resilience, and the struggle for transformation in southern Wisconsin's food system* (Dissertation No. 31330011) [Doctoral dissertation, University of Wisconsin–Madison]. ProQuest Dissertations & Theses Global. https://www.proquest.com/dissertations-theses/farm-place-community-engagement-resilience/docview/3065961320/se-2

Sanderson Bellamy, A., Furness, E., Nicol, P., Pitt, H., & Taherzadeh, A. (2021). Shaping more resilient and just food systems: Lessons from the COVID-19 pandemic. *Ambio: A Journal of Environment and Society*, *50*(4), 782–793. https://doi.org/10.1007/s13280-021-01532-y

Schneider, S., & Niederle, P. A. (2010). Resistance strategies and diversification of rural livelihoods: The construction of autonomy among Brazilian family farmers. *The Journal of Peasant Studies*, *37*(2), 379–405. https://doi.org/10.1080/03066151003595168

Slater, S., Baker, P., & Lawrence, M. (2022). An analysis of the transformative potential of major food system report recommendations. *Global Food Security*, *32*, Article 100610. https://doi.org/10.1016/j.gfs.2022.100610

Strunz, S. (2012). Is conceptual vagueness an asset? Arguments from philosophy of science applied to the concept of resilience. *Ecological Economics*, *76*, 112–118. https://doi.org/10.1016/j.ecolecon.2012.02.012

Swain, J., & King, B. (2022). Using informal conversations in qualitative research. *International Journal of Qualitative Methods*, *21*, Article 16094069221085056. https://doi.org/10.1177/16094069221085056

Tendall, D. M., Joerin, J., Kopainsky, B., Edwards, P., Shreck, A., Le, Q. B., Kruetli, P., Grant, M., & Six, J. (2015). Food system resilience: Defining the concept. *Global Food Security*, *6*, 17–23. https://doi.org/10.1016/j.gfs.2015.08.001

Trauger, A., & Passidomo, C. (2012). Towards a post-capitalist-politics of food: Cultivating subjects of community economies. *ACME: An International Journal for Critical Geographies*, *11*(2), 282–303. https://doi.org/10.14288/acme.v11i2.934

U.S. Department of Agriculture. (2020). *Fiscal year 2020 description of funded projects*. Transportation and Marketing, Local Food Promotion Program. https://www.ams.usda.gov/sites/default/files/media/LFPPDescriptionofFundedProjects2020.pdf

U.S. Department of Agriculture. (2025). *Local Food Promotion Program. Fiscal year 2025 request for applications*. Agricultural Marketing Service. https://www.ams.usda.gov/sites/default/files/media/FY25LFPPRequestforApplicationsRFA.pdf

Valencia, V., Wittman, H., & Blesh, J. (2019). Structuring markets for resilient farming systems. *Agronomy for Sustainable Development*, *39*(2), Article 25. https://doi.org/10.1007/s13593-019-0572-4

Walker, J., & Cooper, M. (2011). Genealogies of resilience: From systems ecology to the political economy of crisis adaptation. *Security Dialogue*, *42*(2), 143–160. https://doi.org/10.1177/0967010611399616

Wood, A., Queiroz, C., Deutsch, L., González-Mon, B., Jonell, M., Pereira, L., Sinare, H., Svedin, U., & Wassénius, E. (2023). Reframing the local–global food systems debate through a resilience lens [Perspective]. *Nature Food*, *4*(1), 22–29. https://doi.org/10.1038/s43016-022-00662-0

Worstell, J. (2020). Ecological resilience of food systems in response to the COVID-19 crisis. *Journal of Agriculture, Food Systems, and Community Development*, *9*(3), 23–30. https://doi.org/10.5304/jafscd.2020.093.015

Zimmerer, K. S. (1994). Human geography and the "new ecology": The prospect and promise of integration. *Annals of the Association of American Geographers*, *84*(1), 108–125. https://doi.org/10.1111/j.1467-8306.1994.tb01731.x

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Realizing nutrition equity in urban food systems: Insights from food justice leaders about mechanisms of implementation

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Abstract

Commonly used measures for assessing local food systems, such as food security or healthy food access, do not provide guidance into the series of actions involved in transforming these outcomes. To address this gap, our research brief presents lessons learned from a community action research project about implementation mechanisms (i.e.,

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series of linked actions) involved in community-led efforts to transform urban food systems to achieve goals of nutrition equity. Our data are derived from the perceptions of 18 community leaders identifying as Black, Indigenous, and People of Color (BIPOC) planning to implement food justice initiatives in Cleveland, Ohio, United States. Content analysis revealed 10 themes and related indicators reflecting mechanisms of implementation and impact of community-led food justice initiatives. Findings underscore the importance of implementation mechanisms that influence changes in community power, food culture and norms, and healthy food retail while mitigating risks of gentrification. Future research is needed to operationalize these mechanisms of implementation to provide guidance for action planning, decision-making, and accountability within urban food systems.

Keywords
food system, community health, health equity, community action research, urban

Disclosures
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Ethics Approval
All procedures performed in this research were in accordance with the ethical standards of the Case Western Reserve University institutional review board and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from participants included in the study.

Introduction and Literature Review

The food system, encompassing all stages from production to consumption, is a vital yet often overlooked system shaping community well-being. Despite its significant impact, the industrialized and globalized nature of the food system limits perceived agency for change. Shifting from global to local food systems can provide more direct opportunities for communities to exert influence to shape the complex set of factors structuring foods available locally (Karetny et al., 2022). Nevertheless, food system complexity often leads to black box understandings of the specific mechanisms that might generate systemic transformation to enhance community well-being.

In this research brief, we explore how community members might exert influence to transform local food systems. Specifically, we present lessons learned about the mechanisms of implementation (i.e., series of linked actions) and impacts related to community-led changes within urban food systems. Our findings provide preliminary insights into themes and potential ways to quantify mechanisms of implementation and impact that may advance nutrition equity—defined as having freedom, agency, and dignity in food traditions resulting in holistic health (Freedman et al., 2022). Our work aligns with calls to develop measures of implementation mechanisms to better understand how strategies work in the real world (Lewis et al., 2022).

Centering Community Perspectives to Understand Food System Dynamics

We engaged those most proximate to nutrition inequities in efforts to uncover the mechanisms of implementation and resulting effects to advance the goal of nutrition equity. Our guiding theory of change underscores the need to engage diverse knowledge sources, such as community members with expertise based on lived experiences, to transform outcomes of local food systems to achieve nutrition equity (Freedman et al., 2022). This aligns with calls to integrate diverse knowledge sources to counteract the deficiencies of science-based knowledge dominating understandings of the complexity of food systems (Brock et al., 2024).

Our lessons learned are based on the perspectives of urban food justice leaders identifying as

Black, Indigenous, and People of Color (BIPOC), groups often excluded from food systems research (Brock et al., 2024). Engaging these perspectives is particularly relevant for achieving nutrition equity since BIPOC communities experience disproportionate burdens related to the food system, from limited access to land for agriculture to the embodiment of inequities in the form of chronic disease (Myers & Painter, 2017; Penniman, 2018; Walker et al., 2021). This population may offer unique perspectives to guide real-world implementation intended to transform urban food systems.

Food System Performance: Trends and Challenges for Assessing Change

Our research is informed by system dynamics structuring nutrition equity, which aligns with calls for measures that reflect the evolving factors influencing food systems (Freudenberg et al., 2018). System dynamics perspectives align with understandings of the food system as being "not simply a linear chain of processes, but rather a network of interacting components defined by multiple trade-offs and feedback loops that is embedded in a broader institutional and environmental context" (Wiltshire et al., 2024, p. 452). Together, these dynamics have the potential to generate emergent properties leading to "health, wealth, connection, and capacity in our communities" (Meter, 2011, p. 7).

Dominant methods for assessing local food systems do not account for dynamic complexity nor do they provide guidance about the mechanisms of implementation to realize positive outcomes for community well-being. Instead, discrete metrics, such as food insecurity, are commonly used as a single indicator of local food system performance. Food insecurity is measured annually in the United States (US) to assess how many households lack sufficient money and resources for adequate food. At least one in 10 Americans persistently experienced food insecurity over two decades of measuring this outcome with worse trends among racialized groups, people with very low incomes, and female-headed households (Rabbitt et al., 2024). Another common metric is access to full-service food stores. The USDA's "low-income and low-foodstore-access" (LILA) measure considers poverty, distance to stores, and vehicle access as interrelated indicators influencing food access (Rhone et al., 2022). From 2015-2019, about one-third of low-income households lived in LILA areas, with little change in the percentage of census tracts defined as LILA during this time-frame (Rhone et al., 2022). These metrics focus on defining problems without documenting the processes involved in implementing solutions. This can lead to solutions centered on external problem-solving agents (e.g., chain grocers to solve LILA problems), which can increase the risk for unintended consequences like green gentrification (Alkon & Cadji, 2018; von Braun et al., 2021). Green gentrification refers to the ways that green infrastructure, like urban farms or farmers markets, may result in increases in nearby property values, triggering displacement of long-time residents (Anguelovski et al., 2022).

There has been some movement to develop tools for assessing the performance of the dynamic dimensions of food systems. The Food Systems Dashboard (Fanzo et al., 2020) is one example for assessing the complexity of global food systems. This dashboard includes multifaceted measures mostly focused on outputs (e.g., fruit yield, pesticide use per area of cropland) and outcomes (e.g., cost of a healthy diet, share of women among owners or rights-bearers of agricultural land) (Fanzo et al., 2020). The New York City Food Metrics Report is an example for assessing local food systems (Freudenberg et al., 2018). Many of the metrics in this report focus on outputs or outcomes resulting from implementation (e.g., number of snack or vending machines in New York City public schools, number of farmers market locations) rather than mechanisms of implementation. The Community Food System Resilience Audit Tool is another tool for assessing local food system performance that begins to move toward assessing mechanisms of implementation, although its focus is on the jurisdiction level rather than community-led changes (Campbell et al., 2022). Taken together, these trends reveal the need for measurement tools focused on processes involved in transforming local food systems through community-driven implementation.

The Present Study

In this research brief, we present lessons learned about implementation mechanisms and related indicators of community-led efforts to transform urban food systems to achieve goals of nutrition equity. These lessons emerged from a community action research project rooted in the lived experiences of BIPOC food justice leaders. Our goal was to gather lessons to begin to quantify the actions and resulting effects involved in implementation of community-led food justice initiatives within urban food systems.

Applied Research Methods

Our lessons emerged from a community action research project aimed at increasing implementation of community-led food justice initiatives by BIPOC leaders in Cleveland, Ohio, U.S. A systems-change intervention was implemented as a part of this study.

Study Design

One component of the systems-change intervention was a six-month fellowship offering group sessions, mentoring, peer support, and networking to boost leaders' capacity. Fellows dedicated 10 hours monthly and received a US$1,500 stipend. The program helped fellows refine their food justice visions, create action plans, enhance leadership skills, and connect with a support network to access resources. We conducted two fellowship cohorts from December 2022 to May 2023 and December 2023 to May 2024, facilitated by three staff each year. The study was approved as exempt by the Case Western Reserve University IRB (STUDY20220691).

Participants

Participants applied to the fellowship through a competitive process involving a written application and interview. Selection was made by the study's advisory council and fellowship staff. Out of 63 applicants, 38 were interviewed, and 21 (33%) were accepted. One declined, and two opted out, leaving 18 who completed the entire program. Participants could consent electronically to join the research study, which operated separately from the fellowship program.

Data Collection

Participants completed a baseline survey including demographic information, which was conducted using REDCap software (Harris et al., 2009; Harris et al., 2019).

At the program's start, each fellow or team created a vision board to outline their transformation proposition and key components of their food justice initiative. The transformation propositions detailed the change they aimed to bring, their unique skills, and how their initiative would disrupt the status quo of the local food system. Our team developed and tested this tool through with five community partners. Methods for using the tool, including the vision board template, are described elsewhere (Boswell et al., 2021).

For this analysis, we used data collected at the beginning of the fellowship related to two questions about what would happen if fellows' visions turned into action: "What difference will your vision make in 6 months, 12 months, and 5 years?" and "How does your vision advance the health of body, mind, and spirit of people in your community?" Data were collected during working sessions facilitated by fellowship staff with each fellow or team of fellows. These lasted about 2.5 hours and were conducted in person or virtually. Responses were recorded by staff onto fellows' vision boards.

Data Analysis

Demographic information was analyzed descriptively using Excel. Vision boards were analyzed using content analysis (Mayring, 2015). For this analysis, 6- and 12-month effects were organized as short-term, and 5-year effects as long-term. Content analysis was conducted based on a codebook informed by existing frameworks related to nutrition equity (Freedman et al., 2022), community-engaged research (Organizing Committee for Assessing Meaningful Community Engagement in Health & Health Care Programs & Policies, 2022), and quality improvement (Leis & Shojania, 2017; Reed et al., 2016). The codebook was updated iteratively after reviewing all the vision boards and integrating feedback from fellows. The final codebook included mechanisms related to different dimensions of implementation: Plan, Do, Reflect, and Activate. A summary of findings was presented

twice to the study's community action research team for feedback and refinement.

Results

Eighteen fellows participated in this study, with 72% identifying as Black or African American and 72% as female. Half had at least five years of experience working in the food system (see Table 1). Our analysis of the vision board data identified 10 themes related to four dimensions of implementation (i.e., plan, do, reflect, activate) that could be assessed over short- and long-term timescales. We organized the themes into mechanisms and related indicators involved in the dynamic process of transforming urban food systems to achieve nutrition equity. Table 2 includes a summary of results by (1) dimension of implementation based on different stages of an initiative, (2) mechanism of implementation reflecting the series of actions involved to achieve implementation goals, and (3) indicators of implementation after different durations of implementation (i.e., 6 to 12 months, 5 years).

Table 1. Self-identified Demographic Characteristics of Fellowship Participants (*N*=18)

	n	%
Race*		
Black or African American	13	72%
American Indian or Alaska Native	2	11%
Asian	1	6%
White	1	6%
Choose not to respond	3	17%
Latine or Hispanic	2	11%
Gender*		
Female	13	72%
Male	5	28%
Nonbinary or Queer	2	11%
Age		
18–24 years	1	6%
25–34 years	7	39%
35–44 years	3	17%
45–54 years	4	22%
55–64 years	3	17%
Experience Working in the Food System		
1 year or less	3	17%
2–4 years	6	33%
5 or more years	9	50%

* Option to choose all that apply.

Short-Term Indicators

Short-term indicators of the implementation mechanisms to achieve nutrition equity were perceived to be realized after 6 to12 months of implementation. Most of these were related to "planning" and "doing" dimensions of the implementation of community-led food justice initiatives with a few indicators related to "reflecting" on early signs of impact.

The "connecting" mechanism of implementation (Mechanism 1) included indicators representing a series of actions related to building and strengthening trustworthy relationships with community and organizational partners. In the short term, indicators focused on networking with other food justice leaders, building relationships with community partners, and establishing linkages with key decisionmakers (e.g., funders, government officials). More than half of the participants identified connecting with a dedicated team of partners and volunteers as an indicator of success after 12 months of planning. Clarifying the primary audience for the initiative and identifying the skills and strengths of this audience were additional indicators related to the planning dimension.

The "growing" mechanism of implementation (Mechanism 2) included indicators intended to strengthen local capacity to realize nutrition equity. In the short term, indicators focused on personal growth and capacity building for leaders and teams, like participation in leadership training or creating a shared vision and action plan. Insights from fellows highlighted that community-led food justice initiatives vary in readiness for implementation. Early-phase initiatives might have "growing" indicators related to learning

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Table 2. Implementation Mechanisms and Related Indictors of Community-led Food Justice Initiatives Designed to Achieve Nutrition Equity

Dimension of Implementation	Mechanisms of Implementation	Definition of Mechanism	Indicators after different durations of implementation	
			Short-term (6–12 months)	*Long-term (5 years)*
PLAN	1. Connect	Build and strengthen trustworthy relationships with community and organizational partners.	• Network with other food justice leaders. (1a) • Build relationships with community partners. (1b) • Establish linkages with key decision makers. (1c) • Form dedicated team of partners and volunteers. (1d) • Clarify primary audience and identify their skills and strengths. (1f)	Leaders across food justice projects are connected. (1g)
DO	2. Grow Capacity	Build local capacity to realize nutrition equity.	• Complete trainings for leader development. (2a) • Create shared vision, action plan, and marketing approach. (2b) • Research to see what works with existing resources. (2c) • Develop or test small-scale prototype. (2d) • Secure space for programming. (2e) • Begin or expand programming. (2f)	• Scale initiatives to different communities. (2g) • Expand scope of work of initiatives. (2h) • Multiple community members leading work. (2i)
	3. Raise Awareness	Spread the word creatively to reach different groups.	• Host small-scale events or field trips to program sites to attract people. (3a) • Marketing campaign to reach more people. (3b) • Message development to engage decision makers. (3c) • Pitching to secure investments. (3d)	
	4. Secure Resources	Secure resources to implement food justice initiatives led by the community.	• Garner funding to pay for program costs. (4a) • Provide stipends for community participation. (4b)	• Own space or land to implement programming. (4c) • Community runs programming autonomously. (4d)
	5. Change Narratives	Create and tell new narratives about community-led food systems change.		• People know where their food comes from. (5a) • Share stories about food cultures and histories. (5b) • Amplify origin stories of diverse food justice initiatives. (5c)

continued

Table 2, continued.

Dimension of Implementation	Mechanisms of Implementation	Definition of Mechanism	Indicators after different durations of implementation	
			Short-term (6–12 months)	*Long-term (5 years)*
REFLECT	6. See and Feel Change	Witness signs of freedom, hope, and dignity in food traditions resulting in holistic health.	• Community vibe at events. (6a) • Feel a sense of belonging and connection. (6b) • Community members deeply engaged. (6c)	• Vibrant programming. (6d) • Intergenerational engagement. (6f) • Loving relationships between all species. (6g)
	7. Describe Processes	People reached by food justice initiatives and evidence about what works and doesn't work based on learning by doing.	• Assessment of pilot program to guide future work. (7a) • Number of people participating in initiative. (7b) • Availability of produce grown in the community. (7c) • Number of community members selling products at local markets. (7d)	• Initiative is financially stable. (7e) • Evidence-based model for establishing food business. (7f) • Systems linking food justice initiatives to institutions. (7g) • Supply chain and procurement models to source locally grown foods to schools, grocery stores, restaurants. (7h) • Linkages to diversified markets. (7i)
	8. Measure Outcomes	Show meaningful improvements in economic opportunity, food security, healthy food access, and holistic health and reduce the risks of gentrification and displacement.		• Livable wage jobs created. (8a) • Reduced nutrition related disease and food insecurity. (8b) • Elimination of food waste. (8c) • Variety of produce grown in community. (8d) • Elimination of food apartheid. (8e) • Improved physical and mental health. (8f) • Wealth creation for community residents. (8g) • Community ownership of land, buildings, and homes near food justice initiatives by legacy residents of the neighborhood to reduce the risk of gentrification. (8h)
ACTIVATE	9. Advocate	Grow collective support and champions for nutrition equity and establish strategy for policy change.		• Advocate for businesses and healthcare to invest in food justice initiatives. (9a) • Clarify and advocate for a unified policy agenda to advance nutrition equity. (9b) • Join national coalitions to replicate and scale food justice initiatives. (9c)
	10. Inform Policy	Translate insights to guide policy development and implementation at all levels.		• Develop comprehensive toolkits and resources to reduce bureaucratic barriers to realize nutrition equity. (10a) • Inform implementation of food justice initiatives in different contexts and conditions. (10b)

best practices and testing small-scale prototypes. Others may be ready to pilot projects, including indicators such as starting a community garden or a breakfast program. Some may be prepared to expand existing programs, including indicators like increasing urban farm production, adding content to apps or websites, or offering new classes.

The "raising awareness" mechanism of implementation (Mechanism 3) included indicators related to a series of actions to spread the word to reach different groups (e.g., community members, funders). In the short term, indicators of success included developing marketing campaigns to raise awareness and hosting small-scale activities to attract community members, such as cooking classes, food giveaways, and field trips to program sites. Additional indicators were related to attracting decisionmakers and people with resources, such as crafting messages about how community-led food justice work is broadly beneficial to different sectors or successfully pitching ideas to secure more resources (e.g., money, time, space, volunteers). These were directly connected with the "secure resources" mechanism of implementation (Mechanism 4) that included indicators, such as securing space (e.g., land, building, kitchen, food retail) and funding to pay for program costs.

While the reflection dimension of implementation had more indicators after longer periods of implementation, a few were perceived to occur in the short term. These included a series of actions related to seeing and feeling change (Mechanism 6) that demonstrates the emergence of freedom, hope, and dignity in food traditions resulting in holistic health. Proposed indicators may be difficult to quantify, such as experiencing a community vibe and a sense of belonging among people engaging with food justice initiatives. The "describing processes" mechanism (Mechanism 7) aligns with output measures often included in assessment tools. In the short term, this mechanism of implementation provides evidence about activities conducted and their reach as well as lessons gained through learning by doing. Sample indicators related to these processes included how the results of pilot testing are used to guide future efforts, number of people aware of or participating in the initiative, availability of produce grown in the community, and the number of community members selling products at local markets.

Long-Term Indicators

After five years of implementation, the proposed indicators of implementation were largely focused on scaling initiatives and advocacy to sustain them. They also included outputs and outcomes that demonstrate measurable impact resulting from implementation of community-driven food justice initiatives. The mechanisms of implementation were perceived to be interconnected. Accordingly, achieving indicators in the short term would modulate the dynamic process of transforming urban food systems to achieve nutrition equity over the long term.

The long term "connecting" mechanism of implementation (Mechanism 1) represented a series of actions that took trustworthy relationships to the next level. Mechanism 1 resulted in the creation of a network of leaders united across food justice initiatives to support each other, share lessons, and build collective power for community-led change. The "growing capacity" mechanism (Mechanism 2) focused on scaling initiatives geographically, such as a garden in every yard in a neighborhood or every city in the US having a food justice navigator. Scaling included expanded scope of work, such as integrating childcare into a food co-op model. It also included growth in the number of community leaders responsible for implementing food justice initiatives and running their programming autonomously (e.g., as a community anchored rather than an institutionally anchored initiative).

By five years, the "change narrative" mechanism of implementation (Mechanism 5) emerged. Mechanism 5 represented a series of actions involved in creating and telling new narratives about community-led food systems change, which were perceived to be transformative due to shifts in mindset. Indicators included more people knowing where their food comes from, amplifying diverse stories about food cultures, and counter-narratives about local food systems by highlighting the origins of community-led initiatives.

After five years of implementation, the "see and feel change" mechanism of implementation (Mechanism 6) included a range of success indicators, such as a "big garden with big community,"

kids engaging in the garden along with grandparents, and "deeply interconnected and loving relationships between all species." The "describe processes" mechanism (Mechanism 7) included the development of effective implementation processes gained through experience. Sample indicators included evidence of what works for making an initiative financially solvent and development of procurement models to source locally grown foods in schools, grocery stores, and restaurants.

Nearly all participants prioritized the "measure outcomes" mechanism of implementation (Mechanism 8) as a goal after five years of implementation with a focus on indicators that demonstrate shifts in power, ownership, and agency within local food systems. Indicators focused on how implementation of community-led food justice initiatives result in meaningful improvements in economic opportunity (e.g., jobs created), food security (e.g., reduced nutrition related disease and illness, elimination of food waste), and healthy food access (e.g., variety of fruits and vegetables grown in the community, elimination of food apartheid). Together, these were perceived to result in broader impacts, including those more commonly associated with local food systems initiatives (e.g., improved physical and mental health) as well as wealth creation resulting in more community ownership of land, buildings, and homes near food justice initiatives by legacy residents of the neighborhood to mitigate the risk of gentrification.

Long-term indicators also focused on activating evidence for lasting change. The "advocating" mechanism (Mechanism 9) included actions involved in building support for policy changes. Sample indicators included creation of a unified policy agenda and joining national coalitions to scale food justice work. The "informing policy" mechanisms of nutrition equity implementation (Mechanism 10) focused on translating community-led insights into toolkits to reduce bureaucratic barriers and tailoring evidence to inform implementation of community-led food justice initiatives in other communities.

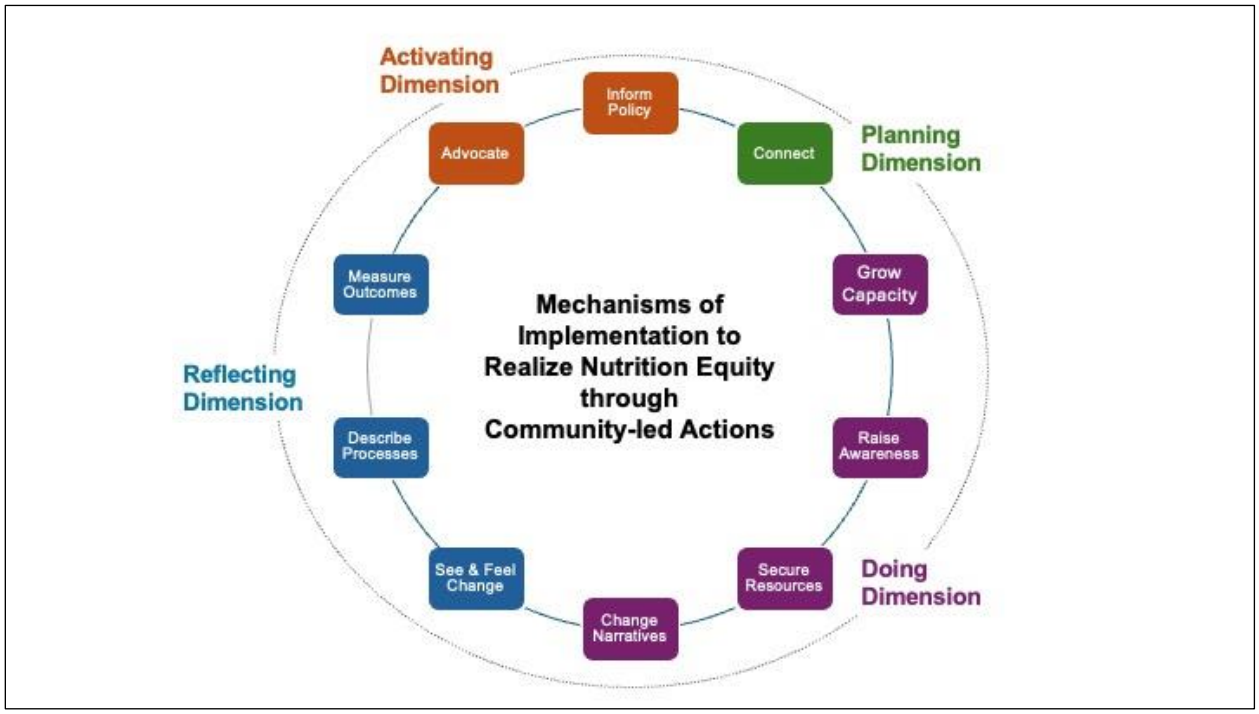
Discussion

Our research brief shares insights from a study where individuals affected by food system inequities helped define the mechanisms of implementation and related impacts to transform urban food systems. The community-engaged research process itself was as crucial as the findings (Brock et al., 2024; Michener & Ford, 2023). Through this approach, we shed light on the black box of local food system complexity, highlighting 10 implementation mechanisms and related indicators to guide community-led food justice initiatives seeking to advance nutrition equity (Figure 1). The findings provide insights into the series of actions involved in advancing freedom, agency, and dignity in food traditions resulting in holistic health within urban communities.

Lessons learned offer insights into the "how" of transformative change, highlighting food systems as dynamic processes influenced by numerous interconnected mechanisms. Our community action research uncovered mechanisms of implementation for shifting leadership of urban food system changes to individuals with lived experiences of nutrition inequities. For example, the implementation mechanism focused on securing resources for community-led food justice initiatives (Mechanism 4) demonstrates how indicators can generate feedback, creating ripple effects. Securing funding to cover program costs (Indicator 4a) may lead to acquiring space or land for future program implementation (Indicator 4c), ultimately enabling the community to autonomously manage the program over time (Indicator 4d).

Findings highlight important aspects of local food systems that lack standardized methods for measurement, such as the strength of partner trust (Mechanism 1) or strategies to mitigate gentrification and displacement due to implementation of food systems change (Mechanism 8). Recent developments introduce measurement frameworks corroborating the need for operationalization of these mechanisms. The "community embeddedness" index for regional food system sustainability includes indicators, such as trust and reciprocity (Wiltshire et al., 2024). The "food justice" dimension of community food systems resilience includes indicators to limit unintended consequences of local food systems development, such as "jurisdiction supports land back and land reparations for BIPOC farmers" (Campbell et al., 2022, p. 112).

Figure 1. Proposed Implementation Mechanisms to Achieve Nutrition Equity in Urban Food Systems Through Community-Led Change



Green represents the "planning" dimension of implementation focused on relationship building, purple the "doing" dimension where activities are being developed and applied, blue the "reflecting" dimension to study processes, outputs, and impact, and orange the "activating" dimension focused on translating findings into policies and practices.

Connection to Existing Research

Our lessons build on an existing model of food system dynamics in racialized urban neighborhoods that was developed using participatory methods (Freedman et al., 2022; Glickman et al., 2022). This model illuminated a range of interrelated factors shaping the goal of nutrition equity (Freedman et al., 2022). Our findings offer guidance on actions needed to accelerate nutrition equity through efforts seeking to increase community power, align change with food culture and norms, improve healthy food retail, and reduce the risk of gentrification. They also align with some indicators of community food systems resilience (Campbell et al., 2022) and regional food system sustainability (Wiltshire et al., 2024).

Findings reinforce the need for implementation of activities designed to promote distributed and democratic leadership to shift power imbalances within local food systems (Campbell et al., 2022; Freedman et al., 2022). Six of the 10 mechanisms of implementation were related to building community power (Mechanisms 1-4, 9, 10). These mechanisms were perceived to be interconnected. Thus, changes in one area, such as growing local capacity to implement food justice initiatives led by the community (Mechanism 2), will influence the pace of change in other areas, such as the ability to translate insights from community-led food justice initiatives to guide policy development and implementation (Mechanism 10).

Findings align with prior research suggesting the need for implementation activities intended to shift food norms and cultures to enhance community health and well-being (Campbell et al., 2022; Freedman et al., 2022). Our findings highlight the importance of implementing activities to generate new narratives about urban food systems (Mechanism 5) and to creatively document how these narratives are embodied through actions that demon-

strate freedom, hope, and dignity in food traditions that support holistic health (Mechanism 6).

As a dynamic process, these shifts in mindset are shaped by access to healthy foods in the local food system. Our findings highlight that increasing access to healthy foods requires multiple interconnected actions. This might begin by hosting small-scale events to attract people to the food access site (Indicator 3a) leading to insights that can guide future work (7a) to increase the number of community members selling their products at local markets (Indicator 7d). Overtime, these insights may lead to a financially stable food access site (7e), evidence-based models for establishing successful food businesses in urban food systems (7f), and ultimately to elimination of food apartheid (8e). Food apartheid attends to the whole food system rather than one part (e.g., supermarkets) emphasizing the ways the food system is structured along lines of race, class, gender, and their intersections (Brones, 2018).

Lastly, findings highlight the importance of implementing assessment activities to examine unintended consequences of changes within urban food systems. Most of the outcomes of implementation considered to be measurable over time reinforced the need for examining how implementation efforts intentionally reduce risks of gentrification. These included indicators to demonstrate meaningful improvements in economic opportunity and community wealth building, food security because of job security, healthy food access and the elimination of food apartheid, and holistic health—mental, physical, and spiritual—resulting from community-led food justice initiatives.

Limitations

Our research has limitations. Fellowship participants' perspectives do not represent all community leaders, especially in rural areas. As a visioning exercise, data were based on leaders' aspirations for food justice initiatives over five years without considering implementation barriers, like funding and capacity, which could affect the pace of achieving success. We did not focus on measurement of these indicators, as gaining wider consensus is needed before operationalizing.

Conclusion

This research brief showcased an approach for engaging food justice leaders to identify implementation mechanisms and related effects within urban food systems. Insights shed light on a series of linked actions to support community-led food justice initiatives seeking to advance nutrition equity. Future research should align these indicators of implementation with existing assessment tools to avoid duplication and achieve consensus on the most relevant measures for practical application. A long-term focus is essential to examine how progress on these indicators of implementation fosters nutrition equity through community-driven change.

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References

Alkon, A. H., & Cadji, J. (2018). Sowing seeds of displacement: Gentrification and food justice in Oakland, CA. *International Journal of Urban and Regional Research*, *44*(1), 108–123. https://doi.org/10.1111/1468-2427.12684

Anguelovski, I., Connolly, J. J. T., Cole, H., Garcia-Lamarca, M., Triguero-Mas, M., Baró, F., Martin, N., Conesa, D., Shokry, G., del Pulgar, C. P., Ramos, L. A., Matheney, A., Gallez, E., Oscilowicz, E., Máñez, J. L., Sarzo, B., Beltrán, M. A., & Minaya, J. M. (2022). Green gentrification in European and North American cities. *Nature Communications*, *13*, Article 3816. https://doi.org/10.1038/s41467-022-31572-1

Boswell, L., Burns, M., Clark, J., Donley, G., Etheridge, K., Freedman, D., Fryerson, S., Gill, I., Harris, A., Hovmand, P., Jackson, M., Kahl, B., Lounsbury, D., & Sommer, R. (2021). *The Food Systems Change Vision Board Toolkit*. Case Western Reserve University, Mary Ann Swetland Center for Environmental Health. https://case.edu/swetland/research/modeling-future-food-your-neighborhood-foodnest-20/decision-support-tools

Brock, S., Baker, L., Jekums, A., Ahmed, F., Fernandez, M., Montenegro de Wit, M., Rosado-May, F. J., Méndez, V. E., Anderson, C. R., DeClerck, F., Anderson, M. D., Bezner Kerr, R., Hoare, B., Wittman, H., Peeters, A., Gubbels, P., Stancu, C., Bellon, S., Lundgren, J. G., … Rogé, P. (2024). Knowledge democratization approaches for food systems transformation. *Nature Food*, *5*, 342–345. https://doi.org/10.1038/s43016-024-00966-3

Brones, A. (2018, May 15). Food apartheid: The root of the problem with America's groceries. *The Guardian*. https://www.theguardian.com/society/2018/may/15/food-apartheid-food-deserts-racism-inequality-america-karen-washington-interview

Campbell, C. G., Papanek, A., DeLong, A., Diaz, J., Gusto, C., & Tropp, D. (2022). Community food systems resilience: Values, benefits, and indicators. *Journal of Agriculture, Food Systems, and Community Development*, *11*(4), 89–113. https://doi.org/10.5304/jafscd.2022.114.006

Fanzo, J., Haddad, L., McLaren, R., Marshall, Q., Davis, C., Herforth, A., Jones, A., Beal, T., Tschirley, D., Bellows, A., Miachon, L., Gu, Y., Bloem, M., & Kapuria, A. (2020). The Food Systems Dashboard is a new tool to inform better food policy. *Nature Food*, *1*, 243–246. https://doi.org/10.1038/s43016-020-0077-y

Freedman, D. A., Clark, J. K., Lounsbury, D. W., Boswell, L., Burns, M., Jackson, M. B., Mikelbank, K., Donley, G., Worley-Bell, L. Q., Mitchell, J., Ciesielski, T. H., Embaye, M., Lee, E. K., Roche, A., Gill, I., & Yamoah, O. (2022). Food system dynamics structuring nutrition equity in racialized urban neighborhoods. *The American Journal of Clinical Nutrition*, *115*(4), 1027–1038. https://doi.org/10.1093/ajcn/nqab380

Freudenberg, N., Willingham, C., & Cohen, N. (2018). The role of metrics in food policy: Lessons from a decade of experience in New York City. *Journal of Agriculture, Food Systems, and Community Development*, *8*(Suppl. 2), 191–209. https://doi.org/10.5304/jafscd.2018.08B.009

Glickman, A. R., Clark, J. K., & Freedman, D. A. (2022). 12 - Participatory modeling of the food system: The case of community-based systems dynamics. In C. Peters & D. Thilmany (Eds.), *Food Systems Modelling* (pp. 257–283). Academic Press. https://doi.org/10.1016/B978-0-12-822112-9.00003-5

Harris, P. A., Taylor, R., Minor, B. L., Elliott, V., Fernandez, M., O'Neal, L., McLeod, L., Delacqua, G., Delacqua, F., Kirby, J., Duda, S. N., & REDCap Consortium. (2019). The REDCap consortium: Building an international community of software platform partners. *Journal of Biomedical Informatics*, *95*, Article 103208. https://doi.org/10.1016/j.jbi.2019.103208

Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics*, *42*(2), 377–381. https://doi.org/10.1016/j.jbi.2008.08.010

Karetny, J., Hoy, C., Usher, K. M., Clark, J. K., & Conroy, M. M. (2022). Planning toward sustainable food systems: An exploratory assessment of local U.S. food system plans. *Journal of Agriculture, Food Systems, and Community Development*, *11*(4), 115–138. https://doi.org/10.5304/jafscd.2022.114.008

Leis, J. A., & Shojania, K. G. (2017). A primer on PDSA: Executing plan–do–study–act cycles in practice, not just in name. *BMJ Quality & Safety*, *26*(7), 572–577. https://doi.org/10.1136/bmjqs-2016-006245

Lewis, C. C., Klasnja, P., Lyon, A. R., Powell, B. J., Lengnick-Hall, R., Buchanan, G., Meza, R. D., Chan, M. C., Boynton, M. H., & Weiner, B. J. (2022). The mechanics of implementation strategies and measures: Advancing the study of implementation mechanisms. *Implementation Science Communications*, *3*, Article 114. https://doi.org/10.1186/s43058-022-00358-3

Mayring, P. (2015). Qualitative content analysis: Theoretical background and procedures. In A. Bikner-Ahsbahs, C. Knipping, & N. Presmeg (Eds.), *Approaches to qualitative research in mathematics education: Examples of methodology and methods* (pp. 365–380). Springer Netherlands. https://doi.org/10.1007/978-94-017-9181-6_13

Meter, K. (2011). Metrics from the field: Seventeen reasons to do food system assessments. *Journal of Agriculture, Food Systems, and Community Development*, *2*(1), 7–9. https://doi.org/10.5304/jafscd.2011.021.014

Michener, J., & Ford, T. N. (2023). Racism and health: Three core principles. *The Milbank Quarterly*, *101*(Suppl. 1), 333–355. https://doi.org/10.1111/1468-0009.12633

Myers, A. M., & Painter, M. A., II. (2017). Food insecurity in the United States of America: An examination of race/ethnicity and nativity. *Food Security*, *9*, 1419–1432. https://doi.org/10.1007/s12571-017-0733-8

Organizing Committee for Assessing Meaningful Community Engagement in Health & Health Care Programs & Policies. (2022, February 14). Assessing meaningful community engagement: A conceptual model to advance health equity through transformed systems for health [Commentary]. *NAM Perspectives*. National Academy of Medicine. https://doi.org/10.31478/202202c

Penniman, L. (2018). *Farming while Black: Soul Fire Farm's practical guide to liberation on the land*. Chelsea Green Publishing.

Rabbitt, M. P., Reed-Jones, M., Hales, L. J., & Burke, M. P. (2024). *Household food security in the United States in 2023* (ERR-337). U.S. Department of Agriculture, Economic Research Service. https://doi.org/10.32747/2024.8583175.ers

Reed, J. E., Davey, N., & Woodcock, T. (2016). The foundations of quality improvement science. *Future Hospital Journal*, *3*(3), 199–202. https://doi.org/10.7861/futurehosp.3-3-199

Rhone, A., Williams, R., & Dicken, C. (2022). *Low-Income and Low-Foodstore-Access Census Tracts, 2015–19* (EIB-236). U.S. Department of Agriculture, Economic Research Service. https://doi.org/10.22004/ag.econ.329749

von Braun, J., Afsana, K., Fresco, L. O., Hassan, M., & Torero, M. (2021). Food system concepts and definitions for science and political action. *Nature Food*, *2*, 748–750. https://doi.org/10.1038/s43016-021-00361-2

Walker, R. J., Garacci, E., Dawson, A. Z., Williams, J. S., Ozieh, M., & Egede, L. E. (2021). Trends in food insecurity in the United States from 2011–2017: Disparities by age, sex, race/ethnicity, and income. *Population Health Management*, *24*(4), 496–501. https://doi.org/10.1089/pop.2020.0123

Wiltshire, S., Beckage, B., Callahan, C., Chase, L., Conner, D., Darby, H., Kolodinsky, J., Kraft, J., Neher, D. A., Poleman, W., Ricketts, T. H., Tobin, D., von Wettberg, E. J. B., & Niles, M. T. (2024). Regional food system sustainability: Using team science to develop an indicator-based assessment framework. *Journal of Agriculture, Food Systems, and Community Development*, *14*(1), 449–472. https://doi.org/10.5304/jafscd.2024.141.011

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Assessing access and use of nutrition support programs, food insecurity, and health status in urban Native American families with young children in Montana: A case study

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Abstract

The purpose of this cross-sectional, mixed methods case study was to assess participation in, and use of, nutrition support programs (NSPs) and their impact on food insecurity and health status of American Indian and Alaska Native (AIAN) families with young children (ages 0–8) living in three urban areas in Montana. Convenience sampling was used to recruit urban AIANs to participate in a

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Disclsoures

This project was approved by the Indian Health Service (IHS) National Institutional Review Board (NIRB), under project number N20-N-07. Project members completed necessary sections of the Online Research Ethics course developed through the Practical Ethics Center at the University of Montana with the Office of Research Integrity (ROI). The authors report there are no competing interests to declare.

survey that contained closed and open-ended questions. A final sample of 177 responses were included in the analysis. Fisher exact tests, Wilcoxon rank-sum tests, and analysis of variance was used to model program participation, access, use, health scores, and food insecurity status as a function of demographic measures. Standard logistic regression was used in models with binary responses such as food insecurity. Proportional odds logistic regression was used to compare the proportion of respondents in poor, fair, good, very good, and excellent health for each of the five ordinal health measures with respect to program participation, access, use, food insecurity, and changes in the amount and variety of fruits and vegetables consumed. All logistic models used a single predictor and thus are unadjusted for additional factors. Thematic analysis was conducted on the open-ended questions. Most respondents (N = 132) identified as AIAN and 54% of respondents were categorized as food insecure. Most respondents (56–94.8%) agreed that SNAP, WIC, and DSD were helpful for improving their diets. Participants described frustrations with the SNAP application process, including long call back or wait times and difficulties getting questions answered and scheduling required certification appointments. Participants also expressed feeling discriminated against by caseworkers and community members when accessing SNAP. Respondents reporting SNAP was "very easy" to access had significantly higher general health scores (Proportional odds regression, overall p = 0.004). Higher physical functioning scores were associated with being food secure (p = 0.077). The odds of "Very Good" or "Excellent" social functioning scores were 2.26 times larger for participants identified as food secure than for participants identified as food insecure (CI: 1.21–4.28). The odds of "Very Good" or "Excellent" mental health scores were 2.10 times larger for participants identified as food secure than for participants identified as food insecure (CI: 1.13–3.96). Although further research is needed to establish causal relationships between food security, health status, dietary quality, and NSP use, our results advance understanding of the lived experiences of urban AIANs who participate in these programs. These results also emphasize the need for policy changes that reduce administrative complexity, improve program visibility, and incorporate culturally tailored approaches to better serve historically underreported communities.

Keywords
food insecurity, health, nutrition support programs, American Indian/Alaska Native, Urban Indian Organizations, SNAP, WIC, nutrition incentive program

Introduction

Food security refers to consistent access to safe and nutritious foods in sufficient quantities necessary to sustain a healthy lifestyle and normal bodily functions (Bickel et al., 2000). An individual's food security status is influenced by various factors, including social determinants of health, household characteristics, and economic factors. Lacking access to a nutritious diet has direct and indirect consequences for health and well-being across the lifespan (Hartline-Grafton & Hassink, 2021). Children living in households with low to marginal food security are particularly vulnerable to adverse outcomes, such as increased health risks, impaired coping skills and emotional regulation, and lower academic performance (Ryu & Bartfeld, 2012; Shankar et al., 2017). Low food security is also associated with higher risk of chronic diseases such as Type 2 diabetes (Levi et al., 2023). In response to food insecurity, the U.S. government administers several nutrition support programs (NSPs) to improve food access and security among low-income households. The two largest NSPs are the Supplemental Nutrition Assistance Program (SNAP) and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), which have been shown to improve household and child food security (Ettinger de Cuba et al., 2019; Kreider et al., 2016; Mabli & Ohls, 2015).

National statistics on food security can provide a high-level understanding of food security; in 2023, 17.9% of all U.S. households (10.6% in Montana) with children under 18 were categorized as having low food security (U.S. Department of Agriculture Economic Research Service, 2024a, 2024b). However, aggregated statistics often mask the experience of many underreported populations,

including the estimated 9.7 million Americans identifying as American Indian/Alaskan Native (AIAN), alone or in combination with at least one other race (U.S. Census Bureau, 2020). While 22% of AIANs live on reservations or other trust lands, more than 70% live in urban areas (Urban Indian Health Institute, 2025). Food insecurity rates in tribal communities have been reported as high as 75% (Mullany et al., 2013; Tomayko et al., 2017). Food insecurity rates among AIANs are significantly higher compared to non-Hispanic Whites (NHWs), and urban AIANs are 1.4 times more likely to be food insecure than rural AIANs (Jernigan et al., 2017). Low-income AIAN families with young children are particularly vulnerable to food insecurity, with the reported prevalence of food insecurity significantly higher in urban households (80%) than rural (45%) (Tomayko et al., 2017). Additional research on urban AIAN experiences with food insecurity and how lack of healthy, safe foods influences health status is necessary for making well-informed decisions about NSP policies, which may improve health disparities in this population.

Background on Urban AIANs and the Federal Government

The federal government holds both a moral and legal obligation to uphold its "promise of all proper care and protection" to tribal nations, which includes protection of tribal rights, lands, and resources, as well as a duty to provide health care services (Warne & Frizzell, 2014, p. 263). But since 1953 the government has sought to shift its approach in tribal relations from self-governance to termination and assimilation (National Archives, 2024a). The Bureau of Indian Affairs established an urban relocation program to promote AIAN assimilation by promising housing and employment assistance for those relocating from reservations to urban centers (Hendrix, 2019; National Archives, 2024b). These program supports, however, were short-lived, and promises of financial stability went largely unfulfilled. Many AIANs thus have faced significant challenges adjusting to urban life, including discrimination, job insecurity, and loss of cultural connection to their tribal communities (Hendrix, 2019; National Archives, 2024b). In response, the Indian Health Service (IHS) was established to deliver health and educational assistance to federally recognized tribes (Warne & Frizzell, 2014). However, IHS programs have faced chronic underfunding and staffing shortages, leading to inadequate preventive and reactive care for AIAN clients (Frerichs et al., 2022). In addition, urban AIANs often have less access to IHS services, significantly limiting their healthcare options. Urban Indian Organizations (UIOs) were established to address the gap in healthcare and provide culturally inclusive services for urban AIANs.

In Montana, there are UIOs in five cities: Butte, Helena, Billings, Great Falls, and Missoula. Each organization serves clients affiliated with all 12 Montana tribes, and many AIAN clients who have moved to Montana cities from out of state. In these cities, urban AIANs experience higher rates of unemployment and mortality than other races (Urban Indian Health Institute, 2021a, 2021b, 2021c). An Urban Indian Health Institute analysis found that Montana urban AIANs have disproportionately higher incidence of disease, comorbidity, and mortality compared to NHWs, particularly among AIAN mothers (Urban Indian Health Institute, 2025). In Montana, NHW males tend to live 16 years longer than AIAN males and NHW women live 19 years longer than AIAN women (Montana Department of Public and Human Health Services (DPHHS), 2017).

Despite living away from their native lands, many urban AIANs remain resilient and continue to practice their cultural traditions, including customary food practices. Each tribe is distinct, with its own traditions and cultural identity. Cultural adaptations of health promotion programs that seek to improve food security for urban AIANs could modify both surface structures (social and behavioral characteristics) and deep structural levels (worldview, norms, beliefs, and values) to promote their acceptance and comprehension (Castro et al., 2004). Thus, in this study we were interested in exploring how food assistance programs can be culturally adapted to better serve urban AIAN populations. By understanding how urban AIANs participate in NSPs like SNAP and WIC, our research intends to inform NSP policies in order to improve program design and implementation. The research

could also help NSPs to be more culturally relevant, accessible, and effective for this underserved demographic, in turn decreasing food insecurity and health disparities in the urban AIAN population.

Urban AIAN and Nutrition Education, Access, and Services

The proportion of SNAP and WIC participation among AIAN households is significantly higher than NHW households. In three urban cities in Montana, from 2013–2017 SNAP participation for AIAN households was 4.5 times higher in Billings, 3.1 times higher in Great Falls, and 2.4 times higher in Missoula compared to NHW households in those cities (Urban Indian Health Institute, 2021a, 2021b, 2021c). Similarly for WIC participation AIAN households were 2.5, 2.2, and 2 times higher than NHW households, respectively (Urban Indian Health Institute, 2021a, 2021b, 2021c). These disparities in program use highlight the disproportionate burden of food insecurity in urban AIAN communities and underscore the critical role that NSPs play in supporting dietary needs.

A nutrition incentive program (NIP) is a type of NSP that offers matching funds to specifically purchase fruits and vegetables to improve food security and health outcomes for SNAP participants (County Health Rankings & Roadmaps, 2020; Durward et al., 2019). A recent national study of NIPs found that 53.9% of all NIP participants and 79% of AIANs self-reported as food insecure, with longer program participation associated with lower reported food-insecure rates (USDA National Institute of Food and Agriculture, 2023). Montana's NIP is called Double SNAP Dollars (DSD) and is offered in 40 state locations. However, participation rates and experiences of urban AIANs in Montana who are eligible to use the DSD program are not well known.

Purpose of Study

The purpose of this study was to assess participation in, and use of, SNAP, WIC, and DSD, and to assess the food insecurity and health status of AIAN families in three urban areas in Montana. The results could inform program processes and policies that shape how urban AIANs experience these programs and potentially strengthen urban AIAN participation in the programs, leading to improved food security and well-being.

Methods

Study Design

The project partnership consisted of staff from three Urban Indian Organizations (UIOs) in Montana, a DSD program director from a local nonprofit, and a project evaluation team from the University of Montana. The cross-sectional study used a mixed-method approach consisting of a survey and interviews. This paper describes the survey component and results; the interview study component will be reported in a future publication.

The project partnership was formed in 2020 and IRB approvals for the study were obtained in February 2021. Recruitment began in March 2021. Data collection and analysis was completed in December 2022. Three co-authors were involved in participant recruitment, implementing the survey, and conducting the interviews. Five of the co-authors were involved in data analysis.

Community-based Participatory Research and Survey Development

Our project employed Community-based Participatory Research (CBPR) approaches that engaged in long-term, equitable partnerships with the Montana urban AIAN communities and UIOs, creating a more balanced relationship between the scientific rigors of researcher-driven studies and community control while maintaining respect for local wisdom. These research practices helped to increase the likelihood of implementing effective and sustainable public health interventions (Israel et al., 1998, 2001). The CBPR approaches included an Equitable, Participatory Evaluation Toolkit, a Memorandum of Understanding that described the guiding principles for conducting the study, co-design of survey and interview data collection tools and dissemination materials, and research training opportunities for project partners and staff, students, and community members. These approaches helped to facilitate a collaborative community and academic partnership in all phases of the research and integrate knowledge and action for the mutual benefit

of all partners, two core principles of adapting a CBPR approach for Indigenous research (Laveaux & Christopher, 2009).

The survey was initially developed from validated food security and health status instruments (Bickel et al., 2000; McHorney et al., 1993; Ware et al., 1995). Existing literature specific to accessing and using federal NSPs such as WIC and SNAP also informed the development of the survey. The partnership reviewed and approved the initial survey instrument. Ten AIAN adults in one of the urban communities provided programmatic feedback about the survey. For example, they were asked if they understood the questions, if there were other ways the questions could be asked so that survey participants would better understand them, and if the questions were culturally appropriate. We revised the survey based on this input. These individuals did not participate in the final survey.

Survey Measures

The study evaluated food security status using the validated two-item food security measure (Hager et al., 2010). The partnership chose to use this instrument rather than the longer 10- and 18-item food security assessment modules due to concern about length and potential participant fatigue in completing the survey. The two food security measurement statements participants responded to were: (Question A) "Within the last 12 months I/we worried whether our food would run out before I/we got money to buy more," and (Question B) "Within the last 12 months the food I/we bought just didn't last and I/we didn't have money to get more."

Health status was evaluated for general health, physical functioning, mental health, bodily pain, social functioning, and vitality using the 12-item Short Form Survey Instrument (SF-12) (Ware et al., 1998). The SF-12 provides a brief, reliable measure of overall health status and has been widely used as a screening tool in population health surveys, and successfully used with AIAN communities (Brown et al., 2007). The SF-12 instrument calculates health status scores, ranging 0–100 in 25-point increments, corresponding to categories of Poor, Fair, Good, Very Good, and Excellent health.

The survey collected participant demographic and descriptive information (e.g., age, educational achievement, household income, number of children living in the household age 0–8, marital status, annual income, race, ethnicity, and gender).

Two questions assessed changes in participants' fruit and vegetable consumption. Using a six-point Likert scale, respondents were asked, "as a result of using nutrition support programs, the *amount* (or *variety)* of fruits and vegetables increased greatly, increased some, stayed the same, decreased some, decreased greatly, or doesn't apply." In the sections specific to an individual nutrition support program (e.g., SNAP, WIC and DSD), participants were asked: "How does <name of NSP> impact your family's diet?" Participants could respond, "We eat healthier than we normally would," "We eat as we normally would," or "We eat less healthy than we normally would." Participants who selected either "healthier" or "less healthy" were subsequently asked open-ended follow-up questions: "If you responded that you eat healthier than you normally would, how does <name of NSP> help your family eat healthier?" or "If you responded that you eat less healthy than you normally would, how does <name of NSP> prevent your family from eating healthier?"

Participants also responded to open-ended questions designed to explore perceived enhancers and barriers to accessing SNAP, WIC, and DSD. Questions included what their family liked about these programs, and how the programs could be improved so that they would be easier to access and use.

Sampling Approach

We used a convenience and snowball sampling approach to recruit AIAN families with children 0–8 that had participated in WIC, SNAP, DSD, or other NSPs within the last six months. The age range was limited to align with the project's funding purpose and participant inclusion criteria, which was to "build evidence about nutrition supports for low-income families with young children (0–8 years old)."

Eligible participants lived in one of three urban communities in Montana: Great Falls, Missoula, and Billings. Recruitment materials, including flyers

describing the study, were posted at each UIHO site and at public locations in each community (e.g., gas stations, convenience and grocery stores, etc.). We also recruited participants at local community events such as health fairs, pow-wows, and other cultural events.

Participants had the option to complete the survey in person using a paper survey and pen/pencil at a UIHO or community event, or online via Qualtrics. The survey content was identical across formats. Online participants had the option to exit the survey and return later to complete it. Participants chose the survey format that was most convenient for them.

Upon completion of the survey, participants received a $20 grocery store gift card and were given the option to enter a raffle for larger prizes. One of the co-authors manually entered paper survey data into Qualtrics. The online survey employed standard bot detection measures, including CAPTCHA scores through the Qualtrics bot flagging system.

Data Analysis

Survey data was entered into an Excel spreadsheet and proofed for accuracy with edit and logic checks to ensure data integrity. Three of the co-authors cross-checked the Qualtrics survey data and performed additional bot detection assessments, which consisted of applying a bot detection and decision matrix to the data. The matrix was developed by the partnership and was based on observations of clear data outliers (e.g., a city or country geographically distant from the study locations) coupled with published reports of typical bot activity (e.g., extremely brief survey completion time, contradictory responses, repetitive responses to open-ended questions, listed phone number was disconnected, and suspicious email addresses).

Descriptive and demographic data were analyzed for SNAP, WIC, and DSD participating households versus households that indicated they did not participate in the NSP and for food-insecure households versus food-secure households. These data included household size, number of children, household income, and head of household education level. Health measures were classified for respondents using an ordinal scale (excellent, very good, good, fair, and poor) for general health, physical function, mental health, social functioning, vitality, and bodily pain. Participants were identified as either food insecure or food secure based on how they answered the two food insecurity questions.

Fisher exact tests, Wilcoxon rank-sum tests, and analysis of variance modeled program participation, access, use, health measures, and food insecurity status as a function of demographic measures. Standard logistic regression was used in models with binary responses such as food insecurity. Proportional odds logistic regression compared the proportion of respondents in poor, fair, good, very good, and excellent health for each of the five ordinal health measures with respect to program participation, access, use, food insecurity, and changes in the amount and variety of fruits and vegetables consumed. All logistic models used a single predictor and thus are unadjusted for additional factors. Twelve participants were excluded from all analyses involving the five health measures because they indicated that extenuating circumstances affected their answers to the health questions. We conducted all quantitative analyses in R, version 4.1.2. We conducted thematic analysis on qualitative questions (Elo & Kyngäs, 2008).

Results

Eleven participants completed a paper survey, and 229 participants completed the survey online. Of the 240 surveys, 63 were eliminated during the final bot detection assessments, leaving 177 for final analysis. We used all available data for any given variable or analysis of several variables and omitted incomplete responses. All significant results assessing the relationship between a categorical response and an explanatory variable were derived from a proportional odds logistic regression model framework.

Demographics

The vast majority (94.3%) of the respondents identified as AIAN. Females comprised 82.4% of respondents, 63.4% of the sample were adults (30–59), and 46% had a college degree. Most respondents (56.98%) reported an annual household income below $30,000 (Table 1).

SNAP, WIC, and DSD Programs

Participation rates and accessibility ratings were calculated for each NSP (SNAP, WIC, and DSD), along with participant perceptions of whether the program helped their family eat healthier.

SNAP

Eighty-seven participants (52.7%) reported participating in SNAP (Table 1) and using a 4-point Likert scale (very easy, easy, difficult, and very difficult) rated their family's ability to access SNAP. Of these, 83.9% rated SNAP as either "very easy" or "easy" to access. Among 86 participants who rated SNAP's dietary impact, 55.8% (n = 48) responded that SNAP helps their family eat healthier than they normally would. Notably, participants who indicated SNAP access as "very easy" were significantly younger than those who rated SNAP access as "easy" (mean age = 32.39 vs. 41.25, p = 0.009).

WIC

Fifty-eight participants (34.3%) reported participation in WIC (Table 1) and on the 4-point Likert scale rated their family's ability to access WIC. Of

Table 1. Demographics and Survey Respondent Characteristics

	n (%)				
Characteristics	**All Respondents (*N* = 177)**	**WIC Participants (*n* = 58)**	**SNAP Participants (*n* = 87)**	**DSD Participants (*n* = 20)**	**Other Participants (*n* = 32)**
Gender					
Female	117 (82.4)	42 (87.5)	61 (84.7)	13 (76.5)	25 (86.2)
Male	24 (16.9)	6 (12.5)	11 (15.3)	4 (23.5)	4 (13.8)
Age					
< 20	7 (4.9)	3 (6.3)	3 (4.1)	0 (0.0)	1 (3.3)
20–29	36 (25.4)	17 (35.4)	20 (27.4)	3 (17.6)	7 (23.3)
30–39	62 (43.7)	20 (41.7)	31 (42.5)	9 (52.9)	9 (30.0)
40–49	20 (14.1)	3 (6.3)	8 (11.0)	0 (0.0)	9 (30.0)
50–59	8 (5.6)	3 (6.3)	5 (6.8)	3 (17.6)	3 (10.0)
60+	9 (6.3)	2 (4.2)	6 (8.2)	2 (11.8)	1 (3.3)
Race					
AIAN	132 (94.3)	44 (93.6)	70 (97.2)	16 (94.1)	28 (93.3)
White	17 (12.1)	4 (8.5)	4 (5.6)	2 (11.8)	6 (20.0)
Black	2 (1.4)	1 (2.1)	1 (1.4)	1 (5.9)	2 (6.7)
Prefer Not to Answer	1 (0.7)	0 (0)	1 (0.7)	0 (0)	0 (0)
Education					
High School or less	33 (23.4)	13 (27.1)	23 (31.5)	4 (23.5)	7 (24.1)
Some College	43 (30.5)	14 (29.2)	29 (39.7)	4 (23.5)	8 (27.6)
College Degree	49 (34.8)	17 (35.4)	18 (24.7)	5 (29.4)	9 (31.0)
Graduate Degree	16 (11.3)	4 (8.3)	3 (4.1)	4 (23.5)	5 (17.2)
Yearly Income					
<$10,001	34 (25.8)	19 (43.2)	26 (37.1)	3 (18.8)	7 (25.9)
$10,001–$30,000	41 (31.1)	13 (29.5)	27 (38.6)	6 (37.5)	6 (22.2)
$30,001–$50,000	29 (22.0)	10 (22.7)	11 (15.7)	4 (25.0)	10 (37.0)
$50,000+	28 (21.2)	2 (4.5)	6 (8.6)	3 (18.8)	4 (14.8)

Notes: Percentages were computed based on the number of respondents to each survey question. For example, there were 165 respondents to the question about SNAP participation, 87 of whom said they participated, yielding a percentage of 87/165 = 52.7%. Counts overlap between WIC, SNAP, DSD and Other categories because there were 34 participants in SNAP and WIC, 10 in WIC and DSD, 9 in WIC and Other, 15 in SNAP and Other, 6 in DSD and Other, and 17 in SNAP and DSD.

these, 98.3% rated WIC as either "very easy" or "easy" to access. Of the 55 participants who rated WIC's dietary impact, 58.2% (n = 32) responded that WIC helps their family eat healthier than they normally would.

DSD

Twenty participants (12.3%) reported participation in DSD and rated on the 4-point Likert scale their family's ability to access DSD. All participants (100%) rated access to DSD as either "very easy" or "easy." Of the 19 respondents who rated DSD's dietary impact, 94.8% (n = 18) responded that DSD helps their family eat healthier than they normally would.

Food Security Status

One hundred and forty-nine participants responded to both food security questions (A and B) (Hager et al., 2010). Of the 149 responses to question A, more than two-thirds indicated this was at least sometimes true (69.8%; n = 104). Of the 149 responses to question B, more than half indicated this was at least sometimes true (55%; n = 82). In total, 54.4% of respondents indicated that by both measures they were food insecure.

There were more children aged 0–8 years in food insecure households (mean number of children = 1.74 vs. 1.29, p = 0.037). The odds of food insecurity among urban AIAN participants who used SNAP was 4.11 times that of those who did not use SNAP (95% CI: 1.99–8.77, p = 0.0001) (Figure 1). Respondents reported lower food insecurity among lower-income households (Logistic model of food insecurity on income level, p = 0.003, Figure 2(e)).

Fruit and Vegetable Consumption

The majority of respondents (62%, n = 91) indicated eating 1–2 servings of fruits and vegetables per day, 22.6% (n = 33) ate 3–4 servings per day, and 2.1% (n = 3) ate 5 or more servings per day. Conversely, 13% (n = 19) of the sample consumed less than one serving per day of fruits and vegetables.

Health Status

Health status for each participant was scored for six domains of health: general, physical functioning, bodily pain, vitality, mental health, and social functioning. Scores were categorized on an ordinal scale: 0 (Poor), 25 (Fair), 50 (Good), 75 (Very Good), 100 (Excellent).

General Health

General health scores were calculated for 134 responses. The median score was 50 (Good), and 89% of respondents had a score of 25, 50, or 75. Respondents reporting that SNAP was "very easy"

Figure 1. Bar Graphs of Food Security Distributions by Program Participation

Results shown for Food Security Question B, where a household was identified as food insecure if they indicated that for both of the two food security questions.

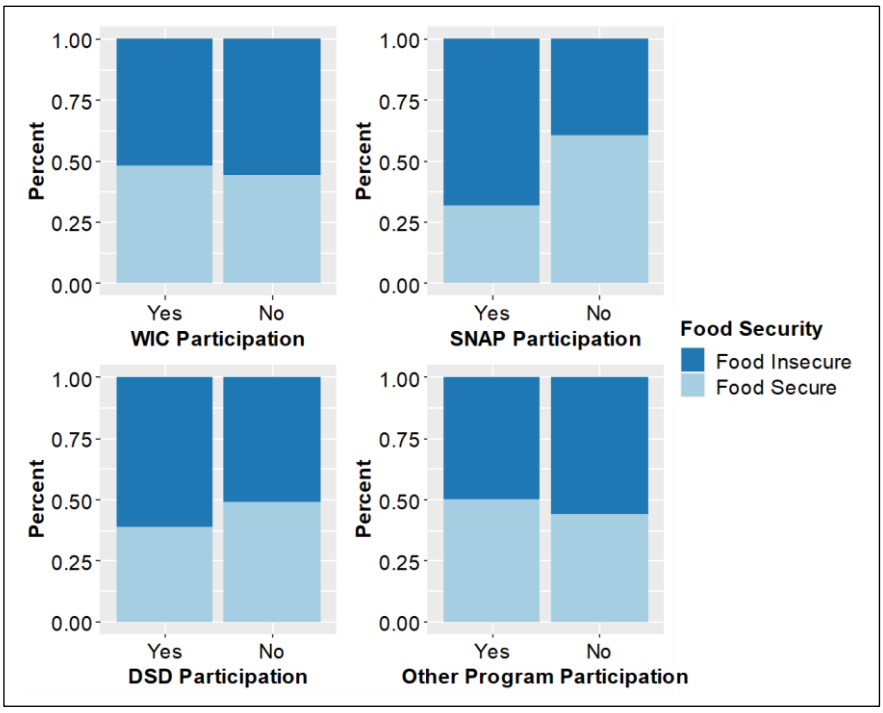
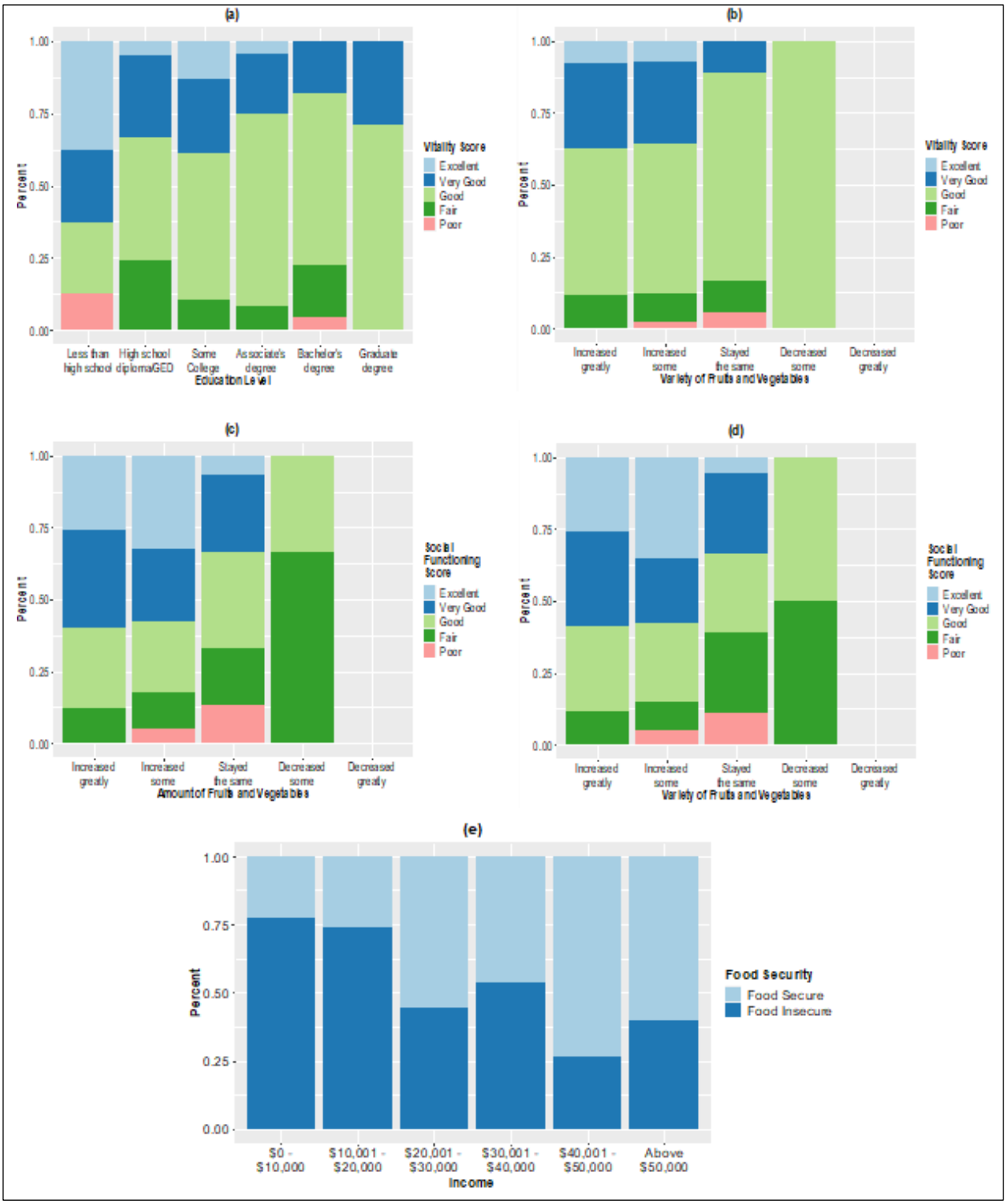


Figure 2. Bar Graphs of Health Score and Food Security Distributions by Educational, Fruit and Vegetable Intake, and Annual Income Variables



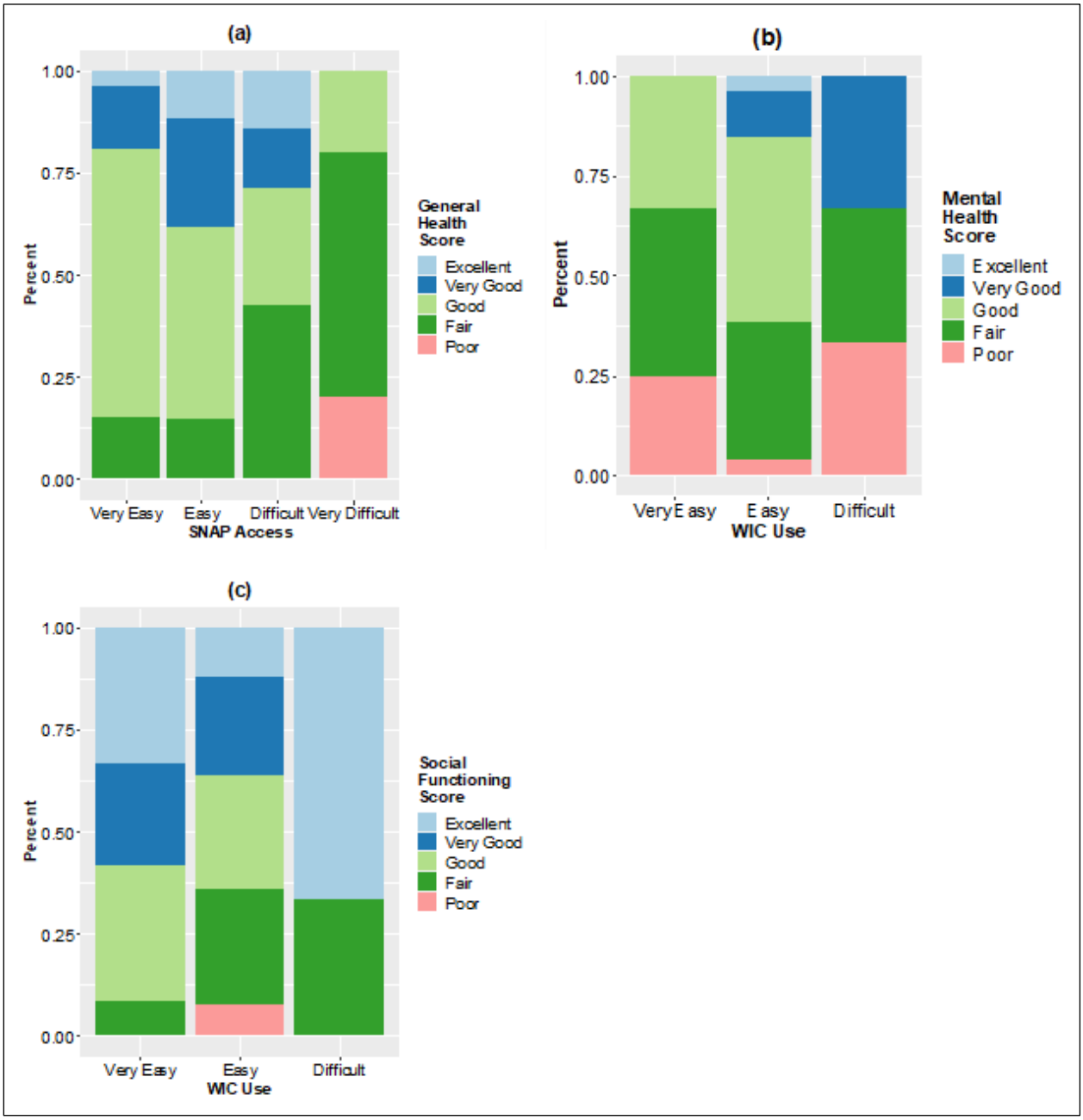
to access had significantly higher general health scores (Proportional odds regression, overall p = 0.004, Figure 3(a)).

Physical Functioning

Physical functioning scores were calculated for 133 responses. The median score was 100 (Excellent), with 55% of respondents scoring at this level.

Higher physical functioning scores were associated with being younger (p = 0.041, Figure 6(a)) and being food secure (p = 0.077, Figure 4). Specifically, the odds of a "Very Good" or "Excellent" physical functioning score decreased by 1.36 times for each 10-year increase in age (CI: 1.01–1.83); the same odds were 1.81 times as large for food insecure participants (CI: 0.94–3.54). SNAP and DSD

Figure 3. Bar Graphs of Health Score Distributions by Program Use/Access Relationships



participants generally had lower physical functioning scores ($p = 0.097$, $p = 0.097$, Figure 5(a, b)), with the odds of "Very Good" or "Excellent" physical functioning scores 1.76 times smaller for SNAP participants than non-participants (CI: 0.90–3.47) and 2.36 times smaller for DSD participants than non-participants (CI: 0.85–6.45).

Bodily Pain

Bodily pain scores were calculated for 134 responses. The median score was 100 (Excellent), with 51% scoring at this level. Higher bodily pain scores were strongly associated with being younger ($p = 1.1x10^{-5}$, Figure 6(b)). Specifically, the odds of "Very Good" or "Excellent" bodily pain scores decreased by 1.93 times per 10-year increase in age (CI: 1.44–2.64).

Vitality

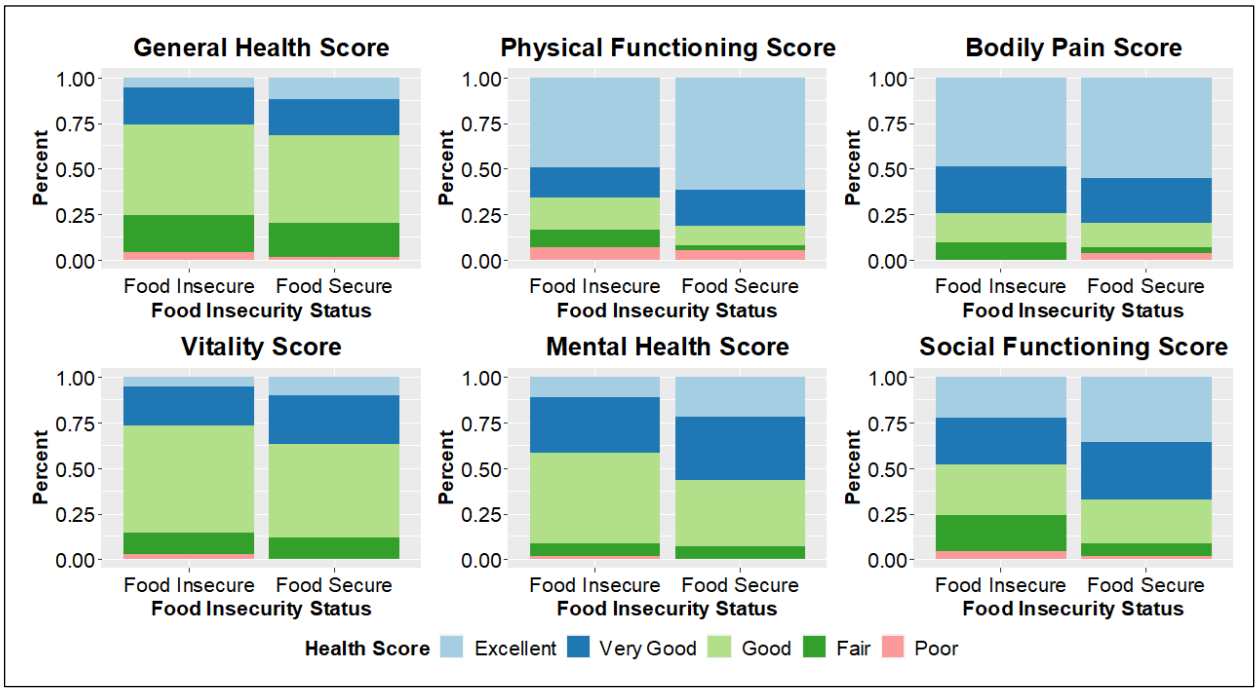
Vitality scores were calculated for 131 responses. The median score was 50 (Good), with 91% scoring 25, 50, or 75. Higher vitality scores were associated with being younger ($p = 0.046$, Figure 6(c)), and the odds of having "Very Good" or "Excellent" vitality scores decreased by 1.56 times per 10-year increase in age (CI: 1.06–2.42). Those with higher education levels tended to have lower scores ($p = 0.099$, Figure 2(a)), with the odds of "Very Good" or "Excellent" scores 10.33 times larger for those with less than a high school diploma compared to those with a college degree (CI: 1.89–57.98). Participants who reported that their fruit and vegetable intake "increased greatly" due to NSP tended to have better vitality scores ($p = 0.119$, Figure 2(b)) with the odds of "Very Good" or "Excellent" vitality scores 2.74 times larger for those who indicated that fruit and vegetable intake "increased greatly" compared to those who indicated that intake "stayed the same" (CI: 1.01–7.67).

Mental Health

Mental health scores were calculated for 132 responses. The median score was 50 (Good), with 83% scoring between 25 and 75. Food secure respondents had significantly higher mental health scores compared to food insecure participants (p=0.019, Figure 4), with the odds of having "Very

Figure 4. Bar Graphs of Health Score Distributions by Food Insecurity Status

Results shown for Food Security Question B, where a household was identified as food insecure if they indicated that for both two food security questions.

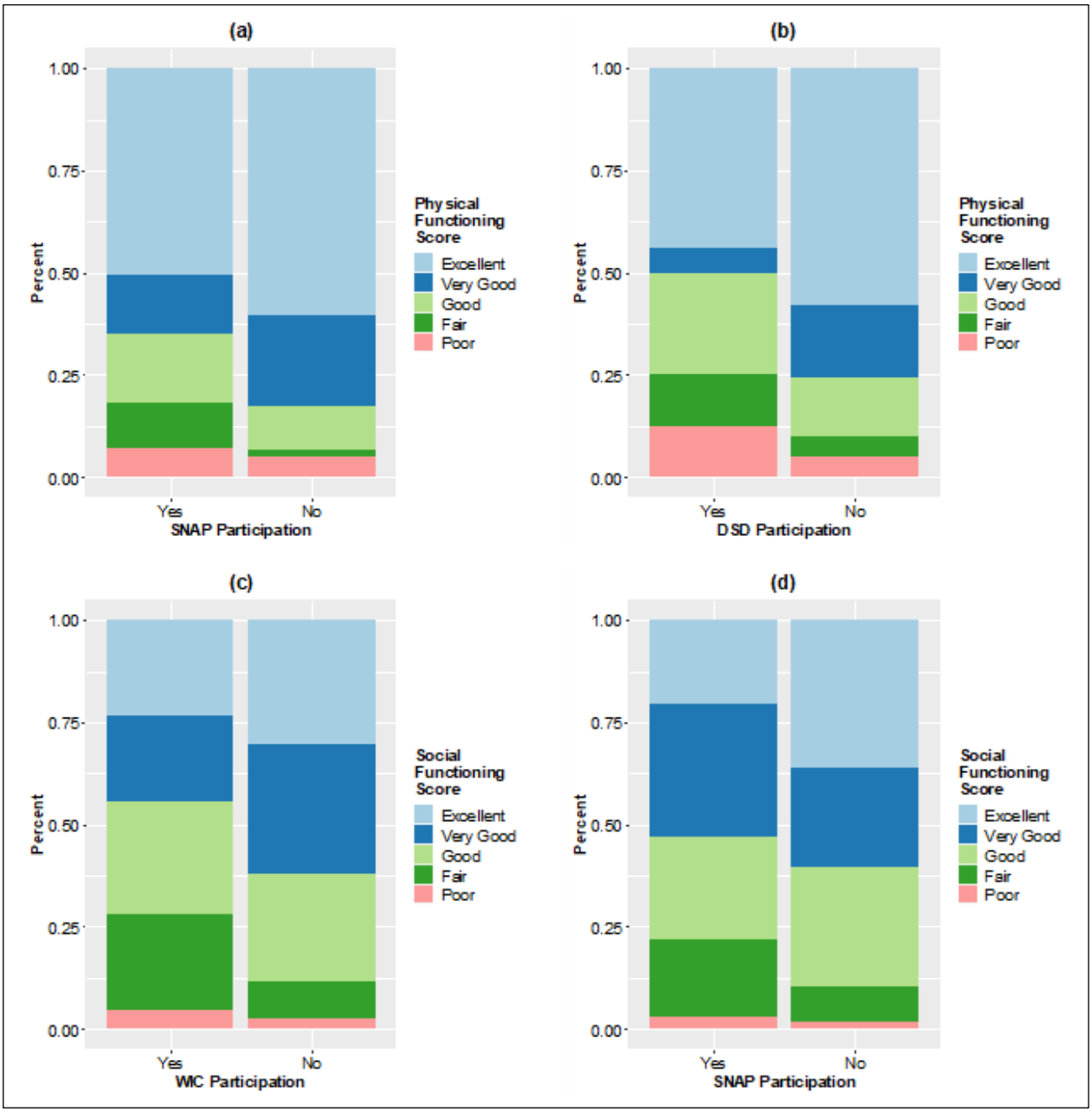


Good" or "Excellent" mental health scores 2.10 times larger for participants identified as food secure than for participants identified as food insecure (CI: 1.13–3.96). Younger participants also tended to have higher scores ($p = 0.017$, Figure 6(d)), with the odds of "Very Good" or "Excellent" mental health scores decreasing by 1.40 times per 10-year increase in age (CI: 1.06–1.87). Mental health scores tended to be higher for those who reported that WIC was "easy" to use, but this relationship was inconsistent ($p = 0.117$, Figure 3(b)).

Social Functioning

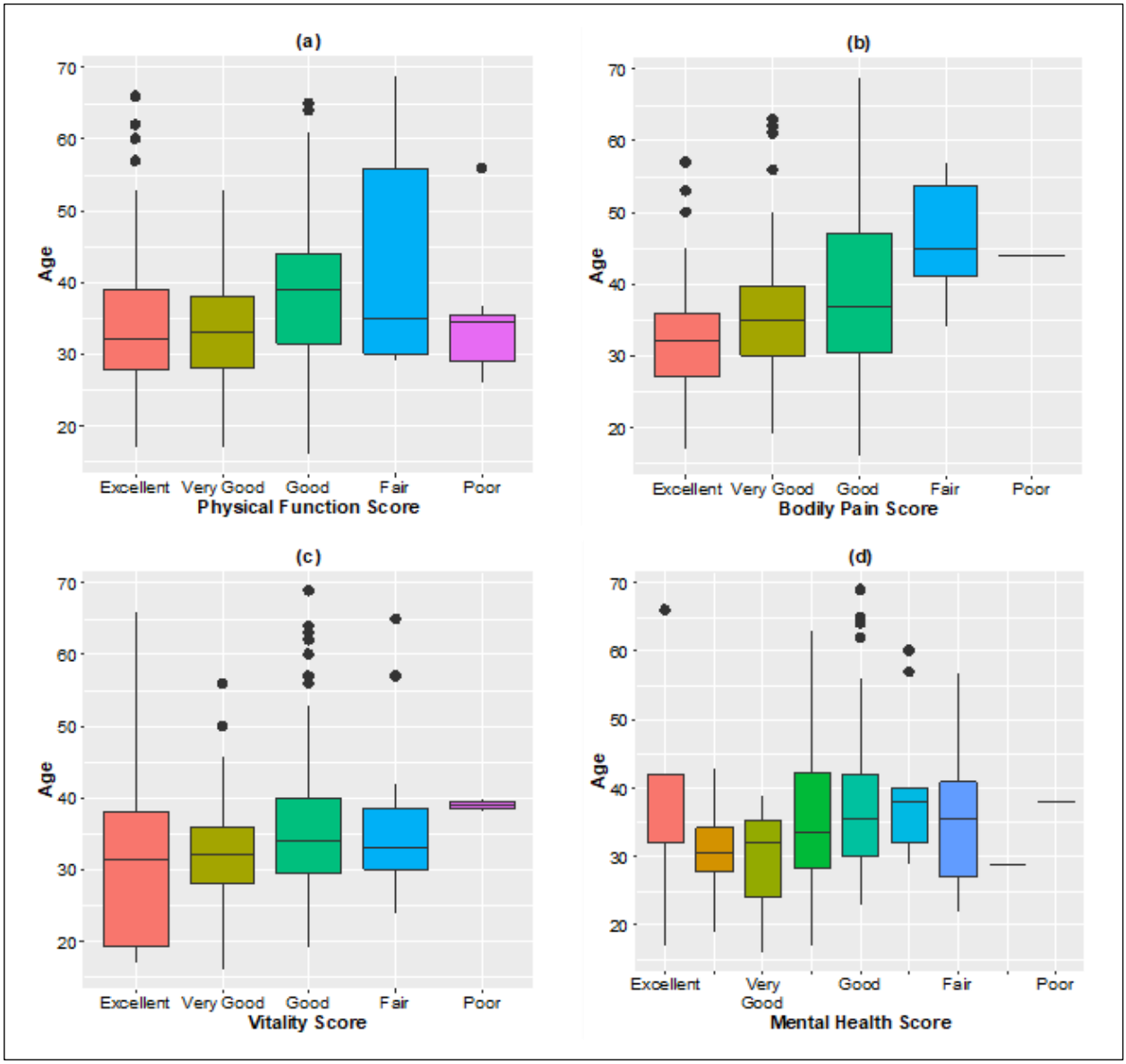
We calculated social functioning scores for 130 responses, with scores of 50, 75, and 100 distributed roughly evenly. Non-WIC and non-SNAP participants tended to have higher social functioning scores compared to WIC participants ($p =$

Figure 5. Bar Graphs of Health Score Distributions by Program Participation



0.040, $p = 0.071$, Figures 5(c,d)), with the odds of having "Very Good" or "Excellent" social functioning scores 2.03 times larger for non-WIC participants (CI: 1.03–4.01) and 1.79 times larger for non-SNAP participants (CI: 0.95–3.40). Food-secure respondents tended to have higher social functioning scores ($p = 0.011$, Figure 4), with the odds of "Very Good" or "Excellent" scores 2.26 times larger for participants identified as food secure than for participants identified as food insecure (CI: 1.21–4.28). Scores tended to be better for those who reported that the amount and variety of fruits and vegetables consumed "increased greatly" as a result of participating in a NSP ($p = 0.012$, 0.008, Figure 2(c, d)), with the odds of better scores 4.08 and 3.94 times larger for those reporting "increased greatly" than for those indicating the amount and variety "stayed the same" (CIs: 1.53–11.19, 1.54–10.44 respectively). Social functioning scores tended to be higher for those who found WIC "Very Easy" to use ($p = 0.100$, Figure 3(c)), with the odds of "Very Good" or "Excellent"

Figure 6. Boxplots of Age Distributions by Level of Health Scores



scores 2.75 times larger for participants who found WIC "Very Easy" to use (CI: 0.83–9.63).

Qualitative Results

After reporting their participation in SNAP, WIC, and DSD, participants were asked open-ended questions to further explore their experiences with the program.

SNAP Enhancers

Participants noted that SNAP allows them to buy more fresh produce, often more expensive than processed food, and helps them maintain an overall healthier diet. Others discussed convenience, as most stores accept SNAP benefits and store employees are familiar with the payment process. For example:

- "My family eats healthier."
- "We are not limited to buying processed foods to get by due to income."
- "I have the funds to buy fruits and veggies, which are more expensive than fast food."
- "Many stores accept EBT (SNAP Benefits) and assist you in using them."
- "More places accepting SNAP. There have been times when we have no cash, but we have a SNAP card and we're stuck at [name of hardware store] to buy a tool to fix something and the kids are thirsty for water or a small snack."

SNAP Barriers

Participants expressed frustrations with the SNAP application process and notable poor experiences with the Office of Public Assistance that oversees program enrollment. Common themes included long call back or wait times, difficulties reaching a real person to ask questions, and difficulties getting the appointments required to become certified for SNAP benefits. For example:

- "…wait times and interviews on the phone take longer than expected."
- "Difficult to get an appointment or reach a representative."
- "Make it easier to report income [for SNAP application] by speaking to a real person."

Other hinderances included feeling discriminated against or judged by community members or caseworkers for accessing SNAP. For example:

- "I honestly see racism as an issue when using SNAP. I had someone say 'wow wish I could get free money' ok yeah, I understand that but if I didn't have SNAP we'd all starve. I budget out our benefits."
- "…the caseworkers are judgmental"

WIC Enhancers

Participants generally had positive remarks about WIC. They liked how the program helped them afford healthier foods for their family, and overall, had a better experience working with the WIC office:

- "We are able to afford plenty of fresh produce and healthier alternatives."
- "By having strict yummy choices on cereal including milk (which my family didn't drink until we got WIC)."
- "[We] didn't have to go in the [WIC] building a simple call was all I needed unless it was a checkup for my child."
- "I can call WIC anytime I have questions."

WIC Barriers

The barriers described regarding WIC involved the program's food eligibility structure, which requires participants to know what foods are WIC-approved. Several participants suggested ways to help mitigate this issue and improve access. Other barriers included income limits preventing families that nevertheless need nutrition support from participating in the program. For example:

- "Lack of labeled foods in stores that apply to WIC so it can be hard to identify when searching for WIC items."
- "Broadening the approval of certain brands or foods so it's easier to obtain WIC approved foods."
- "When local store workers don't know how to do WIC transactions or know what's WIC approved."
- "Extending [WIC] to family in the middle class with two incomes by expanding

income guidelines."
- "Chat support [for WIC's online and app platform] would be helpful."

DSD Enhancers

Although very few respondents used the DSD program, comments about the program overall were positive. Participants liked how the DSD helped them afford fresh fruits and vegetables from farmers' markets, especially as the program facilitated teaching healthy eating habits to children:

- "They [DSD program] improve food security and offer us benefits that enable us to purchase healthier diets."
- "My family learn more about where food comes from and that helps my child learn the importance of respecting the earth and appreciate all that we receive as a blessing from the creator."
- "Promotes kids with habits of seeing and purchasing healthy produce."
- "You walk up, swipe. They take [US]$20 off and hand you [vouchers worth] [US]$40. So easy."

DSD Barriers

Perceived DSD program barriers were lack of signage identifying which vendors accept DSD and lack of knowledge that the program exists. Participants gave a few suggestions to improve awareness:

- "Booths could have clear signs that state they are participating in double snap dollars."
- "More advertisement [about DSD] on Facebook, radio, and TV."

Discussion

Sample and Demographics

To our knowledge, this is the first study to assess participation in and access to NSPs in relation to food security and health domains among urban AIANs. Survey recruitment was highly successful with 177 responses included in the final analysis. Although recruitment focused on AIANs from three Urban Indian Organizations (UIOs), only 94.3% (n = 132) of the participants self-identified as AIAN on the survey. Participants may have selected White (n = 17) or Black (n = 2) as their racial identity for several reasons, including multiracial backgrounds, personal or cultural identity preferences, and how they interpret survey questions about race. It is not uncommon for individuals with AIAN ancestry or connections to AIAN communities to identify with another racial group or to prioritize other aspects of their identity in certain contexts. Some individuals with AIAN ancestry may choose not to identify as such due to historical mistrust, concerns about how their data will be used, and fears of misclassification and miscounting, particularly involving research and organizations that have historically underrepresented or misrepresented Indigenous peoples. Additionally, some respondents may be non-AIAN UIO clients, possibly individuals with AIAN children/family members or community members who accessed services through the UIO and chose to participate in the survey, despite our AIAN-focused recruitment.

Food Security, Access, and Dietary Impacts

Fifty-four % of the survey participants were food insecure, with SNAP and DSD participants more likely to experience food insecurity. However, due to our cross-sectional study design, we cannot determine if participation in these NSPs impacted food insecurity among urban AIANs. This result contrasts with other research that has found a positive association between participating in SNAP and other NIPs and reduced food insecurity (Durward et al., 2019; Mabli & Ohls, 2015). Notably, these studies did not specifically examine AIAN households, which experience disproportionately higher rates of food insecurity and poverty than other minority groups (Jernigan et al., 2017; Shrider & Creamer, 2023).

There may be cultural barriers as well that are specific to AIANs that reduce their access to SNAP and DSD benefits, such as welfare stigma, a negative social perception of using public assistance (Stuber & Schlesinger, 2006). Research on welfare stigma has found that it may impact the effectiveness of programs and increase the food insecurity of SNAP participants (Hatton et al.,

2024). This concern emerged in our open-ended responses, in which several respondents expressed feelings of discrimination when accessing SNAP. Given the limited knowledge of urban AIAN participation and utilization of SNAP, WIC, and DSD programs, further research is needed to explore how these programs impact food insecurity in urban and rural AIAN communities. Such studies should use more rigorous methodologies, including longitudinal and prospective designs.

Most respondents (56–58%) agreed that SNAP and WIC programs were helpful for improving their diets. Among the 20 participants with experience using the DSD program, 94.8% agreed that it helped their families eat better. These findings are supported by the qualitative results, participants describing how NSP benefits helped them overcome financial barriers and afford healthier foods, particularly fruits and vegetables. These findings are consistent with other research, including a mixed-methods study that found SNAP and WIC participation improved diet quality among low-income households with young children (Vinitchagoon et al., 2025). Similarly, a pre- and post-evaluation of a NIP found that participants increased their fruit and vegetable intake from 2.85 to 3.29 times per day (Durward et al., 2019).

Overall, respondents reported high ease of access to the programs: 83.9% for SNAP, 98.3% for WIC, and 100% for DSD. Open-ended responses helped contextualize SNAP's lower rating, with participants noting long call wait times and difficulties with applications and managing eligibility. In contrast, WIC participants frequently reported positive experiences, highlighting friendly staff and easy appointment scheduling. These findings were echoed in a report on federal program customer service, which found that four in ten adults experienced at least one difficulty enrolling in SNAP, with enrollment challenges and mistreatment more commonly reported by minority groups and individuals with disabilities than by NHW adults (McDaniel et al., 2023). Although AIAN families were not directly surveyed in that report, our findings suggest similar barriers were experienced by SNAP-eligible AIAN households.

The majority of the respondents participating in DSD said it was easy to use and helpful for teaching young children about healthy food habits, local farmers, and the agricultural system. Other researchers have found that NIPs can improve food security in low-income households by increasing their ability to purchase fruits and vegetables; our results strengthen this assertion (Durward et al., 2019; Harvey et al., 2021; Savoie-Roskos et al., 2016). Despite high satisfaction among those who used the DSD program, overall awareness of the program was low. This is consistent with findings from other evaluations of NIPs, which frequently cite limited awareness as a barrier (Garner et al., 2020). This barrier suggests a need for broader and more effective outreach campaigns at both federal and local levels. Importantly, messaging strategies should be culturally relevant and community-informed to better engage AIAN households.

Health Scores

Our findings show positive correlations between food security and three of six health domains: physical functioning, social functioning, and mental health. Similarly, other studies show adults in food-insecure households to be significantly more likely to rate their health as poor/fair and to score significantly lower on physical and mental health (Stuff et al., 2004). Other studies report a connection between perceived health status and long-term participation in NSPs and NIPs (Miller & Morrissey, 2021; Parks et al., 2021).

For vitality, physical functioning, and bodily pain scores, younger participants tended to have higher scores. This suggests that potential confounders such as age may also influence health outcomes, which highlights a limitation of the cross-sectional design, that restricts our ability to determine causality between NSP participation and health impacts. Nevertheless, these results help identify potential associations between NSP participation and health among urban AIANs. For example, the vitality score tended to be better for those with higher fruit and vegetable intake and was significantly higher for those participating in an NSP. Participants who had better mental health scores thought WIC was "very easy" to use compared to other WIC participants. The social functioning score tended to be better for participants whose fruit and vegetable intake had significantly in-

creased and for participants who indicated that they found WIC "very easy" to use.

These exploratory findings are significant because they are the first to suggest potential connections between various health domains, food security, and use of SNAP and WIC in urban AIANs. More rigorous research methods, such as longitudinal or prospective studies, are needed to understand how NSPs influence health and to determine causal relationships. Nevertheless, our results could guide persuading more urban AIANs to participate in SNAP and WIC programs. For example, NSP program marketing materials tailored to urban AIANs could describe how participating in SNAP and WIC is associated with better health, social functioning, and vitality in the population.

Food Sovereignty and Systems

Our findings suggest access to and use of NSPs are strongly related to program participation, food security, and certain health measures. Another factor associated with low food security for AIAN families is decreased food sovereignty. Food sovereignty is the right of people, communities, and countries to define their own food and land policies, which includes the right to nutritious and culturally appropriate food and resources (Bell-Sheeter et al., 2014). Food sovereignty movements improve food access by shifting power to local people to build food systems that support cultural, social, economic, and environmental needs (Budd Nugent et al., 2022). A study found that increased calorie intake from traditional, culturally relevant foods was associated with diet quality improvements (Walch & Bersamin, 2020). Other studies have suggested that AIAN food security is intricately tied to their ability to participate in their tribe's culture (Nikolaus et al., 2022; Power, 2008). Further research, with community collaboration, is needed to understand how NSPs can be tailored to better support food sovereignty for urban AIANs households in Montana.

Strengths and Limitations

A strength of this study is that a large sample, 177 responses, was analyzed. While the cross-sectional and self-report design of this study is a limitation, nonetheless this sample provides valuable data about urban AIAN participation in NSPs and a NIP, a population that is underreported and has significant health disparities. Further research to understand barriers, enhancers, and impacts of NSP and NIP participation is needed in this population. Community participatory processes are recommended for future research, as these approaches develop deeper engagement, research knowledge, and skill capacity building with community partners and organizations such as UIOs. In addition, this process improves the likelihood of community buy-in, necessary for developing effective and culturally relevant interventions.

The generalizability of the study results is limited due to the participants' location in only three urban areas of one western state. Many participants were UIO clients, which may have introduced selection bias. Another limitation was the use of non-validated survey questions. However, all survey questions were vetted by local urban AIANs prior to administration, an important step in ensuring that the survey was culturally relative to this specific community.

Conclusion

This case study offers valuable insights into the experiences of urban AIAN families with nutrition support programs (NSPs), an area that research has largely overlooked. By noting barriers such as administrative burdens with SNAP, challenges navigating WIC-approved food lists, and low awareness of programs such as DSD, our findings help to fill a critical knowledge gap. Although further research is needed to establish causal relationships between these barriers and outcomes like food security, health status, and diet quality, our results advance understanding of the lived experiences of urban AIAN households. They also emphasize the need for policy changes that reduce administrative complexity, improve program visibility, and incorporate culturally tailored approaches in order to better serve historically underrepresented communities. This study represents an important step toward understanding how NSPs and NIPs influence food access and the ability to achieve and maintain a healthy lifestyle among urban AIANs.

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References

Bell-Sheeter, A., Romero, V. A., & Segrest, V. (2014). *Food sovereignty assessment tool* (2nd ed.). First Nations Development Institute. https://www.firstnations.org/wp-content/uploads/publication-attachments/2015_Food_Sovereignty_Assessment_Tool.pdf

Bickel, G., Nord, M., Price, C., Hamilton, W., & Cook, J. (2000). *Guide to measuring household food security. Revised 2000*. Food and Nutrition Service, U.S. Department of Agriculture. https://fns-prod.azureedge.us/sites/default/files/FSGuide.pdf

Brown, B., Noonan, C., & Nord, M. (2007). Prevalence of food insecurity and health-associated outcomes and food characteristics of Northern Plains Indian households. *Journal of Hunger & Environmental Nutrition, 1*(4), 37–53. https://doi.org/10.1300/J477v01n04_04

Budd Nugent, N., Ridberg, R. A., Fricke, H., Byker Shanks, C., Stotz, S. A., Jones Chung, A. G., Shin, S., Yaroch, A. L., Akers, M., Lowe, R., George, C., Thomas, K., & Seligman, H. K. (2022). Food sovereignty, health, and produce prescription programs: A case study in two rural tribal communities. *Journal of Agriculture, Food Systems, and Community Development*, *11*(3), 177–196. https://doi.org/10.5304/jafscd.2022.113.014

Castro, F. G., Barrera, M., Jr., & Martinez, C. R., Jr. (2004). The cultural adaptation of prevention interventions: Resolving tensions between fidelity and fit. *Prevention Science, 5*(1), 41–45. https://doi.org/10.1023/b:prev.0000013980.12412.cd

County Health Rankings & Roadmaps. (2020). *Fruit & vegetable incentive programs*. Population Health Institute, University of Wisconsin School of Medicine. https://www.countyhealthrankings.org/strategies-and-solutions/what-works-for-health/strategies/fruit-vegetable-incentive-programs

Durward, C. M., Savoie-Roskos, M., Atoloye, A., Isabella, P., Jewkes, M. D., Ralls, B., Riggs, K., & LeBlanc, H. (2019). *Double Up Food Bucks* participation is associated with increased fruit and vegetable consumption and food security among low-income adults. *Journal of Nutrition Education and Behavior, 51*(3), 342–347. https://doi.org/10.1016/j.jneb.2018.08.011

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing, 62*(1), 107–115. https://doi.org/10.1111/j.1365-2648.2007.04569.x

Ettinger de Cuba, S. A., Bovell-Ammon, A. R., Cook, J. T., Coleman, S. M., Black, M. M., Chilton, M. M., Casey, P. H., Cutts, D. B., Heeren, T. C., Sandel, M. T., Sheward, R., & Frank, D. A. (2019). SNAP, young children's health, and family food security and healthcare access. *American Journal of Preventive Medicine, 57*(4), 525–532. https://doi.org/10.1016/j.amepre.2019.04.027

Frerichs, L., Bell, R., Lich, K. H., Reuland, D., & Warne, D. K. (2022). Health insurance coverage among American Indians and Alaska Natives in the context of the Affordable Care Act. *Ethnicity & Health, 27*(1), 174–189. https://doi.org/10.1080/13557858.2019.1625873

Garner, J. A., Coombs, C., Savoie-Roskos, M. R., Durward, C., & Seguin-Fowler, R. A. (2020). A qualitative evaluation of *Double Up Food Bucks* farmers' market incentive program access. *Journal of Nutrition Education and Behavior, 52*(7), 705–712. https://doi.org/10.1016/j.jneb.2019.11.010

Hager, E. R., Quigg, A. M., Black, M. M., Coleman, S. M., Heeren, T., Rose-Jacobs, R., Cook, J. T., Ettinger de Cuba, S. A., Casey, P. H., Chilton, M., Cutts, D. B., Meyers, A. F., & Frank, D. A. (2010). Development and validity of a 2-item screen to identify families at risk for food insecurity. *Pediatrics, 126*(1), e26–e32. https://doi.org/10.1542/peds.2009-3146

Hartline-Grafton, H., & Hassink, S. G. (2021). Food insecurity and health: Practices and policies to address food insecurity among children. *Academic Pediatrics, 21*(2), 205–210. https://pmc.ncbi.nlm.nih.gov/articles/PMC7347342/

Harvey, S., Valentine, H., Landfried, L., Lee, J., & Gibson, C. (2021). Food insecurity and health-related quality of life among SNAP Nutrition Incentive participants. *Journal of Hunger & Environmental Nutrition*, *17*(4), 540–552. https://doi.org/10.1080/19320248.2021.2009951

Hatton, C. R., Bresnahan, C., Tucker, A. C., Johnson, J., John, S., & Wolfson, J. A. (2024). Food for thought: The intersection between SNAP stigma, food insecurity, and gender. *Social Science & Medicine, 361*, Article 117367. https://doi.org/10.1016/j.socscimed.2024.117367

Hendrix, L. R. (2019). *1953 to 1969: Policy of termination and relocation*. American Indian Learning Resources, Stanford Medicine Ethnogeriatrics. https://geriatrics.stanford.edu/ethnomed/american_indian/learning_activities/learning_1/termination_relocation.html

Israel, B. A., Schulz, A. J., Parker, E. A., & Becker, A. B. (1998). Review of community-based research: Assessing partnership approaches to improve public health. *Annual Review of Public Health, 19*, 173–202. https://doi.org/10.1146/annurev.publhealth.19.1.173

Israel, B. A., Schulz, A. J., Parker, E. A., & Becker, A. B. (2001). Community-based participatory research: Policy recommendations for promoting a partnership approach in health research. *Education for Health, 14*(2), 182–197. https://journals.lww.com/EDHE/abstract/2001/14020/Community_based_Participatory_Research__Policy.6.aspx

Jernigan, V. B. B., Huyser, K. R., Valdes, J., & Simonds, V. W. (2017). Food insecurity among American Indians and Alaska Natives: A national profile using the Current Population Survey–Food Security Supplement. *Journal of Hunger & Environmental Nutrition, 12*(1), 1–10. https://doi.org/10.1080/19320248.2016.1227750

Kreider, B., Pepper, J. V., & Roy, M. (2016). Identifying the effects of WIC on food insecurity among infants and children. *Southern Economic Journal, 82*(4), 1106–1122. https://doi.org/10.1002/soej.12078

Laveaux, D., & Christopher, S. (2009). Contextualizing CBPR: Key principles of CBPR meet the Indigenous research context. *Pimatisiwin, 7*(1), 1–5. https://pmc.ncbi.nlm.nih.gov/articles/PMC2818123/

Levi, R., Bleich, S. N., & Seligman, H. K. (2023). Food insecurity and diabetes: Overview of intersections and potential dual solutions. *Diabetes Care, 46*(9), 1599–1608. https://doi.org/10.2337/dci23-0002

Mabli, J., & Ohls, J. (2015). Supplemental Nutrition Assistance Program participation is associated with an increase in household food security in a national evaluation. *Journal of Nutrition, 145*(2), 344–351. https://doi.org/10.3945/jn.114.198697

McDaniel, M., Karpman, M., Kenney, G. M., Hahn, H., & Pratt, E. (2023). *Customer service experiences and enrollment difficulties vary widely across safety net programs*. Urban Institute. https://www.urban.org/sites/default/files/2023-01/Customer%20Service%20Experiences%20and%20Enrollment%20Difficulties%20Vary%20Widely%20across%20Safety%20Net%20Programs.pdf

McHorney, C. A., Ware, J. E., & Raczek, A. E. (1993). The MOS 36-Item Short-Form Health Survey (SF-36) II. Psychometric and clinical tests of validity in measuring physical and mental health constructs. *Medical Care, 31*(3), 247–263. https://doi.org/10.1097/00005650-199303000-00006

Miller, D. P., & Morrissey, T. W. (2021). SNAP participation and the health and health care utilisation of low-income adults and children. *Public Health Nutrition, 24*(18), 6543–6554. https://doi.org/10.1017/s1368980021003815

Montana Department of Public and Human Health Services (DPHHS). (2017). *Montana state heath assessment 2017*. https://dphhs.mt.gov/assets/publichealth/ahealthiermontana/2017SHAFinal.pdf

Mullany, B., Neault, N., Tsingine, D., Powers, J., Lovato, V., Clitso, L., Massey, S., Talgo, A., Speakman, K., & Barlow, A. (2013). Food insecurity and household eating patterns among vulnerable American-Indian families: Associations with caregiver and food consumption characteristics. *Public Health Nutrition, 16*(4), 752–760. https://doi.org/10.1017/s136898001200300x

National Archives. (2024a). *Bureau of Indian Affairs records: Termination*. American Indian and Alaska Native Records in the National Archives. https://www.archives.gov/research/native-americans/bia/termination

National Archives. (2024b). *Native American urban relocation*. Educator Resources. https://www.archives.gov/education/lessons/indian-relocation.html#:~:text=In%201953%2C%20the%20U.S.%20Congress,a%20voluntary%20urban%20relocation%20program

Nikolaus, C. J., Johnson, S., Benally, T., Maudrie, T., Henderson, A., Nelson, K., Lane, T., Segrest, V., Ferguson, G. L., Buchwald, D., Jernigan, V. B. B., & Sinclair, K. (2002). Food insecurity among American Indian and Alaska Native people: A scoping review to inform future research and policy needs. *Advances in Nutrition*, *13*(5), 1566–1583. https://doi.org/10.1093/advances/nmac008

Parks, C. A., Han, P., Fricke, H. E., Parker, H. A., Hesterman, O. B., & Yaroch, A. L. (2021). Reducing food insecurity and improving fruit and vegetable intake through a nutrition incentive program in Michigan, USA. *SSM Population Health, 15*, Article 100898. https://doi.org/10.1016/j.ssmph.2021.100898

Power, E. M. (2008). Conceptualizing food security for Aboriginal People in Canada. *Canadian Journal of Public Health*, *99*, 95–97. https://doi.org/10.1007/BF03405452

Ryu, J.-H., & Bartfeld, J. S. (2012). Household food insecurity during childhood and subsequent health status: The early childhood longitudinal study—Kindergarten cohort. *American Journal of Public Health, 102*(11), e50–e55. https://doi.org/10.2105/ajph.2012.300971

Savoie-Roskos, M., Durward, C., Jeweks, M., & LeBlanc, H. (2016). Reducing food insecurity and improving fruit and vegetable intake among farmers' market participants. *Journal of Nutrition Education and Behavior*, *48*(1), 70–76. https://doi.org/ 10.1016/j.jneb.2015.10.003

Shankar, P., Chung, R., & Frank, D. A. (2017). Association of food insecurity with children's behavioral, emotional, and academic outcomes: A systematic review. *Journal of Developmental & Behavioral Pediatrics, 38*(2), 135–150. https://doi.org/10.1097/DBP.0000000000000383

Shrider, E. A., & Creamer, J. (2023). *Poverty in the United States: 2022* (Report No. P60-280). U.S. Census Bureau. https://www.census.gov/library/publications/2023/demo/p60-280.html

Stuber, J., & Schlesinger, M. (2006). Sources of stigma for means-tested government programs. *Social Science & Medicine, 63*(4), 933–945. https://doi.org/10.1016/j.socscimed.2006.01.012

Stuff, J. E., Casey, P. H., Szeto, K. L., Gossett, J. M., Robbins, J. M., Simpson, P. M., Connell, C., & Bogle, M. L. (2004). Household food insecurity is associated with adult health status. *Journal of Nutrition*, *134*(9), 2330–2335. https://doi.org/10.1093/jn/134.9.2330

Tomayko, E. J., Mosso, K. L., Cronin, K. A., Carmichael, L., Kim, K., Parker, T., Yaroch, A. L., & Adams, A. K. (2017). Household food insecurity and dietary patterns in rural and urban American Indian families with young children. *BMC Public Health, 17*(1), Article 611. https://doi.org/10.1186/s12889-017-4498-y

U.S. Census Bureau. (2020). *Facts for features: American Indian and Alaska Native Heritage Month: November 2023*. Within Newsroom. https://www.census.gov/newsroom/facts-for-features/2023/aian-month.html

U.S. Department of Agriculture, Economic Research Service. (2024a). *Food security in the U.S.: Key statistics & graphics*. *Food security status of U.S. households with children in 2023*. https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/key-statistics-graphics/

USDA Economic Research Service. (2024b). *State fact sheets—State data. Montana*. https://data.ers.usda.gov/reports.aspx?ID=4035&StateFIPS=30&StateName=Montana

USDA National Institute of Food and Agriculture. (2023). *Gus Schumacher Nutrition Incentive Program (GusNIP): Impact findings Y3. September 1, 2021 to August 31, 2022*. https://nutritionincentivehub.org/media/2uwlf3ch/gusnip-y3-impact-findings-report.pdf

Urban Indian Health Institute. (2021a). *Billings Urban Indian Health and Wellness Center*. Seattle Indian Health Board. https://www.uihi.org/uihp-profiles/billings/

Urban Indian Health Institute. (2021b). *Great Falls Indian Family Health Clinic*. Seattle Indian Health Board. https://www.uihi.org/uihp-profiles/great-falls/

Urban Indian Health Institute. (2021c). *Missoula All Nations Health Center*. Seattle Indian Health Board. https://www.uihi.org/uihp-profiles/missoula/

Urban Indian Health Institute. (2025). *Data dashboard. Health profile introduction.* Seattle Indian Health Board. https://www.uihi.org/urban-indian-health/data-dashboard/

Vinitchagoon, T., Zhang, F. F., Fauth, R. C., Hennessy, E., Maafs, A. G., Browning, E. M., & Economos, C. D. (2025). SNAP and/or WIC participation and diet quality in mother-child dyads living in Greater Boston after pandemic: A mixed-method study. *Journal of Primary Care & Community Health*, *16*. Advance online publication. https://doi.org/10.1177/21501319251317334

Walch, A., & Bersamin, A. (2020). Traditional food intake is positively associated with diet quality among low-income, urban Alaska Native women. *Journal of Hunger & Environmental Nutrition*, *15*(2), 264272. https://doi.org/10.1080/19320248.2019.1619648

Ware, J., Kosinski, M., & Keller, S. (1995). *SF-12: How to score the SF-12 Physical and Mental Health Summary Scales* (2nd ed.). The Health Institute, New England Medical Center. https://www.researchgate.net/publication/242636950_SF-12_How_to_Score_the_SF-12_Physical_and_Mental_Health_Summary_Scales/link/553a38580cf245bdd7627088/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19

Warne, D., & Frizzell, L. B. (2014). American Indian health policy: Historical trends and contemporary issues. *American Journal of Public Health, 104*(Suppl 3), S263–S267. https://doi.org/10.2105/ajph.2013.301682

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Adaptation of the U.S. Food Security Survey Module in a small rural Dominican Republic community: A pilot to assess food insecurity

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Abstract

Food insecurity continues to affect a significant proportion of the population in many countries. The concept and measurement of food insecurity at the household and individual levels has been an area of extensive research resulting, among other things, in the development of the Food Security Survey Module (FSSM) in the United States, where it is now the standard methodology for determining household food security status. One of the purposes of this study was to adapt the U.S. FSSM and assess its validity in the context of a less developed economy. We administered the U.S. FSSM in a pilot household survey of 110 low-income families in the Dominican Republic in 2006–2007 from information generated from a focus group a year earlier. The survey results indicated that 93% of the respondents were food-insecure, of whom 80% experienced very low food security (food insecurity with hunger). In 89% of households with children, children faced very low food security (food insecurity with hunger). The results of this pilot study demonstrate at a preliminary level the validity of the FSSM in its adapted and modified form for assessing the degree of food insecurity in the Dominican Republic.

Keywords

Dominican Republic, food security, survey data, USDA Food Security Survey Module

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Introduction

Food insecurity continues to affect a significant proportion of the population in many countries. According to the Food and Agriculture Organization of the United Nation (FAO), 29.3% of the global population faced food insecurity in 2021 (FAO et al., 2022).[1] The cited figure is 8.1 percentage points higher than the rate that prevailed in 2014, indicating a worsening of the food-insecurity problem globally. No comparable data are available for the Dominican Republic, although it may be deduced from the experience of the Caribbean as a subregion whose food insecurity rate (64%) is reported to be more than twice the global rate during the same year, and represents a rise of 8.9 percentage points compared to 2014 (FAO et al., 2022). The rate of severe food insecurity—a condition in which "individuals have likely run out of food, experienced hunger and, at the most extreme, gone for days without eating, putting their health and well-being at serious risk"—for the region in question in 2021 was reported to be 30.5% (FAO, 2022).

As food insufficiency is recognized to pose long-lasting challenges to nutrition, health, and social policy, researchers both at public and private institutions have recently exhibited renewed and growing interest in its measurement at the household and individual levels (Bickel et al., 1999, 2000; Carlson et al., 1999; FAO, 2003; Girvan, 2001; Olson, 1999; USDHHS, 1993). Most of the recent research on the subject has used food insecurity as a core indicator of the deprivation of basic food needs. The concept of food insecurity at the household and individual levels has been an area of extensive research since the late 1980s by individual researchers and public agencies. This work culminated in a report by the Life Sciences Research Office of the Federation of American Societies for Experimental Biology, published in 1990, in which food (in)security and hunger were conceptualized as follows:

> **Food security**—"Access by all people at all times to enough food for an active, healthy life. Food security includes at a minimum: (1) the ready availability of nutritionally adequate and safe foods, and (2) an assured ability to acquire acceptable foods in socially acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, or other coping strategies)."
>
> **Food insecurity**—"Limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways." (as cited in Bickel et al., 2000, p. 6)

Subsequent to the release of the aforementioned report, a national benchmark measure of food security was developed and tested in order to estimate trends in household food insecurity in the U.S. This process involved designing survey instruments with the view to "obtaining information on a variety of specific conditions, experiences, and behaviors that serve as indicators of the varying degrees of the severity of the condition" (Bickel et al., 2000, p. 8). The set of standardized food security questions determined through these surveys provided the basis for the Household Food Security Scale.

The Household Food Security Scale measures the extent of household food insecurity and hunger as perceived, experienced, and described by respondents. The scale, using a single numerical value, is used to classify respondents into one of the following categories, each representing a range of severity: food security (at high and marginal levels), low food security, and very low food security. Ranking individuals or households based on the various degrees of severity of food insecurity is argued to be an important factor that will help target and evaluate food-related policies and programs (Pérez-Escamilla et al., 2020). The construction of the food security scale reflects and underscores the

[1] The prevalence of food insecurity including "moderate or severe food insecurity is an estimate of the proportion of the population who face moderate or severe constraints on their ability to obtain sufficient food over the course of a year" (FAO et al., 2022, Section 1.2, para. 1). This is measured using FAO's Food Insecurity Experience Scale survey module, which is "a set of eight questions asking respondents to self-report experiences associated with limited access to food" (FAO et al., 2022, Section 1.2, para. 1).

importance of household financial resource constraint as the ultimate cause of food insecurity. However, because the scale is based on household conditions, events, behaviors, and subjective reactions, it provides more comprehensive information about the sense, occurrence, and degree of food deprivation than can be ascertained through traditional income and poverty measures.

The food security instruments and scale have been employed by a number of researchers who have studied the prevalence of food insecurity, its determinants, and coping strategies in the U.S. among various segments of the population (e.g., Bezuneh & Yiheyis, 2020; Carlson et al., 1999; Gundersen & Zihiak, 2018; Himmelgreen et al., 2000; Kasper et al., 2000; Myers & Painter, 2017; Nord & Golla, 2009; Polit et al., 2000). The U.S. Household Food Security Scale Module (U.S. HFSSM) has also been adapted and validated for use in other countries, including developing countries. For example, Pérez-Escamilla et al. (2004) assessed the validity of the U.S. HFSSM 15-item scale in Brazil by translating the module into Portuguese and testing it for content and face validity. The authors reported results indicating the validity of the adapted version of the U.S. HFSSM in the city of Campinas, with similar results replicated in four additional states in Brazil.

The validity of the HFSSM 18-item scale was also tested in Trinidad and Tobago by Gulliford et al. (2006) using a survey of primary school children with their parents completing the module questionnaires. The results reported support the application of the U.S. HFSSM to measure and classify food insecurity status of children and adults in Trinidad and Tobago. Hackett et al. (2007) assessed the validity of a modified version of the module on a sample drawn from four rural communities in Ecuador, and the results suggest the usefulness of their modified version to measure food insecurity in the country. Randolph et al. (2007) adapted and validated the U.S. HFSSM in a rural area in Senegal and reported its validity for measuring food insecurity in the country, also drawing similar implications for sub-Saharan and other African countries. The module was also adapted and applied in Peru in the context of urban and rural communities, with the quantitative results showing robustness in the reliability of the adapted 15-item scale (Vargas & Penny, 2010).

In a similar vein, this paper seeks to assess the validity of the U.S. HFSSM among a rural, low-income population in the Dominican Republic based on a survey of rural households conducted in 2006–2007. In addition to adapting the FSSM in the context of the Dominican Republic, the paper assesses the prevalence of food insecurity and explores the characteristics of food-insecure people in a low-income community in the country. To our knowledge, this study is the first attempt to adapt and validate the FSSM instrument to assess household food security status in the Dominican Republic.[2] The rest of the paper is organized as follows: The next section provides an overview of the concept and measurement of food insecurity; we then describes the study site, sample, and methodology used in the study. An overview of the sampled community and the food security status of households is provided next, followed by an analysis of data and a discussion of results. The final section summarizes and offers concluding remarks.

The Study Site, Sample, and Methodology

To put the present study in perspective, we first provide a brief macro-data overview of the study country from which implications for food security may be drawn.[3] The Dominican Republic is an island nation in the Caribbean with a population of 11.1 million as of 2021, with 16.8% living in rural areas. The country's land area is 48,310 sq. km (18,653 sq. miles), of which, in 2020, agricultural land and arable land were 50.3% and 18.2%, respectively, with an average of 0.08 hectare (0.2 acre) of arable land per person. Of the total agricultural land, an average of 9.9% was irrigated in the 2010s, with about one percentage point increase from the preceding decade. With a GDP per capita of US$8,411 (constant 2015 US$) or US$18,626 (in

[2] This paper is based on the food security study report submitted to USDA ERS by Bezuneh et al. (2008).
[3] Unless noted otherwise, the figures in this macro-data overview are from World Bank (n.d.) using the latest year for which data were available at the time of writing.

constant 2017 international $) and an adult literacy rate of 95.2% in 2021, the Dominican Republic ranks among upper-middle-income countries. Its economy grew at annual average rate of 4.3% and 5.6% in the 2000s and 2010s, respectively, with a remarkable turnaround in 2021 at a rate of 12.3% from the decline of 6.7% it suffered in 2020. The majority of the country's economic activity in terms of value-added products originates from the services sector, accounting for 54.6% of GDP in 2021, while the contribution of agriculture, forestry, and fishing was a mere 5.7%. International tourism remains a major source of foreign exchange, although the receipt therefrom as a share of total exports has been on a decline from a mean of 47.2% in the 2000s to 34.4% in 2010s.

The food production index[4] in the country increased by 44.8% in the 2010s compared to that of the 2000s, with a 22.1% increase registered in 2020 relative to the prior decade's average. The country's degree of openness measured in terms of the sum of exports and imports as a share of GDP was 52.7% in 2021, which represented a considerable decline from 79.3% in 2000, compared to an average of 68.4% during the first decade of the 2000s. The country is a net exporter of food, albeit not by a wide margin. In 2021, for example, the share of food imports in total merchandise imports was 16.7%. The corresponding figure for food exports stood at 22.8%.

Despite its upper-middle-income status, the pattern of income distribution in the country with a Gini coefficient of 39.6 in 2020 suggests that access to necessities including food is a challenge for a considerable segment of the population. This figure, which is roughly equivalent to that of the U.S. for the same year, is better than the average of 50.3 recorded in the 2000s. More tellingly, the share of income held by the highest 20% was 45.7% in 2021, although it is lower than the more than 50% for most of the preceding couple of decades.[5] The bottom 40% received 21.7% of the nation's income in 2021. Using the measure of poverty headcount ratio at national poverty lines, 21% of the country's population lived in poverty in 2019 (latest year), 5.6 percentage points lower than what was experienced two years earlier. The measure of poverty headcount ratio at US$6.85 a day (2017 purchasing-power parity) puts the poverty rate at 23.2% in 2021, which is about half of the average of the poverty rate recorded in 2000s.

According to the FAO's estimates, the prevalence of undernourishment in 2019–2021 was 6.7%, in contrast with an average of 19.7% in the decade of 2000s. The country's infant mortality rate (per 1,000 live births) was 27.3 in 2021, not considerably lower than that observed approximately a decade before. Notwithstanding an improvement over the years in the pattern of income distribution and the incidence of poverty and its manifestations, the challenge remains that increases in economic growth and food production have not enhanced access to the fruits of growth for the poorest segment of the population.

As mentioned, knowledge of the degree of severity of the problem of access to food is the first step for targeted policy and program intervention and evaluation. The empirical approach to quantify the effects of lack of access to food encompasses the use of the U.S. HFSSM, which this study seeks to apply and validate, and thereby to assess the extent of food insecurity in the Dominican Republic (D.R.). To that end, a small and relatively poor community, Las Tablas, in the municipality of Baní in Peravia Province, was selected as a survey site for the present study.

The study site is located in the southwest part of the country, about 47 miles (75.6 km) from the capital city, Santo Domingo (Figure 1). Although any community within the country could have been chosen, Las Tablas has features that attracted this pilot work: It is (1) relatively very poor and rural, (2) has a clear demarcation for survey sampling, and (3) has a convenient transportation route for enumeration. Prior to conducting the survey, we first organized and carried out a focus-group exercise to make the survey more culturally sensitive. The final survey was administered in 2006–2007.

[4] "Food production index covers food crops that are considered edible and that contain nutrients" (World Bank, n.d., "Long definition").

[5] No data were found on this variable from the same source prior to 2017.

Figure 1. Map of the Dominican Republic with the Study Area Indicated

Source: Map of Dominican Republic (World Atlas, n.d.).

Despite the long delay since the primary survey, the continuing food insecurity condition in the study area, in particular, and the D.R., in general, prompted us to revisit the food insecurity situation and consider disseminating the findings of the study.[6] As a result, we carried out a review of the current literature not only about the specific study site and country but also across the subregion in order to validate the information that was generated from the survey data. Given the food insecurity situation in the D.R. and our objective of adapting and validating the U.S. food security measurement scale in a different cultural setting, we believe that the data and information are still relevant and valid even after the passage of time.[7] At the time of the survey, this community had 193 households and almost 900 people, with an almost equal gender ratio (453 female and 447 male). One hundred and ten households were randomly selected for this study, representing more than 50% of the households in the community. Every other household in a grid of three streets was selected for

[6] For example, two of the coauthors visited the study site and conducted meetings in October 2018 and March 2019 with field/extension workers to discuss the changes that they were able to observe to the food security situation in the area. We learned from these discussions that the food security situation has not improved and may have gotten worse.

[7] The methodological adaptation process continues to be valuable, particularly for researchers at Instituto Dominicano de Investigaciones Agropecuarias y Forestales (IDIAF), where one of the coauthors is a principal researcher of national food security for the northern region and former director of the institute. The findings and methodology of the study remain relevant and have been reflected in numerous studies including del Rosario, 2021; del Rosario et al., 2018; and del Rosario et al., 2008.

interview. However, 10 to 14 households were included in the final sample even though their spatial locations did not fit either the grid or the every-other-household pattern.

Table 1 summarizes the basic characteristics of the sample. Ninety-three percent of the households surveyed were families with children. Family size ranged between one and 10 (each accounting for 1% of the sample), although a typical family in the sample had fewer than five members. Eighty percent were female-headed. That ratio is somewhat higher among households with no children. The illiteracy rate was 39%, lower among families with children, but still far higher than the national average. For roughly half of the respondents, primary education is the highest educational attainment. The rate of attainment at the secondary level is much lower. The percentage of respondents with primary and secondary education is slightly higher for those in households with children.

The Measurement of Food Insecurity and Adaptation of the U.S. HFSSM

Since 1992, when the Food Security Measurement Project was established as a result of the National Nutrition Monitoring and Related Research Act (1990), the U.S. Departments of Health and Human Service (DHHS) and Agriculture (USDA) have been developing a national standard of measuring food insecurity and hunger through the national nutrition monitoring system (USDHHS & USDA, 1993). As mentioned, one of the outcomes of the joint efforts of these two federal departments in this area has been the Food Security Core Survey Module (FSCSM), which is now the standard method of measuring household food insecurity in the U.S. as well as Canada (Bickel et al., 2000; Tarasuk et al., 1999; USDA, 1998). The USDA, for example, has been monitoring the national food security and hunger status using the FSCSM since 1995 (Andrews et al., 2000).

The food security module is a survey-based method that was developed to provide a numerical scale describing and assessing the food security status of a given population and/or household using a 12-month reference period (that is, the preceding 12-month data). The scale is developed from household direct responses to a series of 18 questions about food security conditions and experiences (see Table A1). A brief review of the nature and implications of these questions is in order (see Bickel et al., 2000, for details).

1. Three questions ask about the food situation of the entire household, seven about the experiences and behaviors of adults, and eight of children (answered only by households with children).
2. Three are follow-up questions that elicit information on the frequency of a previously stated event (Q8a, Q12a, and Q14a).
3. The survey questions were designed and administered in three stages. The first stage serves as an internal screener to the next

Table 1. Selected Characteristics of the Study Sample by Household Child Status

Characteristic	Full Sample	Households with Children	Households with No Children
Number of Households			
Total	110	93	17
% of Total	100%	84.5%	15.5%
Mean Household Size	4.6	5.1	2.4
Household Head, Female (%)	81.8%	80.6%	88.2%
Household Head, Illiteracy Rate (%)	39.1%	37.6%	47.1%
Household Head with Primary Education (%)	52.7%	53.8%	47.1%
Household Head with Secondary Educ. (%)	7.3%	7.5%	5.9%

Note: Percentage figures represent percent of the relevant sample and subsamples.
Reprinted from Bezuneh et al., 2008 (Table 1).

stage of questions.[8]

4. Responses would be recorded as affirmative when respondents chose "yes," "often true," or "sometimes true" as an answer to each food-insecurity question.
5. While the 18 questions as a whole are used to derive a measure of food security status, as subgroups they are designed to capture four kinds of food insecurity situations or events.

Thus, affirmative responses to Q2 and Q3 would indicate an "anxiety or perception that the household budget or food supply was inadequate." An affirmative response to Q4, Q5, and/or Q6 amounted to perceiving "that the food eaten by adults or children was inadequate in quality." In affirming Q8, Q8a, Q9, Q10, Q11, Q12, and Q12a, households were reporting "instances of reduced food intake, or consequences of reduced intake, for adults." Likewise, "instances of reduced food intake or its consequences for children" would be apparent when Q7, Q13, Q14, Q14a, Q15, and Q16 were affirmatively answered (Bickel et al., 2000, p. 24).

The responses to these survey questions were combined into a single measure called the household food security scale.[9] Based on the scale scores, households were formally classified into four categories: food secure, food insecure without hunger, food insecure with moderate hunger, and food insecure with severe hunger. A description of each follows as it appeared in Bickel et al. (2000, pp. 11–12):

Food secure—Households show no or minimal evidence of food insecurity.

Food insecure without hunger—Food insecurity is evident in household members' concerns about adequacy of the household food supply and in adjustments to household food management, including reduced quality of food and increased unusual coping patterns. Little or no reduction in members' food intake is reported.

Food insecure with hunger (moderate)—Food intake for adults in the household has been reduced to an extent that implies that adults have repeatedly experienced the physical sensation of hunger. In most (but not all) food-insecure households with children, such reductions are not observed at this stage for children.

Food insecure with hunger (severe)—At this level, all households with children have reduced the children's food intake to an extent indicating that the children have experienced hunger. For some other households with children, this already has occurred at an earlier stage of severity. Adults in households with and without children have repeatedly experienced more extensive reductions in food intake.

In 2006, the above-listed categories were relabeled (USDA ERS, 2025). Using the same assessment method, the food scale scores are now categorized reflecting levels of food security ranging from high to very low with the following labels: high food security, moderate food security, low food security, and very low food security.[10]

As mentioned, one of the objectives of this study was the adaptation and validation of the U.S.

[8] Thus, respondents were asked the second-stage questions if they affirmatively answered any one of the first-stage questions. Likewise, third-stage questions were posed only to households who provided at least one affirmative response to questions in the second stage.

[9] The scale is normally not affected by hunger due to voluntary dieting since food insecurity and hunger are the result of lack of money or other relevant resources to obtain food, as implied in the 18 questions.

[10] The USDA ERS notes the comparability of the old and new labels as follows. "High food security (old label=Food security): no reported indications of food-access problems or limitations. Marginal food security (old label=Food security): one or two reported indications—typically of anxiety over food sufficiency or shortage of food in the house. Little or no indication of changes in diets or food intake. … Low food security (old label=Food insecurity without hunger): reports of reduced quality, variety, or desirability of diet. Little or no indication of reduced food intake. Very low food security (old label=Food insecurity with hunger): reports of

HFSSM in the D.R. in the context of the study site described above. In order to use the U.S. HFSSM in the context of culturally and economically different countries, one must modify the instrument in a socially and culturally sensitive manner (Nord et al., 2002). Accordingly, the U.S. HFSSM questions were first translated into Spanish, not only as recommended by Harrison et al. (2003) but also, and more importantly, taking into consideration colloquial Dominican Spanish. In addition, we adjusted the U.S. HFSSM standard 12-month reference period to a shorter 30-day period, asking respondents about their relevant experience in the last 30 days rather than the last 12 months.[11] The shorter reference period was used in light of this research project's focus on households that are likely to be confronted with frequent and severe food deprivation. The relevant questions in the HFSSM were accordingly modified and pretested using a focus group from within the study site. The statistical analysis of this study is descriptive, involving interpretive tabular and cross-tabular classificatory analyses.

The study was carried out in several steps. The first step was an explorative exercise in which we explored and learned how selected households in the sampled community described their food situations. This was carried out in a focus-group format with in-depth and open-ended questions and discussions, in which 10 women participated. The results from this activity were then used to make appropriate changes and adaptations to the FSSM prior to implementing it in the study area of Las Tablas. It must be noted, however, that neither the content nor the focus of the core questions of the FSSM changed.

Results of the Modified HFSSM

The data analysis of this study strictly followed the steps and procedures outlined by the authors of the U.S. HFSSM, as revised in 2000. This includes coding and converting survey responses into data and classifying households into the relevant food security status level categories. The scaling analysis of the responses to the pilot survey conducted by the Economic Research Service (ERS) of the USDA, using the Rasch model–based statistical analysis, showed that the item-fit statistics were found to be "quite good (near unity) for most items, indicating that they measure a common phenomenon and do so with approximately equal sensitivity" (USDA ERS, 2000; see Appendix, Figure A1).[12]

Household Food Security Scale Questions: An Overview of the Responses

The responses to food security scale questions administered in Las Tablas are summarized in Table 2, where the standard survey questions and the percentage of sampled households affirming them are recorded. In the full sample, 86% of the respondents worried that their food would run out before they got money to purchase more. The corresponding figure for those who indicated that the food they bought did not last is 84%. A larger proportion of the respondents viewed the quality of their food as inadequate. Thus, in 90% of households, adults felt that they could not afford to eat balanced meals and had to feed their children a few kinds of low-cost food. In three-quarters of the sample, adults cut the size of their meals or skipped meals, and 79% of them had done so for at least three days during the preceding month. In 80% of households, adults ate less than they felt they should, although this figure dropped nine percentage points when asked if they were ever hungry but did not eat. Thirty percent of households reported weight loss for lack of food. A smaller proportion did not eat for a whole day; of this portion of the sample, 91% of them had not eaten for three or more days during the preceding month.

Events of reduced food intake and the consequences thereof for children were relatively fewer,

multiple indications of disrupted eating patterns and reduced food intake" (USDA ERS, 2025, "Ranges of Food Security and Food Insecurity," para. 1–7).

[11] Although in the standard module the questions refer to the previous 12 months, the module may be adjusted to refer to shorter reference periods (Bickel et al., 2000).

[12] Scaling analysis report received from ERS upon the request of the authors. However, further scaling analysis based on a larger survey is recommended before the food security measurement methodology is formalized for general application in the context of the Dominican Republic.

albeit sizeable. Two-thirds of the relevant sample cut the size of children's meals, while three out of five households reported the incidence of children skipping meals. Three-quarters of the households in which children had to skip meals for lack of food had done so for three days or more in the course of the preceding month. Sixty percent of families with children reported instances of hunger among children, with fewer cases of children not eating for a whole day.

Disaggregating the sample into households with and with no children reveals that the two groups affirmed the survey items at different rates. Families with children expressed agreement with six of the 10 common questions at a higher rate than did households with no children. The difference is particularly striking with respect to weight loss and the instance of adults not eating whole day. On the other hand, a greater proportion of households with no children indicated that their food supply did not last and that they were hungry but did not eat (Q3 and Q10). The pattern of responses regarding access to balanced meals and adequate amount of food (Q4 and Q9) was essentially the same.

Household Food Security Status: Who Is Food Insecure?

Item frequencies across households described above are useful, individually and as a subgroup, to

Table 2. Household Food Security Items: Affirmative Responses by Child Status

		Affirmative Responses (%)		
			Households with:	
Q. No.	In the last 30 days:	Full Sample	Children	No Children
Stage 1 Questions				
Q2	Worried whether food would run out.	86.4	87.1	82.4
Q3	Food bought just didn't last.	83.6	82.8	88.2
Q4	Couldn't afford to eat balanced meals.	92.7	92.5	94.1
Q5	Relied on only a few kinds of low-cost food to feed the children.	88.2	88.2	N/A
Q6	Couldn't feed the children a balanced meal.	88.2	88.2	N/A
Stage 2 Questions				
Q7	The children were not eating enough.	79.6	79.6	N/A
Q8	Adult(s) in the household cut size of meals or skipped meals.	75.5	76.3	70.6
Q8a	Adult(s) cut or skip meals, 3 or more days.	60.0	61.3	52.9
Q9	Ate less than felt he or she should.	81.8	81.7	82.4
Q10	Hungry but didn't eat.	72.7	71.0	82.4
Q11	Lost weight because there wasn't enough food.	31.8	35.5	11.8
Stage 3 Questions				
Q12	Adult(s) did not eat for a whole day.	20.9	24.7	00.0
Q12a	Adult(s) did not eat for whole day, 3 or more days.	19.1	22.6	00.0
Q13	Cut size of child's meals.	66.7	66.7	N/A
Q14	Child skipped meals.	60.2	60.2	N/A
Q14a	Child skipped meals, 3 or more days.	46.2	46.2	N/A
Q15	Child hungry but couldn't afford more food.	61.3	61.3	N/A
Q16	Child did not eat for a whole day.	9.7	9.7	N/A

Notes: QN= the serial number of the questions as they appear in the Household Food Security Survey Module. Figures represent percent of the relevant sample.
Reprinted from Bezuneh et al., 2008 (Table 2).

assess the various manifestations and events of food deprivation. However, we need the aggregate value of these frequencies across the survey questions for each respondent to determine the extent and severity of food insecurity. Accordingly, a measure of food security scale value was derived based on affirmative responses as per USDA's guidelines. The sample was then classified into the various categories of food security status, as shown in Table 3.

A glance at the full sample in Table 3 shows that 7% of the respondents were food-secure, with no or minimal perception and experience of food hardship during the reference period. The overwhelming majority (93%) were food insecure, some more so than others, with the percentage rising as a higher degree of food deprivation is considered. A small proportion of the food insecure (20%) had access to just enough food to avoid hunger. Households with very low food security represented 74% of the entire sample and 80% of the food-insecure group. Out of every five households, more than two suffered food deprivation that would be characterized as severe hunger. Roughly half of these households reported instances of an adult skipping or cutting meals or having gone hungry at least one whole day during the reference month.

It appears that families with no children were more food secure than families with children. The experiences of different groups of households also varied with respect to the degree of food insecurity. Households with no children had a substantially higher incidence of low food than did households with children. However, all cases of severe hunger occurred in families with children, among whom 52% experienced it.

Also presented in Table 3 is a measure of food insufficiency, which is based on the pattern of responses to the first screening question of the food security survey. Respondents are classified as food insufficient if they "sometimes" or "often" did not have enough to eat. Although this measure is known to be weaker and conceptually less encompassing than the food security measure, it is juxtaposed for comparative purposes and as a complementary indicator of food hardship. According to this indicator, most of the survey respondents were food insufficient. The average figure for the full sample of 80% contrasts to the 93% who felt food insecure as gauged by the pattern of their responses to the 18 survey questions. In sum, most of the surveyed households faced food insecurity, with the majority experiencing a high degree of severity.

The Prevalence of Food Insecurity: Child Versus Adult Scale [13]

Although the prevalence of "food insecurity with severe hunger" could provide a reasonable proxy

Table 3. Food Security and Sufficiency

		Households with:	
Category and Outcome*	Full Sample	Children	No Children
Secure (%)	7.3	6.5	11.8
Insecure (%)	92.7	93.5	88.2
Low food security (%)	19.1	16.1	35.3
Very low food security (%)	73.6	77.4	52.9
Food insecurity with moderate hunger** (%)	30.0	25.8	52.9
Food insecurity with severe hunger** (%)	43.6	51.6	00.0
Food insufficient (%)	80.0	81.7	70.6
Sample Size (*n*)	110	93	17

* Figures (except those in the last row) represent percentages of the relevant sample size.
** Using old labels applied at the time of survey.

[13] In the Dominican Republic, persons are considered children up to the age of 14 years. Those aged 15 and older are considered adults.

measure for children's hunger, there is a concern that the proxy measure would underestimate the incidence. Supporting this view is the evidence of a considerable number of households with only moderate hunger who reported instances of hunger among children (Bickel et al., 2000). This has led to the development of a new children's food security subscale calculated from the responses to the eight items in the survey that ask about the conditions and experiences of children (Nord & Bickel, 2002). Table 4 compares the prevalence and degree of food insecurity between children and adults. It is clear that in both cases, most of the respondents are food insecure. The prevalence of food insecurity is slightly (two percentage points) higher among adults than among children. The same relative magnitude was observed with respect to the incidence of very low food security. On the other hand, low food security appeared to be more common among children than among adults.

Table 4. Food Security Status: Adult Versus Child Scale

Category and Outcome	Household Scale	Adult Scale	Child Scale
Secure (%)	7.3	12.7	10.8
Low food security (%)	19.1	20.9	26.9
Very low food security (%)	73.6	66.4	62.4
Sample size (*n*)	110	110	93

The Added Survey Questions[14]: Summary of Findings

In addition to the standard food security survey instruments, the pilot survey included, among others, questions about the relative importance of certain food items, distance to markets, the relative importance of produced and purchased items, employment status, women's contribution to household income, and respondents' characterization of their overall well-being. This section tabulates the responses to the additional questions and explores the relationships some of them may have with the prevalence and degree of food insecurity.

The Relative Importance of Certain Food Items in Households' Diets

Table 5 records the percentage of households who indicated their ranking of specified food items in their diet at the time of the survey and a couple of years prior to the survey, focusing on the highest three items. Using the highest percentage of households recorded in each column as an indicator of household's ranking, it can be gleaned from the table that rice (*arroz*) and beans (*habichuela*) were identified by more than three-quarters of the respondents as the two most important food items among the nine types of food

Table 5. Ranking of Food Items: Current (17a)

	Percent of Households Ranking Item					
	Current (at time of survey)			Two/Three Years Prior		
Food Item	1st	2nd	3rd	1st	2nd	3rd
Beans (*Habichuela*)	26.4	50.0	9.1	2.8	2.9	1.3
Milk (*Leche*)	12.7	8.2	18.2	16.0	12.7	2.7
Rice (*Arroz*)	52.7	25.5	7.3	2.8	2.9	1.3
Plantain (*Plátano*)	4.5	5.5	12.7	5.7	8.8	6.7
Chicken (*Pollo*)	0.0	4.5	29.1	2.8	5.9	10.7
Eggs (*Huevos*)	1.8	4.5	15.5	6.6	2.9	13.3
Cassava (*Yuca*)	0.9	0.9	1.8	10.4	22.5	24.0
Sweet Potato (*Batata*)	0.0	0.0	1.8	43.4	16.7	16.0
Potato (*Papa*)	0.9	0.9	4.5	9.4	24.5	24.0

[14] See Table 9 and the survey questions in the Appendix.

listed. Respondents' ranking of the nine food items in their diets two or three years ago indicates that sweet potato (*batata*) ranked first, followed distantly by milk (*leche*) and Cassava (*yuca*).[15]

A striking contrast emerges between the two sets of rankings. At the time of the survey, the majority of the respondents (53%) indicated that rice was their most important food item. By contrast, this food item was ranked first only by 3% of the respondents in their diets a couple of years ago. At that time, sweet potato was selected by 43% of the households as most important, but at the time of this survey, no one chose it as the top item. These two sets of rankings demonstrate a clear shift and reversal of the relative importance of different kinds of food in people's diets.

Economic Activities and Living Conditions: Implications for Food Security

This section describes the responses to the additional questions included in the pilot survey related to economic activities and living conditions and then explores them for food security. The first row of Table 6 presents the frequencies of the responses to a selection of the added questions. The majority of households surveyed resided not far from markets where they made purchases, but relatively few households described the distance as "very near." Most respondents (92%) purchased the food they consumed. The remainder acquired it through a combination of their own production and purchases.

Thirty-nine percent of the interviewees were gainfully employed, with service and other nonagricultural activities identified as the major source of employment. Women's contribution to household income was affirmed only by 25% of the sample. The majority of the respondents felt unhappy about their lives. Nearly half of these described their situation as "not happy at all." Only 8% of the respondents felt that they were very happy (see Appendix, Table A1).

The remainder of the present section explores the implications of distance to markets, employment status, type of work, sources of food, and women's contribution to household income for the prevalence and degree of food insecurity, as well as households' characterization of their overall happiness level classified by food security status. Table 6 provides a dichotomous breakdown of household food security status by the aforementioned attributes. Consider first the cross-tabulation of market distance and household food security status. Regardless of how far households travel to make purchases, the percentage of households falling in the food status categories increases as a higher degree of food deprivation is considered. This is true for the majority of the subsamples constructed. Having noted that, none of the households residing far or very far from the market where they shop were classified as food secure. Put differently, all food-secure households reported that they resided close to the market where they made purchases. On the other hand, those who were located far from the market experienced severe hunger at a higher rate than households residing nearby did. In fact, although not shown in the table, none of the households that described the location of the market as very near experienced severe hunger.

It appears that households with employed members tended to enjoy a higher degree of food security than did households with no employed adults. Six of the eight food-secure families had employed members; all but two households with no employed members were food insecure. Households with no employed members experienced severe hunger at a higher rate (14 percentage points higher) than their counterparts with employed members. Among families with employed adults, those engaged in the service sector tended to be more food secure than those engaged in agricultural and other activities. None of the households whose members were working in the agricultural sector was classified as food secure. Those householders who identified agriculture as the source of their employment suffered greater insecurity with hunger than did their counterparts working in the other two sectors of the economy.

Households that produced their food and sup-

[15] The majority of the households did not indicate the order of importance of the various food items beyond the third rank. Even for the third rank, the response rate was only 68%.

plemented it by purchases were slightly more food secure than families who obtained their food supplies only from purchases, the paucity of households in the former category notwithstanding. Respondents who acquired their food only from purchases appear to have experienced moderate hunger at a lower rate that the other group. The converse is true with respect to the incidence of severe hunger. The probability of being food secure was three times higher among households where women contributed to the family income than among families where women were not reported to have generated income.

Of those who felt good about their lives ("happy" and "very happy"), 16% were classified as food secure. The corresponding proportion for those who described their life situation as "not very happy" or "not happy at all" stood at 3%. It is observed that a greater percentage of "unhappy" respondents faced very low food security. Considering extreme cases (not shown in the table), 44% of the "very happy" respondents were food secure, while 65% of the "not happy at all" subsample faced severe hunger. It is worth noting, however, that some people felt "happy" even when they perceived their food condition as unsatisfactory and a few others felt "unhappy" in spite of relative food security, indicating the absence of perfect correlation between the perceptions and experiences of being "happy" and being "food secure."

Summary and Conclusions

The primary purpose of this study was to adapt and validate the U.S. Food Security Survey Module in the context of the Dominican Republic and thereby assess the prevalence of food insecurity and hunger in a rural community in the country. The module was administered as a pilot in a household survey of 110 low-income families in the country. The study found that 93% of the respondent were food insecure. A relatively small proportion of the food-insecure households (20%) experienced low food security. Households who faced very low food security represented 74% of the entire sample and 80% of the food-insecure group. Child hunger was observed among 89% of households with children. Only 7% of the households were found to be food secure, with no or minimal

Table 6. Food Security Status by Employment and Other Indicators

		Distance To Buy		Employment Status*		Type of Work*			Sources of Food*		Women's Contribution		Happiness*	
Category and Outcome (%)	Full Sample	Near	Far	Empd.	Not Empd.	Agr.	Service	Nonagr.	Purchases	Own Prod.+	Yes	No	Happy	Not Happy
% of Relevant Sample†	---	65.4	34.6	39.1	60.9	27.3	31.8	40.9	91.8	8.2	24.5	75.5	34.5	65.5
Secure	8	11.4	0.0	14.0	3.0	0.0	21.4	16.7	6.9	11.1	14.8	4.8	15.8	2.8
Low food security	21	18.6	21.6	14.0	22.4	8.3	21.4	11.1	19.8	11.1	14.8	20.5	21.1	18.1
Very low food security:	81	70	78.4	72.1	74.7	91.7	57.2	72.2	73	77.7	70.3	74.7	63.1	79.1
Moderate hunger‡	33	32.9	27.0	37.2	25.4	41.7	28.6	38.9	28.7	44.4	37.0	27.7	26.3	31.9
Severe hunger‡	48	37.1	51.4	34.9	49.3	50.0	28.6	33.3	44.6	33.3	33.3	47.0	36.8	47.2
Sample Size§	110	70	37	44	67	12	14	18	101	9	27	83	38	72

* Empd.=employed, Agr.=agriculture, Nonagr.=non-agricultural activities exclusive of services. Own Prod.+=own production and purchases. The four alternative responses about distance to where purchases are made are collapsed in the above table into two: "Near" encompasses "near" and "very near" while "far" includes "far" and "very far." Likewise, the four alternative responses to "how good or happy respondents feel about their lives" are reduced into two groups: "Happy" and "very happy" are combined to form the group "happy." Responses "not very happy" and "not happy at all" constitute the "not happy" group.

† Percent of the sample applicable to a given indicator. The aggregate sample size for "Distance" is 107 because of 3 other responses.

‡ Old label in use at the time of survey.

§ All figures except sample size are percentages.

Note: This is an expansion of data reported in Bezuneh et al., 2008, Table 15.

perception and experience of food hardship during the reference period (the preceding month).

The responses to the additional survey questions revealed the following. There was a shift in the relative importance of certain food items in households' diets. A minority of respondents were gainfully employed, most engaged in services and other nonagricultural activities. Women contributed to household income in a quarter of the sample. Most of the households bought the food they consumed, and the majority resided near markets where they made purchases. Nearly two-thirds of the respondents characterized their living condition as unhappy. Notwithstanding the lack of observations, a cross-tabulation of these findings with the status of food security revealed that those who were employed, engaged in the service sector, resided near markets where they made purchases, depended on own production supplemented by purchases, and where women contributed to household income were marginally more food secure than their comparators.

Finally, despite the long delay in disseminating the information in a peer-reviewed journal, the results from this pilot study could serve as the first step in addressing the question, Could the HFSSM used in wealthy countries be appropriate to measure food security in low-income countries, such as the Dominican Republic? Consistent with the related evidence reviewed above, our observation and experience during this pilot study and the results from it lead us to believe that the core HFSSM instruments could usefully be adapted to assess the food security status of households in countries with less-developed economies, such as the Dominican Republic.

References

Andrews, M., Nord, M., Bickel, G., & Carlson, S. (2000). *Household food security in the United States, 1999* (Food Assistance and Nutrition Research Report No. 8). Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. https://www.ers.usda.gov/publications/pub-details?pubid=46904

Bezuneh, M., & Yiheyis, Z. (2020). Household food insecurity, coping strategies, and happiness: The case of two public housing communities. *Journal of Agriculture, Food Systems, and Community Development*, *9*(3), 215–226. https://doi.org/10.5304/jafscd.2020.093.018

Bezuneh, M., Yiheyis, Z., del Rosario, P. J., & Ortiz, L. (2008). *Measuring food security in the Dominican Republic: Adaptation of the U.S. Food Security Survey Module* (Report CCR-47). https://ers.usda.gov/publications/pub-details?pubid=85985

Bickel, G., Carlson, S., & Nord, M. (1999). *Household food security in the United States 1995-1998 (Advance report)*. Food and Nutrition Service, U.S. Department of Agriculture. https://fns-prod.azureedge.us/sites/default/files/foodsec98.PDF

Bickel, G., Nord, M., Price, C., Hamilton, W. L., & Cook, J. T. (2000). *Guide to measuring household food security, revised 2000*. Office of Analysis, Nutrition, and Evaluation, Food and Nutrition Service, U.S. Department of Agriculture. https://nhis.ipums.org/nhis/resources/FSGuide.pdf

Carlson, S. J., Andrews, M. S., & Bickel, G. W. (1999). Measuring food insecurity and hunger in the United States: Development of a national benchmark measure and prevalence estimates. *The Journal of Nutrition*, *129*(2), 510S–516S. https://doi.org/10.1093/jn/129.2.510S

del Rosario, P. J. (2021). *El consumo de alimentos en República Dominicana* [*Food consumption in the Dominican Republic*]. Instituto Dominicano de Investigaciones Agropecuarias y Forestales (IDIAF). https://www.academia.edu/59822112/del_Rosario_El_consumo_de_alimentos_en_Rep%C3%BAblica_Dominicana

del Rosario, P. J., & Morrobel, J. (2018). *Ocupación y pobreza rural en la República Dominicana* [*Employment and rural poverty in the Dominican Republic*]. Instituto Dominicano de Investigaciones Agropecuarias y Forestales (IDIAF). https://www.academia.edu/download/73546288/OCUPACION_Y_POBREZA_RURAL_EN_LA_REPUBLICA_DOMINICANA.pdf

del Rosario, P. J., Bezuneh, M., & Ortiz, L. (2008). *Medición de la inseguridad alimentaria en hogares de la República Dominicana*. Instituto Dominicano de Investigaciones Agropecuarias y Forestales (IDIAF). https://idiaf.gob.do/publicaciones/detalle_publicacion.php?ID=132

DePalma, A. (2001, March 24). Latin America's poor survive it all even boon times. *The New York Times*. https://www.nytimes.com/2001/06/24/weekinreview/world-free-trade-s-promise-latin-america-poor-survive-it-all-even-boom-times.html

Food and Agriculture Organization of the United Nations [FAO]. (2002). *El estado de la inseguridad alimentaria en el mundo 2002* [*The state of food insecurity in the world 2002*]. https://www.fao.org/4/y7352e/y7352e00.htm

FAO. (2003). *Measurement and assessment of food deprivation and undernutrition* [Symposium proceedings]. International Scientific Symposium, Rome, 26-28 June 2002. https://www.fao.org/4/y4249e/y4249e00.htm#Contents

FAO, IFAD, PAHO, UNICEF, & WFP (2022). *Latin America and the Caribbean — Regional overview of food security and nutrition, 2022 — Statistics and trends*. https://doi.org/10.4060/cc2314en

Girvan, N. (2001). *Societies at risk? The Caribbean and global change* (MOST Discussion Paper Series No. 17). UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000110757

Gulliford, M. C., Nunes, C., & Rocke, B. (2006). The 18 Household Food Security Survey items provide valid food security classifications for adults and children in the Caribbean. *BMC Public Health*, *6*, Article 26. https://doi.org/10.1186/1471-2458-6-26

Gundersen, C., & Ziliak, J. P. (2018). Food insecurity research in the United States: Where we have been and where we need to go. *Applied Economic Perspectives and Policy*, *40*(1), 119–135. https://doi.org/10.1093/aepp/ppx058

Hackett, M., Zubieta, A. C., Hernandez, K., & Melgar-Quiñonez, H. (2007). Food insecurity and household food supplies in rural Ecuador. *Archivos latinoamericanos de nutricion*, *57*(1), 10-17. https://coin.fao.org/coin-static/cms/media/6/13101635604950/2007_f_sec_ecuador_alan.pdf

Harrison, G. G., Stormer, A., Herman, D. R., & Winham, D. M. (2003). Development of a Spanish-language version of the U.S. Household Food Security Survey Module. *The Journal of Nutrition*, *133*(4), 1192–1197. https://doi.org/10.1093/jn/133.4.1192

Himmelgreen, D., Perez-Escamilla, R., Segura-Millan, S., Peng, Y-K., Gonzalez, A., Singer, M., & Ferris, A. (2000). Food insecurity among low-income Hispanics in Hartford, Connecticut: Implications for public health policy. *Human Organization*, *59*(3), 334–342. https://doi.org/10.17730/humo.59.3.76557m317748l414

Kasper, J., Gupta, S. K., Tran, P., Cook, J. T., & Meyers, A. F. (2000). Hunger in legal immigrants in California, Texas, and Illinois. *American Journal of Public Health*, *90*(10), 1629–1633. https://doi.org/10.2105/ajph.90.10.1629

Myers, A. M., & Painter, M. A. (2017). Food insecurity in the United States of America: An examination of race/ethnicity and nativity. *Food Security*, *9*(6), 1419–1432. https://doi.org/10.1007/s12571-017-0733-8

National Nutrition Monitoring and Related Research Act, P. L. 101-445. (1990). https://www.govinfo.gov/content/pkg/COMPS-13694/pdf/COMPS-13694.pdf

Nord, M., & Bickel, G. (2002). *Measuring children's food security in U.S. households, 1995-99* (Food Assistance and Nutrition Research Report No. 25). U.S. Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/publications/pub-details?pubid=46624

Nord, M., Andrews, M., & Carlson, S. (2002). *Household food security in the United States, 2001* (Food Assistance and Nutrition Research Report No. 29). U.S. Department of Agriculture, Economic Research Service. http://www.ers.usda.gov/briefing/foodsecurity

Nord, M., & Golla, A. M. (2009). *Does SNAP decrease food insecurity? Untangling the self-selection effect* (Economic Research Report No. 85). U.S. Department of Agriculture, Economic Research Service. https://ers.usda.gov/sites/default/files/_laserfiche/publications/46295/10977_err85_1_.pdf?v=33442

Olson, C. M. (1999). Nutrition and health outcomes associated with food insecurity and hunger. *The Journal of Nutrition*, *129*(2), 521S-524S. https://doi.org/10.1093/jn/129.2.521S

Pérez-Escamilla, R., Segall-Corrêa, A. M., Kurdian Maranha, L., Sampaio, M. d. F. A., Marín-León, L., & Panigassi, G. (2004). An adapted version of the U.S. Department of Agriculture Food Insecurity Module is a valid tool for assessing household food insecurity in Campinas, Brazil. *The Journal of Nutrition*, *134*(8), 1923–1928. https://doi.org/10.1093/jn/134.8.1923

Pérez-Escamilla, R., Vilar-Compte, M., & Gaitan-Rossi, P. (2020). Why identifying households by degree of food insecurity matters for policymaking. *Global Food Security*, *26*, Article 100459. https://doi.org/10.1016/j.gfs.2020.100459

Randolph, S., Gaye, I., Hathie, I., & Perez-Escamilla, R. (2007). *Monitoring the realization of the right to food: Adaptation and validation of the U.S. Department of Agriculture Food Insecurity Module to rural Senegal* (Economic Rights Working Papers 6). Human Rights Institute, University of Connecticut. https://ideas.repec.org/p/uct/ecriwp/6.html

Polit, D. F., Andrew S. London, A. S., & Martinez, J. M. (2000). *Food security and hunger in poor, mother-headed families in four U.S. cities* (MDRC Working Paper). Manpower Development Research Corporation. https://www.mdrc.org/sites/default/files/full_371.pdf

Tarasuk, V. S., & Beaton, G. H. (1999). Household food insecurity and hunger among families using food banks. *Canadian Journal of Public Health*, *90*, 109–113. https://doi.org/10.1007/BF03404112

U.S. Department of Agriculture, Economic Research Service [USDA ERS]. (2025, January 10). *Food security in the U.S.—Definitions of food security*. https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/definitions-of-food-security#ranges

U.S. Department of Health and Human Services & USDA. (1993). Ten-year comprehensive plan for the National Nutrition Monitoring and Related Research Program. *Federal Register*, *58*(111), 32752–32806. https://www.govinfo.gov/app/details/FR-1993-06-11

Vargas, S., & Penny, M. E. (2010). Measuring food insecurity and hunger in Peru: A qualitative and quantitative analysis of an adapted version of the USDA's Food Insecurity and Hunger Module. *Public Health Nutrition*, *13*(10), 1488–1497. https://doi.org/10.1017/S136898000999214X

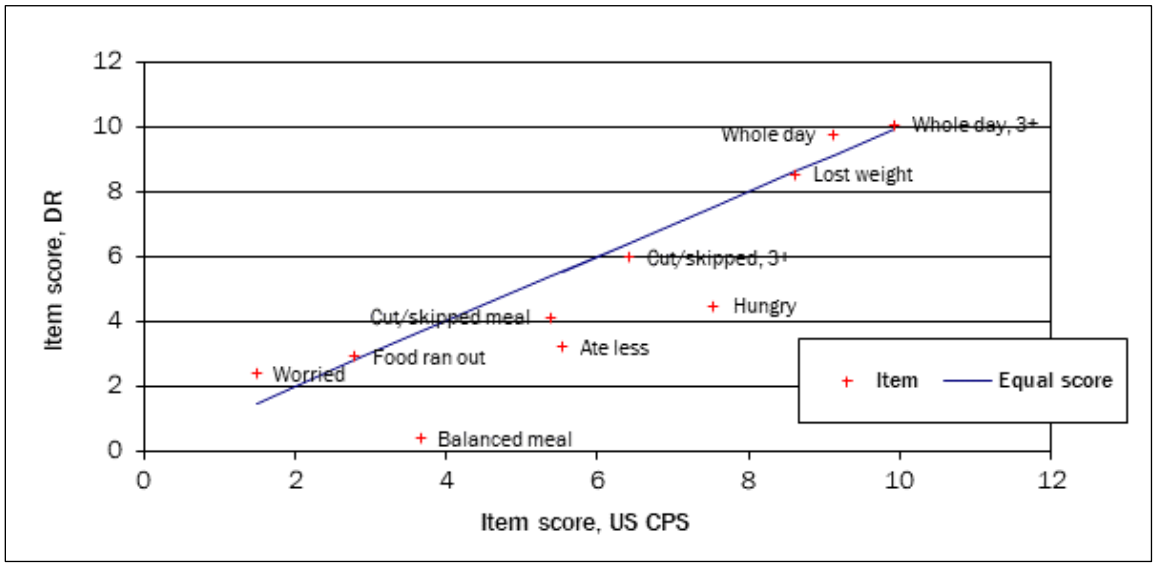
World Bank. (n.d.). *DataBank: Metadata glossary*. Retrieved February 2024 from https://databank.worldbank.org/metadataglossary/world-development-indicators/series/AG.PRD.FOOD.XD

Appendix

Table A1. Responses to Other Added Questions (% of Respondents)

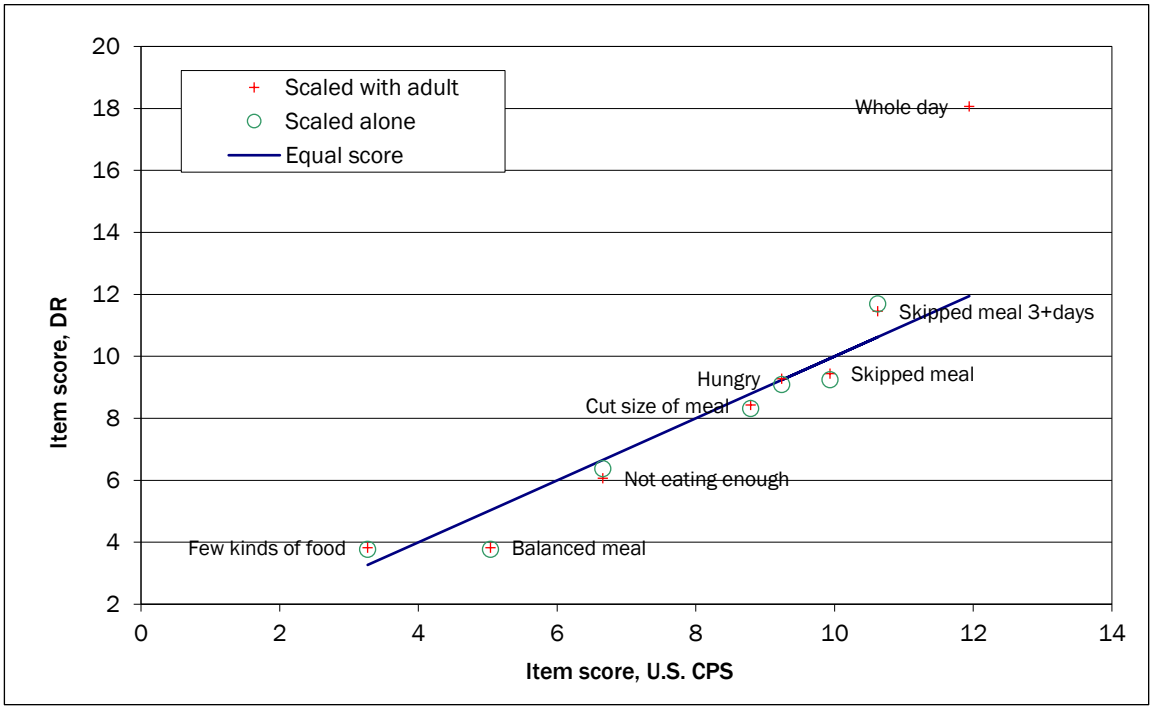
Question	%
Market distance to make purchases	
Very far	10.9
Far	22.7
Near	60.0
Very near	3.6
No response	2.7
Sources of food items	
Purchases	91.8
Own products and purchases	8.2
Family member employed?	
Employed	39.1
Not Employed	60.9
If employed, type of work (*N*=44)	
Agricultural	27.3
Nonagricultural	40.9
Services	31.8
Do women contribute to household income?	
Yes	24.5
No	75.5
How happy?	
Very happy	8.2
Happy	26.4
Not very happy	34.5
Not happy at all	30.9

Figure A1. Comparison of Item Severity Scores on Adult Food Security Scale, Dominican Republic Food Security Pilot Survey vs. US CPS-FSS (metrics equated based on all items except balanced meals, ateless, and hungry)



Note: Figure reprinted from Bezuneh et al., 2008 (Figure 3).
Source: Prepared by ERS based on data from the Dominican Republic Food Security

Figure A2. Comparison of Item Severity Scores on Children's Food Security Scale, Dominican Republic Food Security Pilot Survey vs. U.S. CPS-FSS (metrics equated based on all items except balanced meal and whole day)



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Food insecurity coping strategies among households with average dietary diversity and caloric intake scores in rural Uganda

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Abstract

This study assessed the livelihood education programs (LEPs) of the Center for Sustainable Rural Livelihoods. The center is based at Iowa State University (ISU) and operate in Uganda through the ISU Uganda Program, with the goal of ending hunger in Uganda. We used mixed methods, using surveys and focus groups. The surveys assessed dietary and caloric intake statuses and food access pathways with 454 households (316 LEP partici-

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Author's Note

The first author's graduate thesis (Ikendi, 2019) formed the basis of this article. Similarly, this article is an expansion of the research poster that was presented to the Association for International Agricultural and Extension Education held in Orlando FL, April 22-25, 2024.

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pants and 138 nonparticipants). Twelve focus groups conducted with 125 LEP clients explored dietary changes and coping strategies during food scarcity. Overall, 44.1% households had good diets, and 42.5% had acceptable caloric intake. LEP participants were associated with good diets and acceptable caloric intake compared to nonparticipants. Specifically, participation in livestock programs was associated with good diets, and agronomy, postharvest, livestock, and nutrition programs were associated with acceptable caloric intake. Foodstuffs were mainly accessed through home (farmgate) production, especially protein and energy foods, and market purchases for animal-source foods and vegetables. Focus groups identified shifts in consumption from fresh to dried foods like sweet potatoes and cassava flour during scarcity. Consumption of animal-source proteins was low, and foods like meat and fish went off the menu during scarcity periods. Mothers selling their labor in exchange for food or cash, reliance on husbands, use of food reserves, and livestock sales were the main food insecurity coping strategies. Others included profits from small businesses, borrowing, friends, and fruit gathering. These results imply the benefit of participating in LEPs. Efforts to develop postharvest programs for starchy food, in addition to monitoring the adoption of storage practices, will benefit households.

Keywords
agronomy and land use, caloric intake, caloric consumption, coping strategies, dietary diversity, income innovations, livestock integration, nutrition and infant feeding, nutrition education centers, postharvest technologies, water supply and public health, Uganda

Abbreviations
Center for Sustainable Rural Livelihoods of the Iowa State University (CSRL)
Food and Agriculture Organization of the United Nations (FAO)
Food consumption scores (FCS)
Household Dietary Diversity Scores (HDDS)
Iowa State University Uganda Program (ISU-UP)
Livelihood education programs (LEPs)
National Agriculture Advisory Services (NAADS)
Nutrition Education Centers (NECs)
Office of the Prime Minister of Uganda (OPM)
Volunteer Efforts for Development Concerns (VEDCO)
Water, sanitation, and hygiene (WASH)

Introduction

At the end of the Millennium Development Goals (2000–2015), world leaders set a target to achieve zero hunger by 2030 through the Sustainable Development Goals (SDGs; United Nations, 2015). The Food and Agriculture Organization of the United Nations (FAO) and its partners monitor the progress of SDGs annually. FAO et al. (2025) projected a reducation in the number of undernourished, "but 512 million people are still projected to be facing hunger in 2030, of whom nearly 60 percent will be in Africa" (p. xii). Moreover, in the post-COVID-19 recovery period, food insecurity has been exacerbated by global disruptions in production and trade due to the Ukraine–Russia war (El Bilali & Ben Hassen, 2024), climate change (Li et al., 2025), and the foreclosure of humanitarian aid from the United States (Cavalcanti et al., 2025).

In Uganda, our country of study, the global hunger index has consistently ranked Uganda as *serious* in hunger severity (Wiemers et al., 2024), in line with several trend analyses (Akumu et al., 2023; Ogenrwoth et al., 2022). The 2024 census indicated a 46% prevalence of food insecurity (Uganda Bureau of Statistics, 2024). Many factors predict the disruptions in agri-food production. These factors include hydroclimatic hazzards such as landslides (Kempango et al., 2024; Mulabbi et al., 2025; Nahalomo et al., 2024; Nedala, Mugagga, et al., 2025; Nedala, Puja, et al., 2025) and tensions such as political violence (Bhangyi & Rømer, 2025), ethnic conflicts (Kwikiriza et al., 2023), and rebel movements (Kamugisha et al., 2024; Nanfuka et al., 2025). Other factors include production factors such as agrarian land struggles (Asad et al., 2024), non-native pest invasions (Mulema et al., 2025) and diseases, requiring improvements in crop surveillance tools (Nameere-Kivunike et al., 2023), among other interventions.

Improving food production and access requires concerted efforts through public–private

partnerships, and the Ugandan government has responded to these calls. FAO data shows that public spending on interventions promoting food and nutrition has been growing (FAO et al., 2024, p. 80). The Office of the Prime Minister (OPM) and associated ministries, such as health and agriculture, monitor the implementation of several interventions (OPM, 2020). Key drivers to agricultural development are programs through the National Agriculture Advisory Services (NAADS) since 2000 using the farmer-to-farmer extension model (NAADS, 2024), whose model has direct links with the public–private partnership of the sustainable livelihoods program of our study.

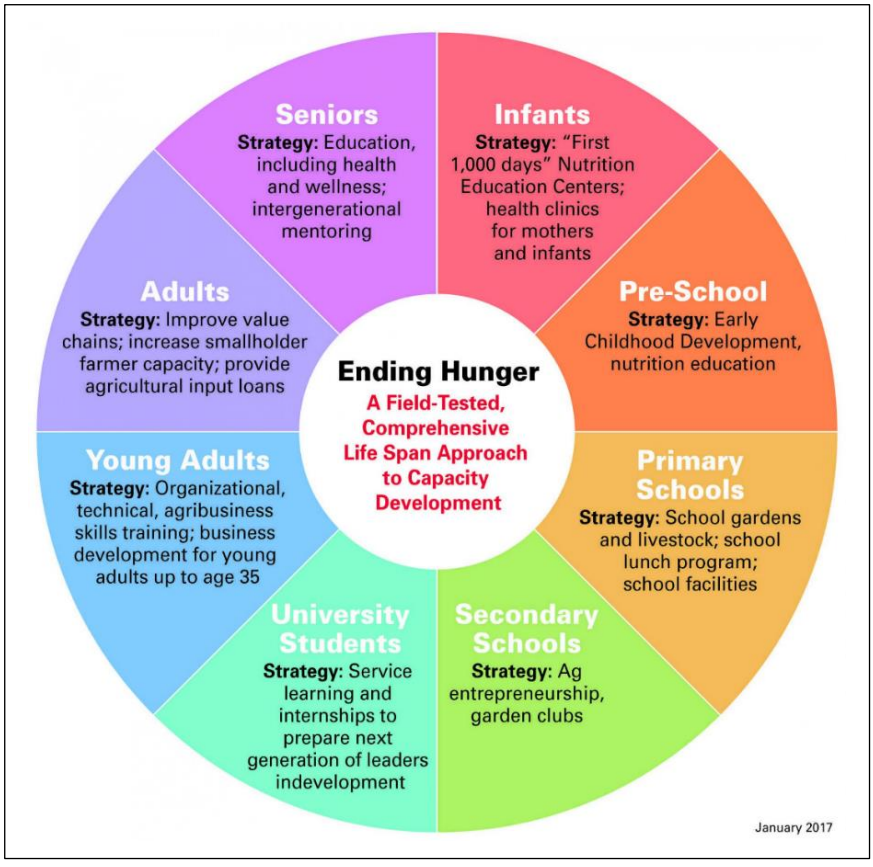
Operationalization of the Sustainable Livelihood Program in Uganda

This study explores the Iowa State University's Center for Sustainable Rural Livelihoods (CSRL) interventions toward ending hunger in rural Uganda. Since 2003, CSRL has operated in tripartite partnership with Makerere University (MAK), located in Kampala, Uganda, and not-for-profit non-governmental organizations, including the Volunteer Efforts for Development Concerns (VEDCO) (2004-2014); and Iowa State University Uganda Program (ISU-UP) 2014 to date (Butler & Acker, 2015; Ikendi & Retallick, 2025). The CSRL/VEDCO phase adopted a farmer-to-farmer approach where food security groups were formed as a model of extension to harness livelihood assets (Masinde, Butler, & Mazur, 2015; Sseguya et al., 2009; Sseguya et al., 2015). Harnessing livelihood assets was in line with the livelihood framework, supporting development organizations to assess the status of community capitals, including social, financial, natural, human, and fiscal capital as an entry for development interventions (Natarajan et al., 2022).

However, in 2014, there was a shift from the farmer-to-farmer extension approach, partly due to presidential suspensions of NAADS in 2007 and 2014 (Rwamigisa et al., 2018). CSRL/ISU-UP designed and adopted a comprehensive human capacity-building approach (Figure 1). This capacity development model touches the lives of all people from pregnancy to seniors through interrelated livelihood education programs (LEPs) (Ikendi, Mwenyi et al., 2025), building their capacities toward sustainable food security (Ikendi, Owusu et al., 2023a) and nutrition security (Ikendi, Owusu et al., 2023b; 2023c).

The LEPs include *agronomy* to improve the knowledge of farmers in soils, crops, and natural resource management and to increase access to quality and diverse crop inputs (Akitwine, 2021;

Figure 1. CSRL/ISU-UP Comprehensive Lifespan Approach to Capacity Building Model



Anderson, 2023; Ikendi et al., 2024; Kwikiiriza, 2022; Tusiime et al., 2019; Tusiime et al., 2020; Wokibula et al., 2024; Wokibula & Westgate, 2016). *Postharvest programs* foster reduction of postharvest losses in schools and communities (Ahimbisibwe et al., 2024; Asimo et al., 2024; Bbosa et al., 2017; Bbosa et al., 2020; Brumm et al., 2021; Ikendi et al., 2024; Mayanja et al., 2018; Tumutegyereize et al., 2022). *Livestock programs* educate farmers on sustainable livestock breeding and management practices to improve their income and consumption of animal-source proteins (Ikendi, Owusu, et al., 2025; Kugonza et al., 2014; Masinde, McMillan, et al., 2015; Semahoro et al., 2018; Walugembe et al., 2014).

Community innovations work to diversify the incomes and assets of mothers and in- and out-of-school youth through crafts, saving schemes, sewing, bookmaking, soapmaking, and school gardens (Ikendi, Mwenyi, et al., 2025; Martin, 2018). CSRL/ISU-UP also provide technical backup to food security support groups to initiate sustainable food and income-generating activities. *Education programs* through global service-learning build the capacity of young program participants using school gardens as outdoor experiential learning laboratories (Ikendi, Mwenyi et al., 2025; Ikendi, Retallick, & Nonnecke, 2023; Ikendi, Retallick, Nonnecke, & Kugonza, 2023; Nonnecke et al., 2015). *Youth entrepreneurship programs* engage youths in managing small to medium businesses to improve their livelihoods (Banige et al., 2024a, 2024b; Duerfeldt et al., 2016; Ikendi, 2022; Ikendi, Mwenyi et al., 2025; Nyarko & Masambuka-Kanchewa, 2025; Orozco & Lukwata, 2025).

Nutrition programs have two components: community nutrition and school feeding programs. A *community nutrition program* addresses nutrition challenges through community-based approaches using nutrition education centers (NECs) for managing acute malnutrition among women and children up five years old (Ikendi, Owusu et al., 2023b; 2023c; Masinde, McMillan, et al., 2015; Winham et al., 2016). The program utilizes locally grown foodstuff such as soybeans, millet, and grain amaranths to make nutrient-dense therapeutic porridge. The program partners with government nurses to provide complementary services such as immunization, HIV counseling, and family planning. Also, the nutrition program enhances school lunches with proceeds from school gardens to reduce hidden hunger in schools (Byaruhanga et al., 2017; Nonnecke et al., 2016; Ssabika et al., 2024). *Public health programs* work to increase access to safe water by drilling boreholes and advocating for community hygiene and sanitation practices (Ikendi, Masinde et al., 2025) and food safety (Nabwiire et al., 2023).

All LEPs regularly assess their impact on food and nutrition security. Program studies have assessed these LEPs on household food security (Ikendi, Owusu et al., 2023a; Sseguya et al., 2018) and nutrition security (Ikendi, Owusu et al., 2023c). However, no studies have assessed their impact on dietary diversity and caloric intake and food insecurity coping strategies. This study was conducted to bridge that gap and support program planning and improvements in ending hunger in rural Uganda. The study compared the dietary and caloric intake status of households by their affiliation with the NECs and participation in the LEPs. Overall, the study had six objectives:

1. Determine the household dietary diversity status and compare to their affiliation with NECs and participation in LEPs.
2. Determine the household caloric intake status and compare to their affiliation with NECs and participation in LEPs.
3. Establish the factors influencing household dietary diversity and caloric intake.
4. Find out the household dietary diversity/food access pathways.
5. Identify changes in food consumption patterns between periods of plentiful food and scarcity.
6. Identify the household coping strategies during food scarcity.

Literature Review

Achieving sustainable food and nutrition security requires multifaceted food production strategies at all levels, both macrolevels—global, regional, and national—and microlevels, in particular, the household (FAO et al., 2025; Swinnen & Barrett, 2025; Wiemers et al., 2024). Food and nutrition security

comprises four core pillars: availability, access, utilization, and stability (FAO et al., 2013). Food security is related to food availability and access, while nutrition security focuses on food utilization within our bodies. Food stability relates to future assurances of food.

Food availability provides proxy indicators of the physical presence of food through farm production, purchase, food aid, gifts, or trade. Food availability is influenced by natural resources like land. Land access and control, especially by women, contribute greatly to food production (Barak et al., 2023; Kangogo et al., 2024; Kakungulu et al., 2025; Kemigisha, 2025; Mukoda et al., 2025). Similarly, trade polices influence food availability by regulating the flow of between countries (Barlow et al., 2020).

Food access relates to the ability to obtain food through production, relief, exchanges, or purchases. Food availability does not guarantee access, especially in the neoliberal economy, where food is a commodity for sale (Bradley et al., 2023a; Canfield et al., 2021). Therefore, household income influences the purchasing power (Ahmad et al., 2024; Kakati, 2025), affecting mostly animal-source foods with higher prices (Paro et al., 2024). Accelerating agrifood trade among women and youth improves food access (Agole et al., 2025; Kironde et al., 2024; Leon-Himmelstine et al., 2021; Namata et al., 2024). Also, investments in livestock enterprises, especially by women (Bain et al., 2020; Colverson et al., 2020; Kakungulu et al., 2025; Nagasha et al., 2024; Waiswa & Jolly, 2021), contribute positively to diets and income.

Food utilization relates to the ability of the body to absorb nutrients from the foods consumed, influenced by its health status and the diet. Also, household cleanliness, especially water and sanitation facilities such as latrines, reduces predisposition to illness like diarrhea (Auma et al., 2024; Ikendi, Masinde et al., 2025; Mabkhot & Piaralal, 2024; Workman et al., 2022). Food availability and access are influential but do not guarantee nutrition utilization. For instance, high income may result in consumption behaviors, such as preference for a hypocaloric diets (low-calorie foods), leading to being underweight, or a hypercaloric diet (high-calorie foods), leading to overweight (Blüher, 2025). Also, consumption of alcohol or fast foods with low nutrient density may affect nutrition utilization (Almoraie et al., 2024; Bradley et al., 2023b).

Food stability looks at sustainable food access, including the lean periods or periods of food scarcity. Ensuring sustainability requires enhancing production and price stabilization (Gahamanyi & Tchouassi, 2025) and improving postharvest technologies (Mayanja & Oluk, 2023; Taku-Forchu et al., 2023), food safety and social programs (Gilligan et al., 2025; Wanyakha & Grudens-Schuck, 2025; Wanyakha et al., 2025), and agricultural insurance (Ceballos et al., 2025).

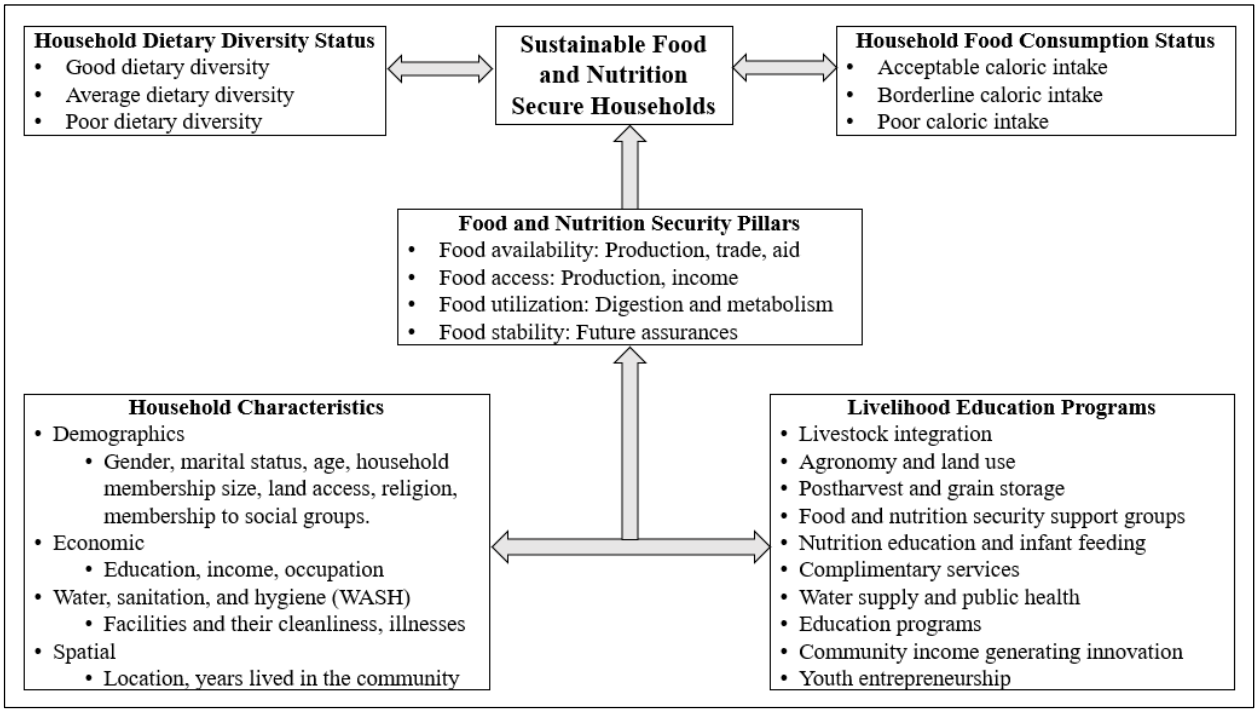
This study focused on food access measured by household dietary diversity and caloric intake (Swindale & Bilinsky, 2006). Dietary diversity is assessed as a 24-hour recall of the foods consumed by the household to give a proxy indicator of whether the household had a good, average, or poor diet on the household dietary diversity scale. Caloric intake is assessed as a seven-day recall of the food consumed to determine the level of food consumption, whether acceptable, borderline, or poor, on the food consumption scale.

A conceptual framework (Figure 2) was designed with a concept of starting from where the communities are (Masinde & McMillan, 2015), assessed through understanding the status of their community capital assets (Natarajan et al., 2022; Sseguya et al., 2009). The framework shows how household characteristics influence household participation in LEPs and collectively influence the food and nutrition security pillars. By the principle of the theory of change, development interventions need to understand the nature of the communities where they operate. Lanou et al. (2021) echoed the vital role of meeting and starting from where people are in promoting behavioral change in food consumption patterns.

Methodology

This study adopted a mixed methods approach. A survey was used to determine dietary and caloric intake statuses and food access pathways; focus group discussions gleaned information on dietary patterns and coping strategies during food scarcity. The study was conducted in the Butansi and Namasagali subcounties of Kamuli District,

Figure 2. Household Dietary Diversity and Caloric Intake Conceptual Framework Design for the Study



Uganda (Figure 3), where the CSRL/ISU-UP implements LEPs to end hunger. The IRB oversight was approved by ISU under IRB number 18-356-1.

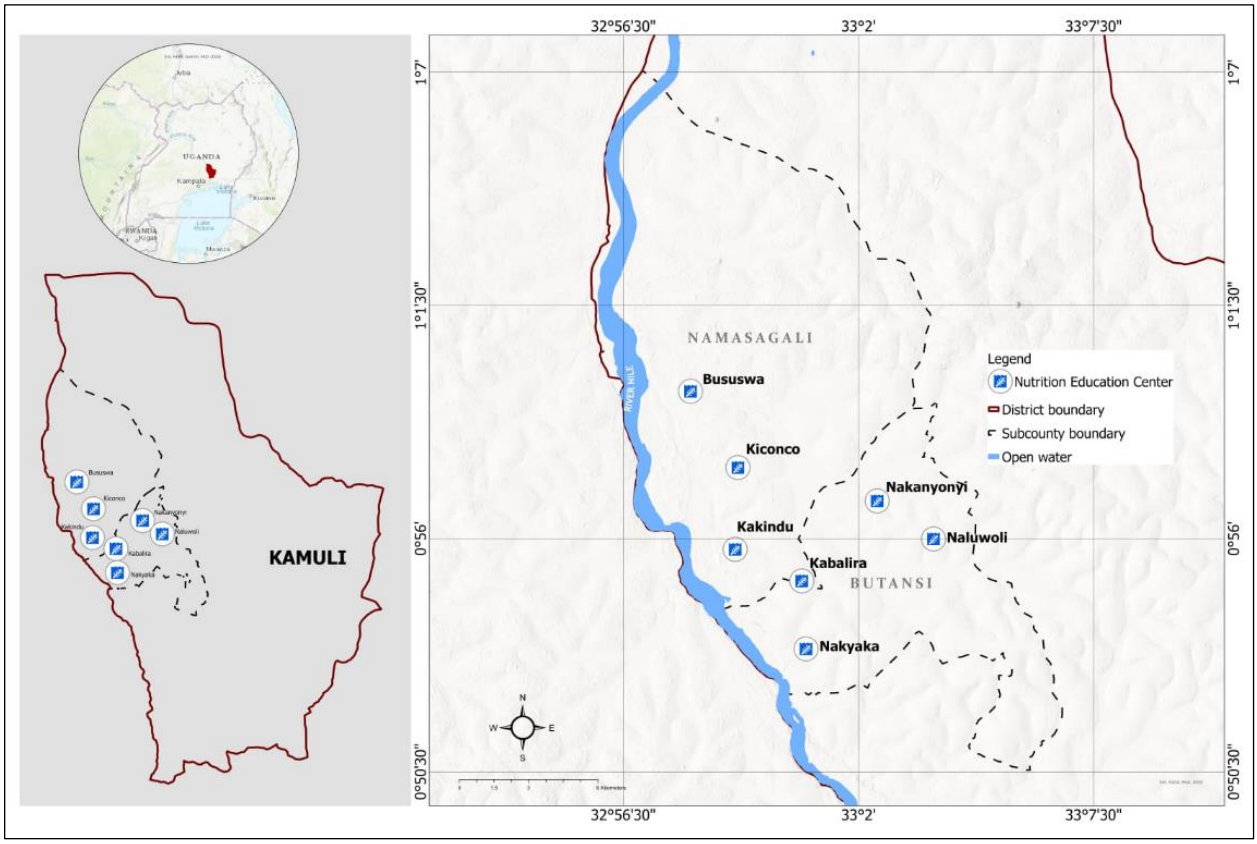
The target population were clients of the NECs or households who had participated in other LEPs, while nonparticipants had never participated in any LEPs. NECs are community-based centers where women and children (≤59 months) at risk for malnutrition are rehabilitated through nutrition therapy of nutrient-dense porridge (Ikendi, Owusu et al., 2023b; Masinde, McMillan et al., 2015). Households (n = 1,503) served by the NECs formed the sampling frame. A representative sample of 306 at a 95% confidence interval was determined and randomly drawn.

The community-based NEC trainers assisted the research team in identifying the NEC participants, and 82.7% (n = 253) were accessed and interviewed. We sought to compare an NEC household to a non-NEC household within a quarter-mile radius. Non-NEC households (n = 201) were also interviewed, giving us 454 households in the survey. However, among the 201 households, 63 households had participated in other LEPs, and these households were labeled *participants: non-NEC clients*. The rest, 138 households, were labeled *nonparticipants*.

Data Collection, Analysis, and Interpretation

In data collection, affiliation to the NECs and participation in LEPs were determined by dichotomous "yes" or "no" questions. Then, a food frequency questionnaire (Appendix A) was adopted to collect data on household-level food consumption in a 24-hour recall to assess dietary diversity using the Household Dietary Diversity Scores (HDDS) and a seven-day recall to assess caloric intake using the Food Consumption Scores (FCS) metrices (Swindale & Bilinsky, 2006). Respondents were asked to describe the household foodstuffs eaten within 24 hours and during the last seven days. Each food was marked as either 0 (*not consumed*) or 1 (*consumed*). Participants also indicated how each food was accessed: 1 = grown/reared, 2 = bought, 3 = exchanged, 4 = loaned, 5 = gift, and 6 = food aid. For HDDS, foods are grouped into 12 food groups: cereals, vegetables, legumes/pulses, roots/tubers, fruits, meats, seafood, eggs, dairy products, sugar, fats/oils, and miscellaneous, like

Figure 3. Map of Study Areas of Butansi and Namasagali Subcounties in Kamuli District



salt. Each group was assigned a multiplier index of one regardless of the number of foods consumed. Dietary diversity was determined by adding all scores generating 12 points maximum. A three-score cluster was generated and interpreted as: 0–4 (*poor*), 5–8 (*average*), and 9–12 (*good*) dietary diversity.

For FCS, foods are grouped into eight categories with their multiplier indices: main staples (2), legumes/legumes (3), vegetables (1), fruits (1), meats/fish/eggs (4), dairy products (4), sugar (0.5), and oils (0.5). Each foodstuff consumed was multiplied by its respective index. Caloric intake was determined based on the total score and interpreted in three clusters: 0.0–21.4 (*poor*), 21.5–35.0 (*borderline*), and >35.0 (*acceptable*) caloric intake. We then assessed the likelihood associations and differences in dietary diversity and caloric intake between households with their affiliation to NECs and LEPs using Chi-square and ANOVA, respectively, using SPSS version 30.

Factors Influencing HDDS and FCS

Binary logistic regressions were used to assess the association between dependent variables (HDDS and FCS) and selected household-level independent variables: spatial, demographic, socioeconomic, water and sanitation, and production factors (Appendix B). Variables were categorized into dummy variables: HDDS (0 = poor/average, 1 = good dietary diversity), FCS (0 = poor/borderline, 1 = acceptable caloric intake), and independent variables, for instance, education (0 = primary or less; 1 = post-primary education). Before running the binary logistic regressions on HDDS and FCS as categorical/dummy variables, linear regressions were run as continuous variables against the independent variables to test for multicollinearity and key statistical indicators of Tolerance Value (*TV*) and Variance Inflation Factor (*VIF*; Leech et al., 2007). Nineteen independent variables were run, and five were dropped for lack of conformance to TV and/or TIF. The final model for HDDS had

an adjusted R^2 of 0.108 and *TV* of 0.892 (*TV* = $1-R^2$; Appendix C), and FCS had an adjusted R^2 of 0.147 and *TV* of 0.853 (Appendix D). Both models conformed to VIF, which is supposed to be ≥1 but ≤2.5, and ran at 0.05 and 0.1 significance, considered due to reductions in variables' prediction power due to categorizations (Menard, 2000).

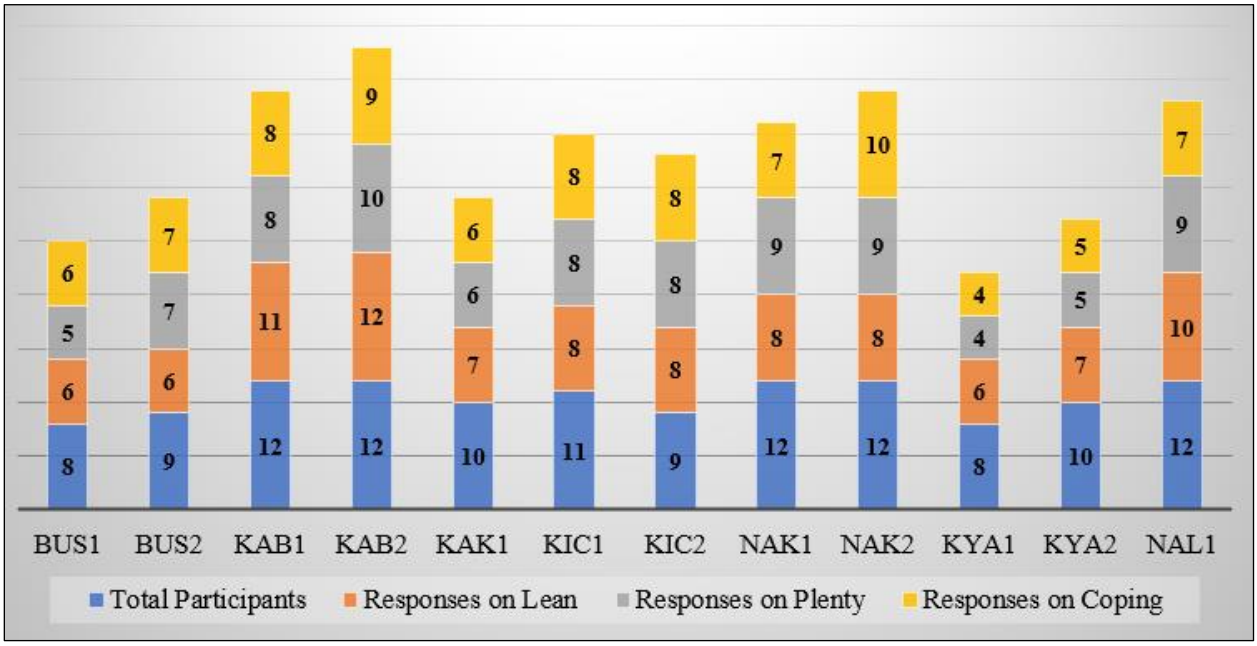
Food Consumption Patterns and Coping Strategies

We conducted 12 focus group discussions in our broader study with 125 NEC mothers. This article extracted responses from two questions. Question 1 asked, what foods are commonly eaten in your household during seasons of plenty and scarcity? Five marks were given to the most consumed foods, descending to one mark for the least consumed. Question 2 asked, during food scarcity, how does your household cope with the situation? (see Figure 4).

Our inquiries through focus groups were grounded in social constructivism, informed by the belief that knowledge is socially constructed and that its meaning emerges inductively (Crotty, 1998). Four members, including three research assistants and the lead author, conducted the discussions. The research assistants asked questions, managed recorders, and transcribed responses. The lead author asked probing questions and wrote field memos used in triangulation and discussions to improve data trustworthiness (Lemon & Hayes, 2020). The four members spoke Lusoga, the native language, easing data collection in a natural flow of conversations focused on the study goal (Rossman & Rallis, 2017). After the discussions, written responses were typed into Microsoft Word. The lead author cross-checked for clarity between the typed documents of each group and their audio recordings and cleaned the data where necessary.

The process of cross-checking went along with preliminary transcriptions, which were done word by word while actively listening to the audio and following written notes, noting the relay time in a member's response and between members. This relay time potentially signified a change of themes, need for clarification, and/or discomfort (Brinkmann, 2022). After transcribing, we fully engaged in dialogues with our data, reading the transcripts line by line, continuously triangulating with the field memos. In that process, we sought to recognize and classify commonalities across the experiences of mothers and perspectives that appeared distinct among them and wrote analytic memos to reflect on emerging unique ideas (Mihas, 2021).

Figure 4. Respondents on Changes in Food Consumption Patterns and Coping Strategies



Themes emerged inductively as we closely read the transcripts (Saldaña, 2024). We then used continual comparisons amongst the themes to determine the predominant ones related to negotiating their distinctiveness and look-alike responses within groups and among them. Frequencies for each theme were generated, and their results are presented with verbatim excerpts to illustrate the "details, emotions, and textures of social relationships" (Rossman & Rallis, 2017, p. 172) about the food insecurity coping strategies.

Positionality and Reflexivity

Reflecting on our positionality was key in the research process to control for any personal bias that would influence both the data collection process and interpretation of the findings (Savolainen et al., 2023; Yip, 2024). Specifically, the lead author is a native of Kamuli district, where the study was carried out. This study was conducted as part of their graduate school thesis, and especially as an impact evaluation of the CSRL program, where the lead author worked as a graduate assistant for monitoring and evaluation. This insider-outsider relationship had the potential to influence the results; however, much support was provided by the graduate committee through guidance and formal examination of the thesis. Moreover, during the focus groups, the lead author specifically took the role of managing the focus group dynamics to ensure everyone spoke, asked probing questions, and wrote methodological field memos, and three trained research assistants led the questioning process. Reflexively experiencing the data collection processes, leading the transcription, and theming ensured rigor and trustworthiness, along with peer debriefing, both as a supervised graduate student and with the co-author during the writing of this manuscript. The guidance and contributions made by the team, moreover, who were all familiar with livelihood programs in an international rural setting, improved our interpretation of the study results.

Results

Results are presented based on specific objectives, including determination of the statuses of dietary diversity and caloric intake to the NECs and participation in LEPs; logistic regression assessing the factors influencing the dietary and caloric intake; food access/dietary diversity pathways; and household coping strategies during lean periods.

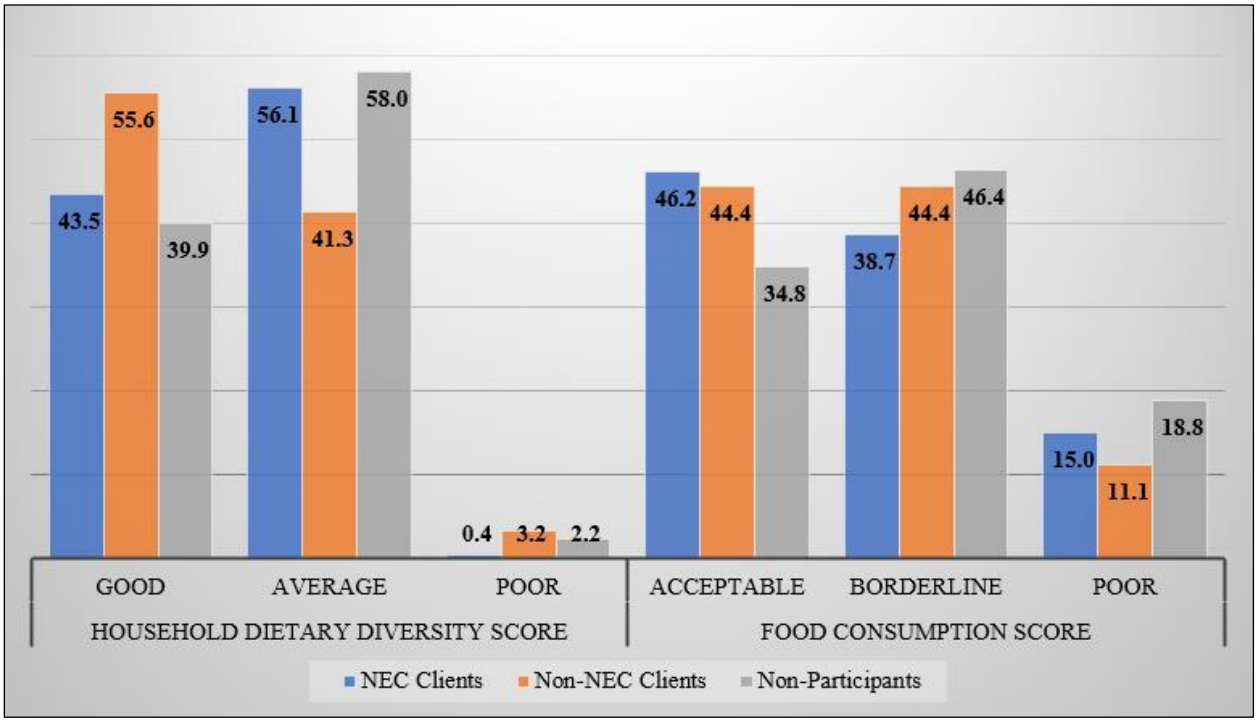
Household Dietary Diversity and Caloric Intake/Consumption Statuses

The study found statistically significant variations within and between households (Figure 5). In dietary diversity, overall, 44.1% had good dietary scores; however, by overall mean score, all households were within an average diet (8.33 ± 1.70). By affiliation with NECs, an ANOVA post hoc analysis showed that non-NEC households (8.84^{b} ± 2.06) had statistically ($p = 0.014$) higher mean scores compared to nonparticipants (8.09^{a} ± 1.65); however, these differences did not differ from NEC households ($8.33^{a,b}$ ± 1.60). Of the CSRL/ISU-UP households (NEC and non-NEC), 45.9% were associated with good diets compared to 39.9% of nonparticipants, which was not statistically significant. For caloric intake, 42.6% had acceptable scores; however, the overall score was 33.67 ± 12.53, indicating that households were within the borderline caloric intake. By affiliation with NECs, an ANOVA post hoc analysis showed that NEC (34.8^{b} ± 12.328) and non-NEC (36.0^{b} ± 13.534) households had statistically ($p = 0.002$) higher mean scores compared to nonparticipants (30.6^{a} ± 11.908). Of CSRL/ISU-UP households, 45.9% had acceptable caloric intake, compared to 34.8% of nonparticipants.

Food Groups Used in Determining HDDS and FCS Statuses

Of the 12 food groups classified for the dietary diversity score, four food groups revealed statistically significant associations with NEC participation. Consumption of fruits, meats, and eggs was, for instance, more associated with non-NEC compared to NEC and nonparticipants. Similarly, of the eight groups that reported their caloric intake, five revealed significant differences between households. NEC households, for instance, had higher caloric intake scores in main staples than nonparticipants, whereas non-NEC participants had higher scores in pulses and meats/fish than nonparticipants. For vegetables, NEC and non-NEC

Figure 5. Household Dietary Diversity and Caloric Intake



households had higher mean scores than nonparticipants. See Appendix E for detailed results.

Livelihoods Education Programs (LEPs) and Dietary Diversity and Caloric Intake

The study found that participants in livestock programs had a statistically more significant likelihood of having good diets than nonparticipants. Similarly, agronomy and postharvest, livestock, and nutrition programs had statistically significant associations with acceptable caloric intake among participants, compared to nonparticipants (Table 1).

Factors Influencing HDDS and FCS Statuses

Table 2 shows two binary logistic regression models: dietary diversity and caloric intake/consumption, regressed against 14 independent variables. Ten variables showed significant relationships with household diets and caloric intake. Among the spatial factors, the subcounty where the household was located was significant. Being in Namasagali had a 66.7% likelihood of poor/average diets, more than in Butansi subcounty. Similarly, there was a 32.9% likelihood of having good diets if the household heads lived in same villages where their homesteads are located rather than living outside them.

In demographic factors, 40.6% of households that had five or fewer members reported good diets, while only 2.0% of households were six or more members reported acceptable caloric intake. In socioeconomic factors, there was a 62.0% likelihood of having poor/average diets if the main occupation was "other jobs" other than farming and a 48.8% likelihood of having poor/borderline caloric intake. Other jobs included boda-boda riders, teachers, traders, builders, shopkeepers, and carpenters. Also, membership in community organizations was associated with a 75.4% likelihood of households having an acceptable caloric intake, more than for nonmembers. Most community organizations included burial and festival groups and village savings schemes.

In WASH, there was a 97.2% likelihood of having acceptable caloric intake among households with clean facilities such as latrines, bathrooms, tippy taps, kitchens, rubbish pits, and plate stands. Similarly, there was a 53.8% likelihood of having good diets among households who spent 30 or fewer minutes fetching water from primary

Table 1. Participation in LEPs and Household Dietary Diversity and Caloric Intake

LEPs, HDDS, and FCS Status	Household Dietary Diversity					Household Caloric Intake				
	Nonparticipants		LEPs Participants			Nonparticipants		LEPs Participants		
	f	%	*f*	%	χ^2	*f*	%	*f*	%	χ^2
Agronomy and Postharvest										
Good	95	40.4	105	47.9	0.102	79	33.6	114	52.1	<0.001
Average	135	57.4	113	51.6		111	47.2	79	36.1	
Poor	05	2.1	01	0.5		45	19.1	26	11.9	
Livestock Integration										
Good	105	37.5	95	54.6	<0.001	95	33.9	98	42.5	<0.001
Average	165	60.4	79	45.4		128	45.7	62	41.9	
Poor	06	2.1	—	—		57	20.4	14	15.6	
Nutrition and Infant Feeding										
Good	91	44.2	109	44.0	0.166	76	36.9	117	47.2	0.086
Average	110	53.4	138	55.6		94	45.6	96	38.7	
Poor	05	2.4	01	0.4		36	17.5	35	14.1	
Water and Public Health										
Good	91	44.6	109	43.6	0.150	76	37.3	117	46.8	0.117
Average	108	52.9	140	56.0		92	45.1	98	39.2	
Poor	05	2.5	01	0.4		36	17.6	35	14.0	
Complementary Services										
Good	77	45.0	123	43.5	0.760	67	39.2	126	44.5	0.535
Average	91	53.2	157	55.5		76	44.4	114	40.3	
Poor	03	1.8	03	1.1		28	16.4	43	15.2	
Community Income Generating Innovations										
Good	189	44.6	11	44.1	0.530	177	41.7	16	42.5	0.418
Average	229	54.0	19	54.6		179	42.2	11	41.9	
Poor	06	1.4	—	—		68	16.0	03	15.6	

water sources like boreholes used for cooking, drinking, irrigation, and animals. In production, keeping livestock was associated with a 24.9% likelihood of having acceptable caloric intake. Similarly, having at least four agricultural implements like hoes and pangas was associated with a 73.4% likelihood of having good diets. Likewise, households having 4 acres (1.6 hectares) of land or more had a 26.2% likelihood of having acceptable caloric intake.

Food Access/Dietary Diversity Pathway

Most foodstuffs were accessed through home or farmstead production, especially high-protein foods like beans and high-energy foods like maize. Market pathways through purchases were evident with animal products like milk and seafood like fish, as well as vegetables (Table 3).

Food Consumption Pattern Between Seasons of Plenty and Lean/Scarcity

Focus groups showed changes in food consumption patterns between seasons plenty and lean seasons (Table 4). In main staples, fresh sweet potatoes were most consumed; however, their consumption was switched for dried sweet potatoes in lean periods, and a similar pattern was observed in cassava consumption. Similarly, among pulses/ legumes, beans were most consumed in seasons of plenty and intermittently consumed in lean periods. In vegetables, leafy greens ranked high in seasons of plenty and also provided reliable food in lean periods. In seafood and meat, silver fish was consumed on average both in plenty and lean periods. Consumption of fish and meat was low in seasons of plenty and almost off the menu in lean seasons.

Table 2. Binary Logistic Regressions for Factors Influencing HDDS and FCS Statuses

	Model (1) for HDDS			Model (2) for FCS		
Model Variables/Factors	B	Sig.	Exp(B)	B	Sig.	Exp(B)
(Constant)	−2.504	0.005	0.082	−2.919	0.001	0.054
Spatial						
Subcounty	−0.405	0.047*	0.667	−0.250	0.245	0.779
Where the household head lives	1.203	0.052**	3.329	0.632	0.283	1.881
Demographics						
Household size	0.341	0.099**	1.406	0.507	0.020*	1.660
Gender	0.247	0.363	1.280	−0.151	0.590	0.860
Socioeconomic						
Education	−0.003	0.990	0.997	0.332	0.135	1.394
Main occupation	−0.478	0.058**	0.620	−0.717	0.007*	0.488
Membership to organizations	0.293	0.342	1.340	1.013	0.004*	2.754
WASH						
WASH cleanliness	0.336	0.107	1.399	0.679	0.002*	1.972
Time to collect water	0.431	0.041*	1.538	0.330	0.133	1.390
Production						
Keeps livestock	0.183	0.489	1.201	0.810	0.006*	2.249
Agricultural implements	0.550	0.009*	1.734	0.171	0.438	1.186
Food reserves	0.068	0.879	1.070	−0.584	0.204	0.558
Land access	0.153	0.620	1.166	0.816	0.021*	2.262
Micronutrient gardens	0.173	0.438	1.189	0.279	0.221	1.321

Model (1): Dietary diversity (0 = poor/average, 1 = good)
Model (2): Caloric intake (0 = poor/borderline, 1 = acceptable)
*Significance at p = 0.05; **Significance at p = 0.1

Food Insecurity Coping Strategies

In focus groups, mothers raised several coping strategies, mostly selling their labor to other community members for food or cash to buy food. All strategies are depicted in Figure 6, and lived experiences are also narrated.

The most used strategy was selling their labor either for cash or food, with narratives involving either the mothers and/or their husbands. One mother said, "I work in people's gardens during food scarcity periods to get some food to feed my family" (BUS1-4). Another mother also said, "My **husband** can go and work in people's sugarcane plantations so that he can get some money to buy food at home" (NAK2-2). While another mother said, "We work together with my husband so that we can get some money for buying food at home" (KAK1-6). Mothers also talked of working and rationing food: "For us, we work in the people's sugar cane plantations and when we get some money, we buy 4kgs of cassava flour to be eaten for four days to save the food" (KAB1-3), illustrating shifts from eating fresh cassava to processed cassava flour. With buying, one mother said, "My husband normally buys food at the shop, such as posho [maize meal]" (BUS1-1).

Using food reserves, specifically stores, a mother shared, "I store my dried food such as maize, cassava, and sweet potatoes. In food scarcity, we eat what I stored, and if the stored food gets finished, we start buying from the shops" (NAL1-3). On food reserves in the gardens**,** a mother narrated that "I normally reserve my cassava in the garden so that it can help me in the periods of food scarcity"; she added, "for us, we do not work in the people's gardens, we entirely eat our cassava during the periods of food scarcity since I have a big garden of cassava" (NAK2-6). Another mother added, "We also cope by eating cassava flour and dried potatoes since we reserve

Table 3. Percentage of Dietary Diversity Pathways by Food Groups

Foods groups	Foodstuffs	Farmstead pathways	Market pathways	Other pathways
Vegetables	Tomatoes	16.3	80.6	0.4
	Onions	9.9	86.6	—
	Eggplants	37.4	35.9	2.6
	Leafy amaranths	42.1	4.8	2.2
Proteins	Beans	79.7	9.5	2.8
	Milk	17.2	57.9	1.5
	Ground nuts	48.9	19.2	5.5
	Soybean	51.1	6.8	5
	Fish	—	49.3	—
	Eggs	22.2	18.7	0.7
	Beef	0.4	37.2	0.4
Energy-Starch	Maize	91.0	4.2	2.4
	Sweet potatoes	68.7	7.9	3.3
	Rice	13.2	59.0	2.4
	Cassava	47.6	11.2	4.6
	Matooke/plantain	33.7	15.2	0.9
	Pumpkins	41.6	2.2	3.7

See Appendix F for details.

them during plenty periods to wait for lean periods" (KIC2-3).

Regarding production strategies, one mother described "planting early maturing crops in the wetlands [swamps] because in most cases, the wetland is always wet, during drought periods, therefore in the food scarcity period we eat some potatoes we planted in the wetlands" (NAK2-8). Yet another mother added, "I go and work in the people's gardens so that they can give me some food, but in the case of vegetables, I grow my vegetables" (BUS2-2), demonstrating multiple strategies, especially with vegetables that can be grown on micronutrient gardens like keyhole and sack. On selling land, one mother said: "For us, if the situation worsens, we can sell a piece of land so that we get money to buy food instead of stealing people's food from their gardens" (NAK2-7). On friends, one mother said, "I cope by getting food from my friends, such as cassava, because my friends normally reserve some cassava in their gardens" (KYA2-1).

On fruit gathering, one mother said, "During lean periods, I tell my children to go and look for some fruit during the day, and then at supper, we can buy some food" (KYA1-2). Related to small businesses, one mother said, "During food scarcity seasons, since I have a small business, I use some profits to buy food for my family and sometimes I can borrow food [obtain on credit] at a different shop and pay later" (KAK1-1). This scenario illustrates social trust among small shop owners. On selling livestock, a mother said, "I am rearing pigs, goats, and chickens. If the situation worsens, I sell some livestock to buy food, but when the food is in plenty, I rarely sell livestock" (NAK2-9). Others reported relying on NEC porridge; a mother stated that "for me, I cope during food scarcity periods by getting the dense-nutrient porridge at the NEC" (KYA2-2).

Discussions and Conclusions

The discussions and conclusions are presented in four sections, including comparative dietary diversity and caloric intake statuses, dietary diversity pathways results from the 454 households surveyed, and changes in food consumption patterns and coping strategies during food scarcity periods from the 125 mothers involved in the 12 focus group discussions.

Household Dietary Diversity and Caloric Intake/Consumption

On average, all 454 households were within average dietary diversity and borderline caloric intake. These findings align with the results found in assessing food security status using the Household Food Insecurity Access Scale within this population, where, on average, households were found to be food insecure (Ikendi, Owusu et al., 2023a). These findings concur with researchers who validated that the three tools that measure food access using HDDS and FCS (Swindale & Bilinsky, 2006) and the Household Food Insecurity Access Scale (Coates et al., 2007) all yield similar results.

Nonetheless, there were improvements in food access from the baseline data of 2015, when HDDS reported 36.4% of households with good diets and FCS reported 38.2% with acceptable caloric intake. In 2019, in this study, HDDS reported 44.1% of households with good diets, and FCS reported 42.2% with acceptable caloric intake.

The CSRL/ISU-UP program households affiliated with the NECs and other program participants classified as non-NEC clients had better dietary and caloric intake scores than non-program participants. By participation in LEPs, households in the agronomy and postharvest programs were associated with good dietary scores. Similarly, acceptable caloric intake scores were associated with participation in agronomy and postharvest, livestock integration, and nutrition and infant feeding programs. Although not statistically significant, participants in water and public health services, complementary services such as nutrient-dense porridge, and income innovation better good dietary diversity and caloric intake than non-program participants.

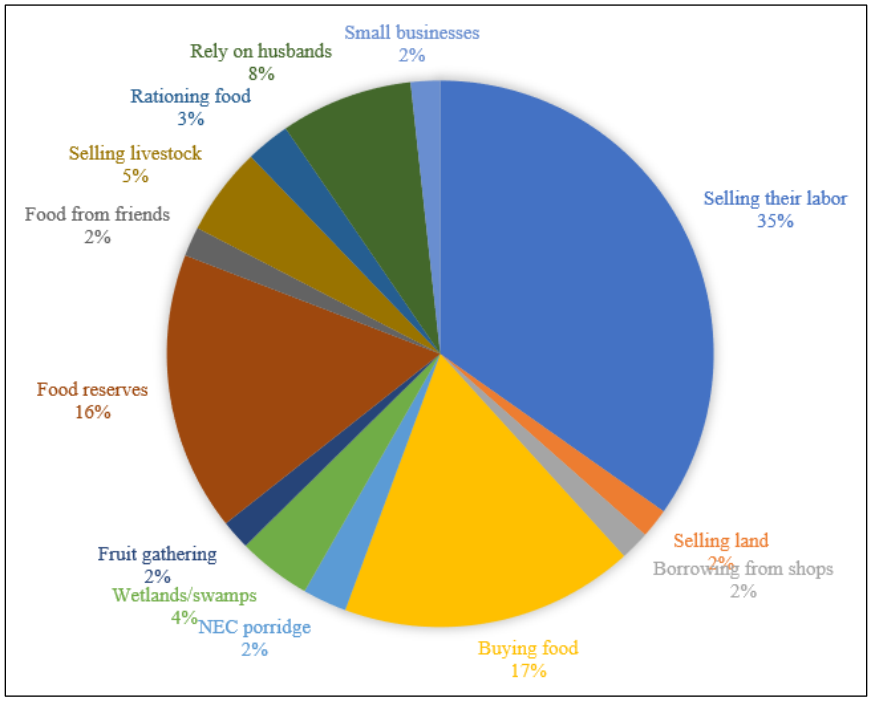
Participants in agronomy programs acquire knowledge on agronomical practices, based on scientific studies conducted within the programs on topics such as soil management (Akitwine, 2021; Anderson, 2023; Wokibula et al., 2024; Wokibula &

Table 4. Frequencies of Ranks in Changes in Food Consumption Patterns

	Ranking consumption in plenty					Ranking consumption in scarcity				
Foodstuffs by food groups	R5	R4	R3	R2	R1	R5	R4	R3	R2	R1
Main Staples										
Sweet potatoes	12	—	—	—	—	—	—	1	1	3
Dried potatoes	—	—	—	—	—	12	—	—	—	—
Posho	12	—	—	—	—	—	3	6	1	2
Rice	—	8	2	1	1	—	—	—	—	—
Fresh cassava	2	6	2	1	—	2	1	3	1	1
Cassava flour	—	—	—	—	—	11	—	—	—	—
Matooke	—	1	4	4	1	—	—	—	—	—
Pumpkin	—	1	1	—	—	—	—	—	—	1
Millet	—	—	—	—	6	—	2	1	5	—
Yams	—	—	—	1	1	—	—	—	—	2
Pulses/Legumes										
Beans	10	—	—	—	—	—	—	—	2	6
Ground nut	2	5	1	—	—	—	—	3	4	1
Soy bean	—	—	2	—	1	—	—	—	—	1
Sim-sim	—	—	1	1	2	—	—	—	1	1
Vegetables										
Leafy greens	11	—	—	—	—	2	5	4	—	—
Eggplants	2	2	—	—	—	1	2	2	—	1
Tomatoes	—	1	—	—	—	1	5	1	—	1
Cabbage	—	—	1	1	—	—	—	—	—	—
Irish potatoes	1	—	—	—	2	—	—	—	—	—
Seafood and Meat										
Silver fish	5	1	—	2	—	5	3	1	—	1
Fish	—	1	3	3	2	—	—	—	1	1
Meat	—	—	4	3	4	—	—	—	—	3
Chicken	—	—	—	—	3	—	—	—	—	—
Eggs	—	—	—	—	2	—	—	—	—	—

Note: R5 = most consumed and R1 = least consumed foodstuff.

Figure 6. Food Insecurity Coping Strategies



Westgate, 2016) and on high-yielding seeds and seed management, especially grain amaranth (Ainebyona et al., 2012; Muyonga et al., 2010), pumpkins (Kwikiiriza, 2022), and tomatoes (Tusiime et al., 2019; Tusiime et al., 2020). Participants also gain best practices, such as establishing micronutrient vegetable gardens like keyholes, sacks, and kitchen gardens to provide vegetables for household diets, including in schools supported by the program (Banige et al., 2024a, 2024b; Byaruhanga et al., 2017; Ikendi, 2022; Ikendi et al., 2024; Duerfeldt et al., 2016; Nonnecke et al., 2016). These micronutrient gardens have been a foundational food security strategy of the CSRL program from its inception in 2004 (Masinde & McMillan, 2015). Micronutrient vegetable gardens have been found to be associated with household food security (Ajal, 2025; Asante et al., 2024; Hansen et al., 2022; Ikendi, Owusu et al., 2023a). In postharvest programs, households get training and also receive storage facilities like silos and tarpaulins at subsidized prices to help with management of food reserves (Bbosa et al., 2017; 2020; Brumm et al., 2021; Ikendi et al., 2024; Mayanja et al., 2018; Tumutegyereize et al., 2022).

Similarly, households in livestock programs, in addition to knowledge, receive breeding animals such as piglets, local chickens, layer chickens, and water tanks to foster production, income, and consumption of animal-source proteins (Ikendi et al., 2025). Farmers engaged in egg production are required to pay back the loans in installments once their birds start laying. Goat farmers who receive breeders repay loans using the fees they charge in communities for breeding. Pig farmers are required to pass on two piglets to fellow farmers at first farrowing. Farmers who receive livestock water tanks cost-share with the program during construction. Livestock act as insurance to crop failure and are food security and poverty reduction pathways, especially among women farmers (Bain et al., 2020; Colverson et al., 2020; Kakungulu et al., 2025; Nagasha et al., 2024; Waiswa & Jolly, 2021).

Likewise, households who participated in nutrition and infant feeding programs are trained in best feeding practices from pregnancy, including exclusive breastfeeding and designing balanced diets for their households (Ikendi, Owusu, & Masinde, 2023; Masinde, McMillan et al., 2015; Winham et al., 2016). Clients receive theoretical and practical trained at the community-based NECs with cooking demonstrations. Such nutrition education programs support behavioral change towards food production and healthy feeding practices (Atim et al., 2024; Kansiime et al., 2021; Nakakawa et al., 2024).

Participants in water and public health receive training on WASH-related diseases and prevention through the construction and maintenance of these WASH facilities, such as latrines, which are key to household health (Auma et al., 2024; Ikendi, Masinde et al., 2025). Participants who receive complementary services such as therapeutic porridge are mainly at-risk-for-malnutrition mothers

and their children under rehabilitation (Ikendi, Owusu et al., 2023b). These clients also get family planning and immunization services with the help of government health center nurses, complementing its efforts in providing health services to needy communities (Namakula et al., 2021; Sharma et al., 2024). Likewise, participants in income innovations engage in craft-making activities like weaving baskets and making soap and bags, which are sold locally and internationally in the United States, helping to increase their income streams (Ikendi, Mwenyi et al., 2025; Martin, 2018). In sum, these findings partly speak to the significant role CSRL/ISU-UP LEPs have had on households by improving access to food.

Household Dietary Diversity/Food Access Pathways

Farmstead/home/own production and market/purchase were the two major dietary diversity pathways. Our findings concur with other studies, which also concluded that the home production pathway increases household dietary diversity (Morrissey et al., 2024; Sekabira et al., 2022; Waaswa et al., 2021; 2024). Wakaba et al. (2025) found similar results in Kenya, and added that market pathways, through sweet potato commercialization, improves dietary diversity. In the current neoliberal economy, where food is considered a commodity for sale (Bradley et al., 2023a; Canfield et al., 2021), farmstead pathways can counter the soaring food prices (Silva e Silva et al., 2024).

In earlier studies, we found low revenue from crops (Ikendi et al., 2024) and livestock (Ikendi et al., 2025) in this sample, and we can conclude that low sales have limitations on food access through market pathways, yet 79.3% of households relied on farming. Low purchasing power affects animal-source proteins, limiting their consumption, yet they have high dietary indices (Swindale & Bilinsky, 2006). Other aspects, like religion, also limit consumption of certain animal-source foods like pork among Muslims and Seventh-Day Adventists (den Hartog, 2024), who formed 21.4% of our study. Additionally, cultural beliefs among some groups in the study region prevent pregnant mothers from eating some species of fish, such as lungfish and mudfish (Tugume et al., 2024), reducing their dietary seafood options.

Dietary Patterns and Food Insecurity Coping Strategies

There were changes in consumption formats for similar foodstuffs, for instance, from consuming fresh sweet potatoes and cassava in the plentiful seasons to consuming dried potatoes and processed cassava flour in lean periods. Also, there were reductions in foodstuffs such as posho, beans, fish, and meat, and foods such as *matooke* (plantain) and rice eventually disappeared from the menu in lean periods. These aspects explain the low dietary diversity and caloric intake identified and the food insecurity within this population (Ikendi, Owusu et al., 2023a) and its neighbors (Kalinaki et al., 2025). Most foodstuffs in lean periods were accessed through purchases. Given the increasing prices with low incomes, it was difficult for households to cope with balanced diets. Moreover, the main coping strategy was selling labor and buying food, which all have implications for soaring food costs.

The other coping strategy was food storage, specifically food kept in store with limitations on recommended storage facilities in the area (Ikendi et al., 2024; Tibagonzeka et al., 2018). And having fresh food in gardens aligns with food crops like cassava and sweet potatoes, which also have a limited lifespan. Relying on husbands as a coping strategy demonstrates the importance of stable marriage in upholding their household and coalescing the families around food (Bradley et al., 2023b; Mohammed et al., 2023). Other strategies, like obtaining food on credit from shops and getting food from friends, demonstrate social capital, specifically cognitive bonding, which demonstrates trust and willingness to live together and help one another (Craig et al., 2025; Malual & Mazur, 2020; Neonbeni et al., 2025; Sseguya et al., 2018).

The production strategy was specifically mentioned by mothers who have access to land, especially wetland/swamps, to allow production in dry seasons. Whereas land access was key, we found that households had access to an average of 3.54 acres (1.43 hectares), with 13.4% accessing less than 4.0 acres (1.6 hectares). Also, the use of wet-

lands has had negative environmental implications, along with the destruction of forests in the study area (Thurow, 2024). Moreover, some mothers mentioned sending their children to gather fruits, though with reductions in forests, the hunter-gatherer strategy is less popular today than in the traditional heritage (Ikendi, 2023; Ingold et al., 2024). This scenario indicates the important role of promoting indigenous and wild edible trees as food security strategies (Okullo et al., 2022).

Similarly, sugarcane production has lured small landholders into modern-day land grabbing (Mwanika et al., 2021). This issue has escalated food insecurity, especially in Namasagali subcounty, which had low diversity scores and high food insecurity (Ikendi, Owusu et al., 2023a). Nevertheless, the promotion of micronutrient vegetable gardening has been key to supporting food production on limited land within program households and schools. Additionally, mothers mentioned using profits from their small businesses. Participants in income innovation programs earn income from making and selling crafts, soap, and sewing products like laptop bags (Ikendi, Mwenyi et al., 2025; Martin, 2018). Mothers use their income to set up small businesses like grocery shops, increasing their food access strategies, and households in income innovation were food secure (Ikendi, Owusu et al., 2023a).

Recommendations for Practice

The results of the study demonstrate the importance of LEPs in influencing food production and access. Since household training was associated with good diets and acceptable caloric intake, it is important that households engage in extension programs to access a blend of knowledge on food production through agronomy and livestock programs. Also, knowledge on nutrition and infant feeding can help support behavioral change toward design of recommended diets. Water and public health will support communities with an understanding of the role and importance of having WASH facilities. Improved cleanliness will reduce household predisposition to related diseases like diarrhea, which affects labor contribution to food production as members are bedridden.

Education opportunities through income innovations will enhance household income streams through women making various craft products using locally available materials and using the skills of their hand. Participating in complementary services, other than therapeutic porridge, reserved for at-risk-for-malnutrition mothers and children (Ikendi, Owusu et al., 2023b), such as immunizations, at NECs with the support of government nurses will help reduce the distances mothers have to travel to health facilities. This opportunity will in turn help them allocate more time to production activities. All education programs and innovations are designed based on scientific research conducted in the communities and blended with indigenous knowledge, making them effective in local communities to drive food security innovation (Davis et al., 2025).

Recommendations for Research

This study found changes in consumption patterns, especially from consuming fresh foods such as sweet potatoes and cassava in seasons of plenty to dried potatoes and cassava flour in seasons of scarcity. This finding implies a need to strengthen the development of postharvest management practices. The current practices have mainly focused on grain storage in the program, and there is a need to allocate research resources to postharvest management of starchy food. Moreover, the adoption of postharvest practices such as drying on tarpaulins and the use of silos was very low and significantly lower among non-trained households within this sample (Ikendi et al., 2024). Improper practices like drying on bare ground lead to food contamination, especially aflatoxins. The use of food reserves, especially food in household stores, was the third-ranked food insecurity coping strategy identified in the focus groups. Studies in Kamuli and other districts found that aflatoxin contamination in cassava was 60% and 35% in potatoes (Tibagonzeka et al., 2018), a factor associated with poor postharvest management. Moreover, potatoes and cassava are the foodstuffs fed to livestock within this sample (Ikendi et al., 2025). Research has shown that contaminated feeds, like poultry mash, has implications for the meat industry (Nakavuma et al., 2020).

The coping strategies that mothers provided demonstrate the unequal burden of finding food to

sustain their households. Strategies like selling labor more often involved women than men, and others, like use of profits from small businesses and obtaining food on credit and from friends, all focused on women. These revelations require additional investigation into men's roles in food insecurity coping strategies in Kamuli district. Studies conducted among both women and men, specifically with *matooke* (plantain), revealed divergencies in preferences such as tastes, connotation of food among women, and bunch and finger size, synonymous with sales for men (Mulugo et al., 2024). Additionally, the fact that *matooke* disappeared from the menu during lean periods, yet it is a staple food, requires further investigation into its production dynamics, as has been done in the central and western regions of Uganda to determine future production prospects (Tenywa et al., 2024). Scientific research (Acker et al., 2015; Ikendi, Mwenyi et al., 2025; Ikendi & Retallick, 2025) and indigenous knowledge (Masinde & McMillan, 2015) are the foundation for the CSRL/ISU-UP extension development to promote the adoption of innovations and create extension curricula to educate farmers on sustainable food production and nutrition technologies through the interrelated livelihoods education programs.

Recommendations for Policy

This study reiterates the important role that partners play in advancing the human capacity development of communities to improve food access through a public–private partnership. The CSRL/ISU-UP human development approach is synonymous with the call by the Office of the Prime Minister (2020) of Uganda to improve the structural functionality of the food and nutrition interventions through stakeholder collaboration. Government policies can support the continuity of public–private collaboration in supporting households through the development, implementation, and monitoring of food security interventions.

References

Acker, D. G., Musoke, H. K., & Sseguya, H. (2015). Capitalizing on impacts & CSRL's multiplier effects. In L. M. Butler & D. E. McMillan, (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 223–254). Kumarian Press.

Agole, D., Brennan, M. A., Baggett, C. D., Ewing, J. C., Crump, A., & Wacal, C. (2025). Determinants of food security status among young farmers with and without disabilities. *Advancements in Agricultural Development*, *6*(2), 1–13. https://doi.org/10.37433/aad.v6i2.567

Ahimbisibwe, S., Ikendi, S., Buyinza, T., Namata, M., Waaswa, A., & Kaaya, A. N. (2024, February 3–6). *Mitigating maize postharvest losses through participatory training in rural Uganda* [Poster presentation]. Southern Region of the American Association for Agriculture Education Conference, Atlanta, GA, USA. https://www.researchgate.net/publication/377965311

Ahmad, B., Badar, H., Gjølberg, O., & Mehdi, M. (2024). Price volatility and food security: Measurement and implications. In M. K. Bashir, G. S. Schilizzi, and G. Ali. (Eds), *Food security in the developing world* (pp. 165–189). John Wiley & Sons.

Ainebyona, R., Mugisha, J., Kwikiriza, N., Nakimbugwe, D., Masinde, D., & Nyankanga, R. O. (2012). Economic evaluation of grain amaranth production in Kamuli district, Uganda. *Journal of Agricultural Science and Technology A*, *2*(2), 178–190. https://www.researchgate.net/publication/319680122

Ajal, M. T. (2025). *Characterisation and production of kitchen gardens and their contribution to food security and livelihoods in Karamoja, northeastern Uganda* [Master's thesis, Swedish University of Agricultural Sciences]. Epsilon Archive for Student Projects. http://urn.kb.se/resolve?urn=urn:nbn:se:slu:epsilon-s-21091

Akitwine, F. (2021). *Pedology of typical soils of Kamuli District and pedotransfer functions to predict cation exchange capacity in limited-resource settings* [Master's thesis, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://doi.org/10.31274/td-20240329-574

Akumu, G., Ogenrwoth, B., Mugisha, J., & Muyonga, J. H. (2023). Dietary patterns in Uganda and their influencing factors: A critical review. *African Journal of Food, Agriculture, Nutrition and Development*, *23*(2), 22328–22353. https://doi.org/10.18697/ajfand.117.22345

Almoraie, N. M., Alothmani, N. M., Alomari, W. D., & Al-Amoudi, A. H. (2024). Addressing nutritional issues and eating behaviours among university students: A narrative review. *Nutrition Research Reviews, 38*(1), 53–68. https://doi.org/10.1017/S0954422424000088

Anderson, A. (2023). *Pedology as a scientific, teachable, and artistic discipline in the 21st century* [Doctoral dissertation, Iowa State University]. Iowa State University Digital Repository. https://dr.lib.iastate.edu/handle/20.500.12876/3wxae0ov

Asad, S. J. S., Anshari, A., & Mulabbi, A. (2024). Agrarian conflicts across Ugandan societies: A complex struggle. *Jurnal Kajian Agraria Dan Kedaulatan Pangan (JKAKP)*, *3*(2), 68–76. https://doi.org/10.32734/jkakp.v3i2.18938

Asante, I. S., Aidoo, M., Prah, S., Hagan, M. A. S., & Sackey, C. K. (2024). Achieving food security: Household perception and adoption of home gardening techniques in Ghana. *Journal of Agriculture and Food Research*, *18*, Article 101329. https://doi.org/10.1016/j.jafr.2024.101329

Asimo, E., Kigozi, J., Kambugu, K. R., Brumm, T., Ikendi, S., & Somers., R. M. (2024, April 22–25). *Design, construction, fabrication, and testing of an indirect heated biomass grain dryer appropriate for low income farmers* [Conference presentation]. Association for International Agricultural and Extension Education Annual Conference: Looking back, focusing forward, Orlando, FL, USA. https://www.researchgate.net/publication/381109443

Atim, E., Atukwase, A., & Kabahenda, M. (2024). Complementary feeding and food handling practices among caregivers in a semi-urban setting in Northern Uganda. *African Health Sciences*, *24*(3), 322–332. https://doi.org/10.4314/ahs.v24i3.36

Auma, B., Musinguzi, M., Ojuka, E., Kigongo, E., Tumwesigye, R., Acup, W., Kabunga, A., & Opio, B. (2024). Prevalence of diarrhea and water sanitation and hygiene (WASH) associated factors among children under five years in Lira City Northern Uganda: Community based study. *PLoS One*, *19*(6), Article e0305054. https://doi.org/10.1371/journal.pone.0305054

Bain, C., Ransom, E., & Halimatusa'diyah, I. (2020). Dairy livestock interventions for food security in Uganda: What are the implications for women's empowerment? *Rural Sociology*, *85*(4), 991–1020. https://doi.org/10.1111/ruso.12332

Banige, D., Ikendi, S., Somers, R., Asimo, A. E., Kitayimbwa, R., & Kabbale, F. (2024a, February 3–6). *Approaches educators use to implement school-based agricultural education in Uganda* [Conference paper]. Southern Region of the American Association for Agriculture Education Conference, Atlanta, GA, USA. https://www.researchgate.net/publication/377965521

Banige, D., Ikendi, S., Somers, R. M., Asimo, A. E., Kitayimbwa, R., & Kabbale, F. (2024b, February 3–6). *Contributions of SBAE to scholarship of agriculture education and lifelong learning* [Conference paper]. Southern Region of the American Association for Agriculture Education Conference, Atlanta, GA, USA. https://www.researchgate.net/publication/377965541

Barak, F., Efitre, J., Odong, R., & Melgar-Quiñonez, H. (2023). Women's agency in nutrition in the association between women's empowerment in agriculture and food security: A case study from Uganda. *World Food Policy*, *9*(2), 228–249. https://doi.org/10.1002/wfp2.12063

Barlow, P., Loopstra, R., Tarasuk, V., & Reeves, A. (2020). Liberal trade policy and food insecurity across the income distribution: An observational analysis in 132 countries, 2014-17. *The Lancet Global Health*, *8*(8), e1090–e1097. https://doi.org/10.1016/S2214-109X(20)30263-1

Bbosa, D., Brumm, T. J., Bern, C. J., Rosentrater, K. A., & Raman, D. R. (2017). Evaluation of hermetic maize storage in 208 liter (55 gal) steel barrels for smallholder farmers. *Transactions of the ASABE*, *60*(3), 981–987. https://doi.org/10.13031/trans.12044

Bbosa, D., Brumm, T. J., Bern, C. J., Rosentrater, K. A., & Raman, D. R. (2020). Effect of blending amaranth grain with maize kernels on maize weevil control during storage. *Transactions of the ASABE*, *63*(2), 401–406. https://doi.org/10.13031/trans.13614

Bhangyi, V. B., & Rømer, M. (2025). Political contestations, human rights violations and the human victims in Uganda: A call for social work actions through indigenous pathways. *Journal of Comparative Social Work*, *20*(1), 271–298. https://doi.org/10.31265/jcsw.v20i1.726

Blüher, M. (2025). An overview of obesity-related complications: The epidemiological evidence linking body weight and other markers of obesity to adverse health outcomes. *Diabetes, Obesity and Metabolism, 27*, 3–19. https://doi.org/10.1111/dom.16263

Bradley, M., Ikendi, S., Rongerude, J., & Haddad, M. (2023a, May 15−18). *Food as a commodity: Network analysis and the Des Moines community* (pp. 512−515) [Conference paper]. American Association for Agricultural Education National Conference. Raleigh, NC. USA. https://www.researchgate.net/publication/371255474

Bradley, M., Ikendi, S., Rongerude, J., & Haddad, M. A. (2023b, May 15−18). *Food as lived experience: A photovoice with high school students* (pp. 516−519) [Conference paper]. American Association for Agricultural Education National Conference. Raleigh, NC. USA. https://www.researchgate.net/publication/371255477

Brinkmann, S. (2022). *Qualitative interviewing: Conversational knowledge through research interviews*. Oxford University Press.

Brumm, T. J., Bern, C. J., & Webber, D. F. (2021). Hermetic storage of maize grain in repurposed food oil containers to control maize weevils. *Journal of Stored Products and Postharvest Research*, *12*(2), 42−46. https://academicjournals.org/journal/JSPPR/article-full-text-pdf/CAD3B6B67690.pdf

Butler, L., & Acker, D. (2015). Epilogue: The partnership today and looking towards the future. In L. M. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 255−268). Kumarian Press.

Byaruhanga, L. A., Masinde, D., Nonnecke, G. R., Lutwama, D., Kimiywe, J., & Nyangaresi, D. M. (2017). Effect of school garden food production on nutrient adequacy of school meals for children attending Namasagali primary school in rural Kamuli district, Uganda. *International Journal of Food Science and Nutrition*, *2*(4), 114−118. https://www.foodsciencejournal.com/assets/archives/2017/vol2issue4/2-4-37-948.pdf

Canfield, M., Anderson, M. D., & McMichael, P. (2021). UN Food Systems Summit 2021: Dismantling democracy and resetting corporate control of food systems. *Frontiers in Sustainable Food Systems*, *5*, Article 661552. https://doi.org/10.3389/fsufs.2021.661552

Cavalcanti, D. M., de Sales, L. D. O. F., da Silva, A. F., Basterra, E. L., Pena, D., Monti, C., Barreix, G., Silva, N. J., Vaz, P., Saute, F., Fanjul, G., Bassat, Q., Naniche, D., Macinko, J., & Rasella, D. (2025). Evaluating the impact of two decades of USAID interventions and projecting the effects of defunding on mortality up to 2030: A retrospective impact evaluation and forecasting analysis. *The Lancet*, *406*(10500), 283–294. https://doi.org/10.1016/S0140-6736(25)01186-9

Ceballos, F., Hazell, P. B., Hill, R. V., & Kramer, B. (2025). Agricultural insurance: Policies and programs for reducing farmer risk. In J. Swinnen and C. B. Barrett (Eds.), *Food policy: Lessons and priorities for a changing world* (pp. 245−264). IFPRI. https://hdl.handle.net/10568/174303

Coates, J., Swindale, A., & Bilinsky, P. (2007). *Household food insecurity access scale (HFIAS) for measurement of food access: Indicator guide (Version 3)*. USAID & FANTA III FHI 360. https://www.fantaproject.org/sites/default/files/resources/HFIAS_ENG_v3_Aug07.pdf

Colverson, K. E., Coble-Harris, L., Galie, A., Moore, E. V., Munoz, O., McKune, S. L., Singh, N., & Mo, R. (2020). Evolution of a gender tool: WEAI, WELI and livestock research. *Global Food Security*, *26*, Article 100375. https://doi.org/10.1016/j.gfs.2020.100375

Craig, A., Hutton, C., Musa, F. B., & Sheffield, J. (2025). Social capital for improved food security in Southern Malawi: Gender dynamics and changes over time. *Food Science and Nutrition Cases*, Article fsncases20250005. https://doi.org/10.1079/fsncases.2025.0005

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Sage.

Davis, K. E., Gandhi, R., Koo, J., Kramer, B., Miller, A., Repishti, J., Spielman, D. J., & Sulaiman V, R. (2025). Agricultural extension services: From transfer of technology to facilitation for innovation. In J. Swinnen and C. B. Barrett (Eds.), *Food policy: Lessons and priorities for a changing world* (pp. 195−220). IFPRI. https://hdl.handle.net/10568/174301

den Hartog, A. P. (2024). *What is edible? A journey through the world of food taboos and food cultures*. Brill.

Duerfeldt, K., Tusiime, S., & Nonnecke, G. (2016). Impact of sack gardening by youth in a Ugandan school garden program. *Horticultural Science*, *51*(9), S371−S372. https://doi.org/10.21273/HORTSCI.51.9S.S1

El Bilali, H., & Ben Hassen, T. (2024). Disrupted harvests: How Ukraine–Russia war influences global food systems – A systematic review. *Policy Studies*, *45*(3–4), 310–335. https://doi.org/10.1080/01442872.2024.2329587

Food and Agriculture Organization of the United Nations [FAO], International Fund for Agricultural Development [IFAD], & World Food Programme [WFP]. (2013). *The state of food insecurity in the world 2013: The multiple dimensions of food security*. https://www.fao.org/3/i3434e/i3434e.pdf

FAO, IFAD, United Nations Children's Fund, WFP, & World Health Organization [WHO]. (2024). *The state of food security and nutrition in the world 2024: Financing to end hunger, food insecurity and malnutrition in all its forms*. https://doi.org/10.4060/cd1254en

FAO, IFAD, United Nations Children's Fund, WFP, & WHO. (2025). *The state of food security and nutrition in the World 2025 – Addressing high food price inflation for food security and nutrition*. https://doi.org/10.4060/cd6008en

Gahamanyi, T. N., & Tchouassi, G. (2025). Is food security impacted by price dynamics? Proof from African nations. *Journal of Agriculture and Food Research*, *22*, Article 102063. https://doi.org/10.1016/j.jafr.2025.102063

Gilligan, D. O., Ahmed, A., Alderman, H., de Brauw, A., Hidrobo, M., Hirvonen, K., Hoddinott, J., Leight, J., Roy, S., & Taffesse, A. S. (2025). Social protection programs: Building the evidence (pp. 267–292). In J. Swinnen & C. B. Barrett (Eds.), *Food policy: Lessons and priorities for a changing world.* IFPRI. https://hdl.handle.net/10568/174304

Hansen, L.-S., Sorgho, R., Mank, I., Schwerdtle, P. N., Agure, E., Bärnighausen, T., & Danquah, I. (2022). Home gardening in sub-Saharan Africa: A scoping review on practices and nutrition outcomes in rural Burkina Faso and Kenya. *Food and Energy Security*, *11*(3), Article e388. https://doi.org/10.1002/fes3.388

Ikendi, S. (2019). *Impact of nutrition education centers on food and nutrition security in Kamuli District, Uganda* [Masters' thesis, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://dr.lib.iastate.edu/handle/20.500.12876/31215

Ikendi, S. (2022, May 16–19). *Developing school-based agriculture education through school gardens* [Poster abstract]. American Association for Agricultural Education National Conference, Oklahoma City, OK, USA. https://www.researchgate.net/publication/371255879

Ikendi, S. (2023). Ecological conservation, biodiversity, and agricultural education as integrated approaches for envisioning the future of sustainable agriculture in North America. *International Journal of Sustainable Development & World Ecology*, *30*(2), 152–163. https://doi.org/10.1080/13504509.2022.2127032

Ikendi, S., Masinde, D., & Owusu, F. (2025). Toward sustainable community health through participatory water and public health education programs in Southeastern Uganda. *International Journal of Health Sciences and Research 15*(9), 284–304. https://doi.org/10.52403/ijhsr.20250931

Ikendi, S., Mwenyi, R. M., & Retallick, M. S. (2025). Love for humanity and universal goodwill: Reflections on philanthropy through theory of change and the United States Land grant values in Uganda. *International Journal of Agriculture Extension and Social Development, 8*(9, Part E), 322–336. https://doi.org/10.33545/26180723.2025.v8.i9e.2422

Ikendi, S., Owusu, F., & Masinde, D. (2023, May 15–18). Community education for behavioral change towards food and nutrition security (pp. 395–398) [Conference paper]. American Association for Agricultural Education National Conference, Raleigh, North Carolina, USA. https://www.researchgate.net/publication/371255846

Ikendi, S., Owusu, F., Masinde, D., Oberhauser, A., & Bain, C. (2023a). Does participation in livelihood education programs impact household food security? A comparative study in rural Uganda. *Journal of Agriculture, Food Systems, and Community Development*, *13*(1), 235–265. https://doi.org/10.5304/jafscd.2023.131.009

Ikendi, S., Owusu, F., Masinde, D., Oberhauser, A., & Bain, C. (2023b). Nutrition education centers: A community-based approach to management of malnutrition. *Journal of Agriculture, Food Systems, and Community Development*, *13*(1), 9–15. https://doi.org/10.5304/jafscd.2023.131.010

Ikendi, S., Owusu, F., Masinde, D., Oberhauser, A. M., & Bain, C. M. (2023c, September 18–20). *Towards nutrition security among mothers and children through livelihood programs* [Poster presentation]. Western Region of the American Association for Agricultural Education Conference: The crossroads of food, agriculture and innovation, Logan, UT, USA. https://www.researchgate.net/publication/374153419

Ikendi, S., Owusu, F., Masinde, D., Oberhauser, A., & Bain, C. (2024). Assessment of agronomy, agroforestry, orchards, grain storage, and postharvest education programs on empowerment of farmers in rural Uganda. *Journal of Agricultural Education*, *65*(1), 99–125. https://doi.org/10.5032/jae.v65i1.98

Ikendi, S., Owusu, F., Masinde, D., Oberhauser, A., & Bain, C. (2025). Livestock extension education: A livelihoods revitalization strategy in rural Uganda. *Journal of Agricultural Education*, *66*(1), Article 50. https://doi.org/10.5032/jae.v66i1.2465

Ikendi, S., & Retallick, M. S. (2025). Strategic leadership and management of multistakeholder organizations. *Journal of Agricultural Education*, *66*(2), Article 9. https://doi.org/10.5032/jae.v66i2.88

Ikendi, S., Retallick, M. S., & Nonnecke, G. R. (2023, May/June). Implementing global service-learning through school gardens. *The Agriculture Education Magazine*, *95*(6), 25–28. https://www.researchgate.net/publication/371256189

Ikendi, S., Retallick, M. S., Nonnecke, G. R., & Kugonza, D. R. (2023). Influence of school garden learning approach on academic development of global service-learners. *Journal of Agricultural Education, 64*(4), 159–179. https://doi.org/10.5032/jae.v64i4.167

Ingold, T., Riches, D., & Woodburn, J. (Eds.). (2024). *Hunters and gatherers: History, evolution and social change*. Taylor & Francis.

Kakati, B. K. (2025). Livelihood challenges in closed tea estates: A case study of Jalpaiguri district of West Bengal, India. *Local Development & Society*. Advance online publication. https://doi.org/10.1080/26883597.2025.2499451

Kakungulu, B., Mwenyi, R. M., Ikendi, S., Natwijuka, M., Arinda, A., Muhe, L., Namirembe, F., & Ahabwe, A. (2025, May 19–22). *Harnessing gender roles in the dairy value chain to improve its productivity in the Southwestern milkshed of Uganda* (pp. 463–466) [Poster proceedings]. American Association for Agriculture Education National Conference: Amplifying our impact through unique voices in agriculture duction, communication, leadership, and extension, Lubbock, TX, USA. https://www.researchgate.net/publication/391491962

Kalinaki, H., Martianto, D., & Riyadi, H. (2025). Food security and its determinants among rural households: A case study in Buwenge eastern Uganda. *BIO Web Conferences*, *171*, Article 03003. https://doi.org/10.1051/bioconf/202517103003

Kamugisha, F., Komakech, H., Kisakye, A. N., & Bukenya, J. (2024). Prevalence of food insecurity and associated factors among refugee households in Rhino Camp Refugee Settlement, Arua District, Uganda. *Journal of Interventional Epidemiology and Public Health*, *7*, Article 12. https://www.doi.org/10.37432/jieph.2024.7.1.103

Kangogo, E., Otieno, D. J., Okello, J., Mwenye, O., & Kapalasa, E. (2024). Impact of farmer training on potato yield: A case of smallholder potato farmers in Malawi. *Frontiers in Sustainable Food Systems*, *8*, Article 1496064. https://doi.org/10.3389/fsufs.2024.1496064

Kansiime, E., Kabahenda, M. K., & Bonsi, E. A. (2021). Improving caregivers' infant and young child-feeding practices using a three-group food guide: A randomized intervention study in central Uganda. *African Journal of Food, Agriculture, Nutrition and Development* , *21*(4), 17834–17853. https://doi.org/10.18697/ajfand.99.20240

Kemigisha, P. (2025). Navigating the gender dynamics of food and nutrition security in southwestern Uganda. *Academia Nutrition and Dietetics*, *2*(1), Article 7645. https://doi.org/10.20935/AcadNutr7645

Kempango, L., Nedala, S., Ikendi, S., Nehren, U., & Nakileza, B. (2024, April 22–25). Harnessing the use of nature-based solutions for landslide risk mitigation in the Mount Elgon region of Uganda [Conference presentation]. Association for International Agricultural and Extension Education Annual Conference: Looking back, focusing forward, Orlando, FL, USA. https://www.researchgate.net/publication/381125168

Kironde, C., Ikendi, S., Lwasa, S., Isoto, R., & Somers, R. (2024, April 22–25). *Consumer awareness of and willingness to pay for traceable honey in Central Uganda* (pp. 622–626) [Conference paper]. Association for International Agricultural and Extension Education Annual Conference: Looking back, focusing forward, Orlando, FL, USA. https://www.researchgate.net/publication/381229316

Kugonza, D. R., Stalder, K. J., & Rothschild, M. F. (2014). Effects of buck and doe size on the growth performance and survival of their progeny. *Livestock Research for Rural Development*, *26*(3), Article 47. http://www.lrrd.org/lrrd26/3/kugo26047.html

Kwikiiriza, S. (2022). *Evaluation of horticultural practices for tropical squash production and marketing among smallholder youth farmers in Kamuli, Uganda* [Master's thesis, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://doi.org/10.31274/td-20240329-303

Kwikiriza, W., Nuwagaba, J., & Byabashaija, D. (2023). Root causes of violent ethnic conflicts and prevention measures in Rwenzori region in Western Uganda. *Scholars Journal of Arts, Humanities and Social Sciences*, *10*, 287–294. https://saspublishers.com/article/18604/

Lanou, A. J., Mathews, L. G., Speer, J., Mills, L, & Gold-Leighton, N. (2021). Effects of experiential food education on local food purchasing and eating behavior. *Journal of Agriculture, Food Systems, and Community Development*, *10*(4), 211–224. https://doi.org/10.5304/jafscd.2021.104.006

Leech, L. N., Barret. K. C., & Morgan, G. A. (2007). *SPSS for intermediate statistics: Use and interpretation*. Routledge.

Lemon, L. L., & Hayes, J. (2020). Enhancing trustworthiness of qualitative findings: Using Leximancer for qualitative data analysis triangulation. *The Qualitative Report*, *25*(3), 604–614. https://nsuworks.nova.edu/tqr/vol25/iss3/3

Leon-Himmelstine, C., Phiona, S., Löwe, A., Plank, G., & Vu, N. (2021). *Young women in the agricultural sector in Uganda: Lessons from the Youth Forward initiative* [Report]. ODI. https://odi.cdn.ngo/media/documents/ODI-YFLP-GenderAgriculture-Report-FINAL-14.05.2021_C6kOx3x.pdf

Li, C., Camac, J., Robinson, A., & Kompas, T. (2025). Predicting changes in agricultural yields under climate change scenarios and their implications for global food security. *Scientific Reports*, *15*, Article 2858. https://doi.org/10.1038/s41598-025-87047-y

Mabkhot, H., & Piaralal, S. K. (2024). Consumer knowledge of food security affects hygiene practices: Mediated by safety concerns and storage. *Future of Food: Journal on Food, Agriculture and Society*, *12*(2), 64–80. https://doi.org/10.5281/zenodo.15041518

Malual, J. D., & Mazur, R. E. (2020). Social capital and food security in post-conflict rural Lira District, northern Uganda. *Disasters*, *46*(1), 80–94. https://doi.org/10.1111/disa.12465

Martin, T. (2018). Individual capacities (human capital) of the Tusubila crafts group[Master's Thesis, Iowa State University]. Iowa State University Digital Repository, Creative Components. https://lib.dr.iastate.edu/creativecomponents/85

Masinde, D., & McMillan, D. E. (2015). Starting where the people are. In L. M. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 111–144). Kumarian Press.

Masinde, D., Butler, M. L., & Mazur, R. (2015). Getting started. In L. M. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 57–81). Kumarian Press.

Masinde, D., McMillan, E. D., Rothschild, M., & Nonnecke, G. (2015). Leaving the door open to emerging needs and opportunities. In L. M. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 145–164). Kumarian Press.

Mayanja, I. K., & Oluk, I. (2023). Intermediate technologies: The key to eradicating post-harvest losses (PHLs) in Sub-Saharan Africa (SSA). *Journal of Advances in Food Science & Technology*, *10*(4), 64–74. https://doi.org/10.56557/jafsat/2023/v10i48419

Mayanja, I. K., Kigozi, J., Brumm, T., & Kawongolo, J. (2018). Design, fabrication, and testing of a pedal-operated maize grain cleaner. *Journal of Advances in Food Science & Technology*, *5*(3), 105–111. https://ikprress.org/index.php/JAFSAT/article/view/4321

Menard, S. (2000). Coefficients of determination for multiple logistic regression analysis. *The American Statistician*, *54*(1), 17–24. https://doi.org/10.1080/00031305.2000.10474502

Mihas, P. (2021). Memo writing strategies: Analyzing the parts and the whole. In C. Vanover, P. Mihas, & J. Saldaña (Eds.), *Analyzing and interpreting qualitative research: After the interview* (pp. 243–258). Sage.

Mohammed, K., Batung, E., Kansanga, M., Nyantakyi-Frimpong, H., & Luginaah, I. (2023). Does joint agricultural decision-making improve food security among smallholder farmers? *African Geographical Review*, *42*(3), 391–410. https://doi.org/10.1080/19376812.2022.2063140

Morrissey, K., Reynolds, T., Tobin, D., & Isbell, C. (2024). Market engagement, crop diversity, dietary diversity, and food security: Evidence from small-scale agricultural households in Uganda. *Food Security*, *16*, 133–147. https://doi.org/10.1007/s12571-023-01411-2

Mukoda, M., Ikendi, S., Mwenyi, R. M., & Semyalo, J. (2025, May 19–22). *Toward gender inclusivity in tomato variety selection and production chain in Uganda* (pp. 620–623) [Poster presentation]. American Association for Agriculture Education National Conference: Amplifying our impact through unique voices in agriculture duction, communication, leadership, and extension, Lubbock, TX, USA. https://www.researchgate.net/publication/391635611

Mulabbi, A., Esagu, J. C., Akello, G., & Turyahabwe, R. (2025). Flood inundation and damage assessment of the degraded Semliki River plains using SAR data, Google Earth Engine, and GIS techniques. *Journal of Degraded and Mining Lands Management*, *12*(4), 8379–8390. https://doi.org/10.15243/jdmlm.2025.124.8379

Mulema, J., Nankinga, C., Kagorora, J. P. K., Tusiime, G., Amayo, R., Chemonges, M., Gumisiriya, C., Kato, F., Kigongo, B. M., Kutunga, D., Mudde, B., Muhumuza, J. B., Mukasa, Y., Musiimenta, Muzira, F., Namas, E., J., Ramathan, I., Sebutare, G., Ssamula, A., … & Ochwo-Ssemakula, M. (2025). Prioritising non-native pest species to inform plant health biosecurity policy decisions and to safeguard agriculture, forestry, biodiversity, and livelihoods in Uganda. *Frontiers in Agronomy*, *7*, Article 1601845. https://doi.org/10.3389/fagro.2025.1601845

Mulugo, L., Kyazze, F. B., Kibwika, P., Ngolobe, E., Bonaventure, A. O., & Kikulwe, E. M. (2024). Gender differentiated utilization of banana as food, medicine and cultural artefact in central Uganda. *NJAS: Impact in Agricultural and Life Sciences*, *96*(1), Article 2384360. https://doi.org/10.1080/27685241.2024.2384360

Muyonga, J. H., Ugen, M., Bisikwa, J., Nakimbugwe, D., Masinde, D., Bbemba, J., & Wambete, J. (2010). *Promoting production and utilization of grain amaranth for improved nutrition and health in Uganda*. *Annual progress report*. McKnight Foundation.

Mwanika, K., State, A. E., Atekyereza, P., & Österberg, T. (2021). Colonial legacies and contemporary commercial farming outcomes: Sugarcane in Eastern Uganda. *Third World Quarterly*, *42*(5), 1014–1032. https://doi.org/10.1080/01436597.2020.1783999

Nabwiire, L., Shaw, A., Nonnecke, G., Talbert, J., Muyanja, C., Boylston, T., Tarté, R., & Prusa, K. (2023). Compliance with food safety standards by beef vendors at butcheries in Kamuli district, Uganda. *African Journal of Food Science*, *17*(9), 192–206. https://academicjournals.org/journal/AJFS/article-full-text-pdf/322527071169

Nagasha, J. I., Ocaido, M., Rajala, E., Hatab, A. A., & Chiwona-Karltun, L., (2024). Gender-based approaches for improving milk safety, value addition, and marketing among smallholder livestock farmers. *Frontiers in Sustainable Food Systems*, *8*, Article 13920. https://doi.org/10.3389/fsufs.2024.1392020

Nahalomo, A., Iversen, P. O., Andreassen, B. A., Kaaya, A., Rukooko, A. B., & Rukundo, P. M. (2023). Food insecurity, dietary diversity and the right to adequate food among households in landslide-prone communities in Eastern Uganda: A cohort study. *PLoS One*, *18*(4), Article e0283078. https://doi.org/10.1371/journal.pone.0283078

Nakakawa, F., Mugisha, J., Kaaya, A. N., Tumwesigye, N. M., & Hennessey, M. (2024). Nutrition education effects on food and nutrition security for women living with HIV/AIDS in Uganda. *Food Policy*, *128*, Article 102715. https://doi.org/10.1016/j.foodpol.2024.102715

Nakavuma, J. L., Kirabo, A., Bogere, P., Nabulime, M. M., Kaaya, A. N., & Gnonlonfin, B. (2020). Awareness of mycotoxins and occurrence of aflatoxins in poultry feeds and feed ingredients in selected regions of Uganda. *International Journal of Food Contamination*, *7*, Article 1. https://doi.org/10.1186/s40550-020-00079-2

Namakula, J., Fustukian, S., McPake, B., & Ssengooba, F. (2021). "They say we are money minded": Exploring experiences of formal private for-profit health providers towards contribution to pro-poor access in post conflict Northern Uganda. *Global Health Action*, *14*(1), Article 1890929. https://doi.org/10.1080/16549716.2021.1890929

Namata, M., Mwenyi, R. M., Ikendi, S., Ahimbisibwe, S., Waaswa, A., & Tatwangire, A. (2024, May 20–23). *Market segmentation and performance of ginger retail traders in Kampala, Uganda* (pp. 462–465) [Poster proceedings]. American Association for Agriculture Education National Conference: Somewhere over the rainbow, Manhattan, KS, USA. https://www.researchgate.net/publication/380668465

Nameere-Kivunike, F., Gamukama, E. A., Nakatumba-Nabende, J., Mutembesa, D., Tusubira, J. F., Nsumba, S., Omongo, C. A., & Namanya, G. (2023). Assessing the contribution of the Adhoc crop health surveillance tool on the food security and livelihoods of smallholder farmers in Uganda. *The Electronic Journal of Information Systems in Developing Countries*, *89*(3), Article e12249. https://doi.org/10.1002/isd2.12249

Nanfuka, E. K., Luwangula, R., Ssenfuuma, J. T., Tibengana, S. B., Canocakacon, J., Ndagire, M., Irumba, J., Kahuma, J.-B., & Walakira, E. J. (2025). "They steal our food": Food insecurity as a barrier to social cohesion between refugee and host communities in Uganda. *Social Sciences*, *14*(2), 116. https://doi.org/10.3390/socsci14020116

Natarajan, N., Newsham, A., Rigg, J., & Suhardiman, D. (2022). A sustainable livelihoods framework for the 21st century. *World Development*, *155*, Article 105898. https://doi.org/10.1016/j.worlddev.2022.105898

National Agriculture Advisory Services. (2024, May). Government rallies farmers to embrace high value crops. *NAADS Newsletter, 6*. https://drive.google.com/file/d/1ptll0jZUDJvfGgpbsqOYbfMlJGdstBXj/view

Nedala, S., Mugagga, F., Nakileza, B., Opedes, H., Ikendi, S., & Kempango, L. (2025, May 19–22). *A suitability assessment of the best eco-engineering agroforestry tree species for landslide control in Mt. Elgon Region of Uganda* (pp. 301–304) [Poster proceedings]. American Association for Agriculture Education National Conference: Amplifying our impact through unique voices in agriculture duction, communication, leadership, and extension, Lubbock, TX, USA. https://www.researchgate.net/publication/391744496

Nedala, S., Puja, S., Kempango, L., & Ikendi, S. (2025). Assessing flood susceptibility and effectiveness of structural flood mitigation measures applied within Mubuku catchment in Rwenzori Region, Uganda. *Natural Hazards*, *121*(2), 1375–1397. https://doi.org/10.1007/s11069-024-06843-3

Neonbeni, R. V., Karjoko, L., & Suwadi, P. (2025). Community participation in resolving boundary disputes between villages. *Journal of Hunan University Natural Sciences*, *52*(4), 21–35. https://doi.org/10.55463/issn.1674-2974.52.4.3

Nonnecke, G., Masinde, D., Byaruhanga, L., Lutwama, D., & Acker, D. (2016). Using school gardens to support school feeding programs at elementary Schools in Uganda [Poster presentation]. *HortScience*, *51*(9S), S370. https://doi.org/10.21273/HORTSCI.51.9S.S1

Nonnecke, G., McMillan, D. E., Kugonza, D., & Masinde, D. (2015). Leaving the doors open to new beneficiaries. In L. M. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 165−189). Kumarian Press.

Nyarko, D. A., & Masambuka-Kanchewa, F. (2025, April 14–17). *Exploring factors influencing Ugandan youths' engagement in agricultural careers: A case study of Kamuli district in Uganda* (pp. 38–40) [Poster proceedings]. Association for International Agricultural and Extension Education Annual Conference: From the highlands to the islands: Bridging community Learning and development through extension, Inverness, Scotland.

Office of the Prime Minister (2020). *Uganda nutrition action plan II (2020/21–2024/25)*. Kampala, Uganda. https://scalingupnutrition.org/sites/default/files/2022-06/national-nutrition-plan-uganda.pdf

Ogenrwoth, B., Akumu, G., Mugisha, J., & Muyonga, J. H. (2022). Nutritional status research in Uganda: A critical review and trend analysis. *African Journal of Food, Agriculture, Nutrition and Development*, *22*(8), 21243–21268. https://doi.org/10.18697/ajfand.113.22340

Okullo, J. B. L., Omujal, F., Enuru, T., Bigirimana, C., Isubikalu, P., Agea, J. G., Bizuru, E., & Obua, J. (2022). Farmers' use of indigenous fruit trees to cope with climate variability in the Lake Victoria Basin Districts of Uganda. *Current Research in Agricultural Sciences*, *9*(1), 59–83. https://doi.org/10.18488/cras.v9i1.3048

Orozco, S. J. A., & Lukwata, M. K. (2025, April 14–17). *Financial literacy levels and financial education needs for youth in Uganda* (pp. 145–147) [Oral proceedings]. Association for International Agricultural and Extension Education Annual Conference: From the highlands to the islands: Bridging community Learning and development through extension, Inverness, Scotland.

Paro, F. R., Davour, R., Acosta, D., Mechlowitz, K., Tiwari, C., & McKune, S. L. (2024). Improving nutrition security in low-and middle-income countries and the role of animal-source foods. *Annual Review of Animal Biosciences*, *13*, 371–88. https://doi.org/10.1146/annurev-animal-111523-102149

Rossman, G. B., & Rallis, S. F. (2017). *An introduction to qualitative research: Learning in the field*. Sage.

Rwamigisa, P. B., Birner, R., Mangheni, M. N., & Semana, A. (2018). How to promote institutional reforms in the agricultural sector? A case study of Uganda's National Agricultural Advisory Services (NAADS). *Development Policy Review*, *36*(5), 607–627. https://doi.org/10.1111/dpr.12318

Saldaña, J. (2024). An introduction to themeing the data. In J. R. Wolgemuth, K. W. Guyotte, & S. A. Shelton (Eds), *Expanding approaches to thematic analysis: Creative engagements with qualitative data* (pp. 11–26). Routledge.

Savolainen, J., Casey, P. J., McBrayer, J. P., & Schwerdtle, P. N. (2023). Positionality and its Problems: Questioning the value of reflexivity statements in research. *Perspectives on Psychological Science*, *18*(6), 1331–1338. https://doi.org/10.1177/17456916221144988

Sekabira, H., Nansubuga, Z., Ddungu, S. P., & Nazziwa, L. (2022). Farm production diversity, household dietary diversity, and nutrition: Evidence from Uganda's national panel survey. *PLoS One*, *17*(12), Article e0279358. https://doi.org/10.1371/journal.pone.0279358

Semahoro, F., Kugonza, D.R., Babigumira, B. M., Walusimbi, S., Nadiope, G., & Okot, M. W. (2018). *Growth performance of chicken genotypes based on indigenous populations of Eastern Uganda*. World Congress on Genetics Applied to Livestock Production. https://www.academia.edu/download/89484636/growth-performance-chicken-genotypes-based-indigenous-populations-eastern-uganda.pdf

Sharma, G., Morgan, C., Wanyoike, S., Kenyon, S., Sheel, M., Jain, M., Boggs, M., & Olayinka, F. (2024). Private sector engagement for immunisation programmes: A pragmatic scoping review of 25 years of evidence on good practice in low-income and middle-income countries. *BMJ Global Health*, *8*(Suppl 5), Article e014728. https://doi.org/10.1136/bmjgh-2023-014728

Silva e Silva, L., Mongeau Ospina, C. A., & Fabi, C. (2024). Food price inflation nowcasting and monitoring. *Statistical Journal of the IAOS*, *40*(2), 325–339. https://doi.org/10.3233/SJI-230083

Ssabika, G., Buyinza, T., Brumm, T., Byakika, S., & Mukisa, I. M. (2024). Microbiological safety and nutritional adequacy of composite porridge flour used in a selected school-feeding program in Kamuli District, Uganda. *European Journal of Agriculture and Food Sciences*, *6*(2), 60–66. https://doi.org/10.24018/ejfood.2024.6.2.794

Sseguya, H., Mazur, R. E., & Flora, C. B. (2018). Social capital dimensions in household food security interventions: Implications for rural Uganda. *Agriculture and Human Values*, *35*, 117–129. https://doi.org/10.1007/s10460-017-9805-9

Sseguya, H., Mazur, R. E., & Masinde, D. (2009). Harnessing community capitals for livelihood enhancement: Experiences from a livelihood program in rural Uganda. *Community Development*, *40*(2), 123–138. https://doi.org/10.1080/15575330903012239

Sseguya, H., Mazur, R. E., Wells, B., & Matsiko, F. (2015). Quality of participation in community groups in Kamuli District, Uganda: Implications for policy and practice. *Community Development*, *46*(1), 14–25. https://doi.org/10.1080/15575330.2014.971036

Swindale, A., & Bilinsky, P. (2006, September). *Household dietary diversity score (HDDS) for measurement of household food access: Indicator guide (Version 2)*. USAID & Food and Nutrition Technical Assistance Project (FANTA), Academy for Educational Development. https://www.fantaproject.org/sites/default/files/resources/HDDS_v2_Sep06_0.pdf

Swinnen, J., & Barrett, C. B. (Eds.) (2025). *Food policy: Lessons and priorities for a changing world*. International Food Policy Research Institute. https://hdl.handle.net/10568/174108

Taku-Forchu, N., Lambert, M. D., Retallick, M. S., Ulmer, J. D., & Opit, G. P. (2023). Drivers of farmers' adoption of hermetic storage bags in Ghana. *Journal of International Agricultural and Extension Education*, *30*(2), 116–136. https://doi.org/10.4148/2831-5960.1064

Tenywa, M., Kabuga, E. Muyanja., Musaazi, F., Namanya, P., Kubiriba, J., …, & Ikendi, S. (2024, November 10–13). *Silicon and potassium increase resistance of East African highland banana to banana weevil damage* (Poster presentation). American Society of Agronomy, Crop Science Society of America, Soil Science Society of America International Annual Meeting. San Antonio, TX. United States. https://scisoc.confex.com/scisoc/2024am/meetingapp.cgi/Paper/156548

Thurow, R. (2024). *Against the grain: How farmers around the globe are transforming agriculture to nourish the world and heal the planet*. Midway Books.

Tibagonzeka, J. E., Akumu, G., Kiyimba, F., Atukwase, A., Wambete, J., Bbemba, J., & Muyonga, J. H. (2018). Postharvest handling practices and losses for legumes and starchy staples in Uganda. *Agricultural Sciences, 9*(1), 141−156. https://doi.org/10.4236/as.2018.91011

Tugume, P., Mustafa, A. S., Walusansa, A., Ojelel, S., Nyachwo, E. B., Muhumuza, E., Nampeera, M., Kabbale, F., & Ssenku, J. E. (2024). Unravelling taboos and cultural beliefs associated with hidden hunger among pregnant and breast-feeding women in Buyende district Eastern Uganda. *Journal of Ethnobiology and Ethnomedicine*, *20*, Article 46. https://doi.org/10.1186/s13002-024-00682-z

Tumutegyereize, P., Oluk, I., Kigozi, J., Mayanja, I., Buyinza, T., & Mbeiza, M. (2022). Assessing the effect of access on the use of improved seed cleaning technologies: Challenges and opportunities among farmers in the Kamuli district-Uganda. *International Journal of Postharvest Technology and Innovation*, *8*(2–3), 243–256. https://doi.org/10.1504/IJPTI.2022.121943

Tusiime, S. M., Nonnecke, G. R., & Jensen, H. H. (2020). Tomato seed value chain analysis and seed conditioning among seed companies in Uganda. *International Food and Agribusiness Management Review*, *23*(4), 501–514. https://doi.org/10.22434/IFAMR2019.0199

Tusiime, S. M., Nonnecke, G. R., Masinde, D. M., & Jensen, H. H. (2019). Evaluation of horticultural practices for sustainable tomato production in eastern Uganda. *HortScience, 54*(11), 1934−1940. https://doi.org/10.21273/HORTSCI14277-19

Uganda Bureau of Statistics (2024). *The national population and housing census 2024 – Final report*. https://www.ubos.org/wp-content/uploads/2024/12/National-Population-and-Housing-Census-2024-Final-Report-Volume-1-Main.pdf

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development*. https://sdgs.un.org/2030agenda

Waaswa, A., Nkurumwa, A. O., Kibe, A. M., & Kipkemoi, N. J. (2021). Communicating climate change adaptation strategies: Climate-smart agriculture information dissemination pathways among smallholder potato farmers in Gilgil Sub-County, Kenya. *Heliyon*, 7(8), Article e07873. https://doi.org/10.1016/j.heliyon.2021.e07873

Waaswa, A., Nkurumwa, A. O., Kibe, A. M., & Kipkemoi, J. N. (2024). Adapting agriculture to climate change: Institutional determinants of adoption of climate-smart agriculture among smallholder farmers in Kenya. *Cogent Food & Agriculture*, *10*(1), Article 2294547. https://doi.org/10.1080/23311932.2023.2294547

Waiswa, D. & Jolly, A. (2021). Waiswa, D., & Jolly, A. (2021). Implications of gender discrimination for household food security among small holder dairy farmers in Nakaloke, Mbale District, Uganda. *Research Journal of Agriculture and Forestry Sciences 9*(2), 1–11. https://www.isca.me/AGRI_FORESTRY/Archive/v9/i2/1.ISCA-RJAFS-2020-033.pdf

Wakaba, D., Ateka, J., & Mbeche, R. (2025). Improved dietary diversity through potato commercialization in Nyandarua County, Kenya. *Food and Energy Security*, *14*(1), Article e70037. https://doi.org/10.1002/fes3.70037

Walugembe, M., Nadiope, G., Stock, J. D., Stalder, K. J., Pezo, D., & Rothschild, M. F. (2014). Prediction of live body weight using various body measurements in Ugandan village pigs. *Livestock Research for Rural Development*, *26*(5), Article 96. https://www.lrrd.cipav.org.co/lrrd26/5/walu26096.htm

Wanyakha, M. T., & Grudens-Schuck, N. (2025). Nutritional education on fruit and vegetable consumption among food pantry clients: A systematic review and a meta-analysis. *Journal of Agriculture, Food Systems, and Community Development*, *14*(3), 433–454. https://doi.org/10.5304/jafscd.2025.143.014

Wanyakha, M. T., Grudens-Schuck, N., & Oberhauser, A. M. (2025). Growing together or growing apart? A study of food donation community garden programming during the COVID-19 pandemic. *Journal of Agriculture, Food Systems, and Community Development*, *14*(1), 285–307. https://doi.org/10.5304/jafscd.2024.141.012

Wiemers, M., Bachmeier, M., Hanano, A., Chéilleachair, R. N., Vaughan, A., Foley, C., Mann, H., Weller, D., Radtke, K., & Fritschel, H. (2024). *Global hunger index: How gender justice can advance climate resilience and zero hunger*. Welthungerhilfe, Concern Worldwide, & IFHV. https://repository.gheli.harvard.edu/repository/13187/

Winham, D. M., Masinde, D., Byaruhanga, L., Nonnecke, G., & Rothschild, M. (2016). Improving accessibility and quality of nutrition and health care in Kamuli district, Uganda. *The FASEB Journal*, *30*(Suppl. 1), Article 674.27. https://doi.org/10.1096/fasebj.30.1_supplement.674.27

Wokibula, R. A. & Westgate, M. E. (2016, November 6–9). *Green manure intercropping systems to boost maize yields: A case study in Kamuli district, Uganda* [Poster presentation]. American Society of Agronomy, Crop Science Society of America, Soil Science Society of America International Annual Meeting: Resilience Emerging from Scarcity and Abundance, Phoenix, AZ, USA. https://scisoc.confex.com/scisoc/2016am/webprogram/Paper100198.html

Wokibula, R. A., Akitwine, F., Mtama, J. G., & Burras, L. C. (2024, November 10–13) Cation exchange capacity within and between pedons of the Kamuli catena, Busoga sub-region, Uganda (Online presentation). American Society of Agronomy, Crop Science Society of America, Soil Science Society of America International Annual Meeting, San Antonio, TX, USA. https://scisoc.confex.com/scisoc/2024am/meetingapp.cgi/Paper/163944

Workman, C. L., Stoler, J., Harris, A., Ercumen, A., Kearns, J., & Mapunda, K. M. (2022). Food, water, and sanitation insecurities: Complex linkages and implications for achieving WASH security. *Global Public Health*, *17*(11), 3060–3075. https://doi.org/10.1080/17441692.2021.1971735

Yip, S. Y. (2024). Positionality and reflexivity: Negotiating insider-outsider positions within and across cultures. *International Journal of Research & Method in Education*, *47*(3), 222−232. https://doi.org/10.1080/1743727X.2023.2266375

Appendix A. Food Frequency Questionnaire for Determination of Household Dietary Diversity Scores and Food Consumption Scores

FOOD ITEM	Yesterday	Last Week	How Accessed*	FOOD ITEM	Yesterday	Last Week	How Accessed*
Cereals				**Other Vegetables**			
Maize (*any form*)				Tomato			
Millet				Onions			
Sorghum				Eggplants			
Amaranth grain				**Fruits**			
Rice				Mango			
Bread				Paw paws			
Chapatti				Orange			
Other cereals				Pineapple			
Legumes and Nuts				Passion fruit			
Beans				Jackfruit			
Soybean				Other fruits			
Other legumes				**Animal Products**			
Groundnuts				Beef			
Sim-sim				Chicken			
Vitamin A–rich Veg.				Pork			
Orange potatoes				Goat			
Pumpkins				Fish			
Carrots				Eggs			
White tubers				Milk			
Sweet potatoes				Ghee			
Cassava				**Other Products**			
Yams				Sugar			
Other tubers				Honey			
Matooke				Sweetened Soda			
Dark Green Veg				Sweets			
Cabbage				Tea			
Leaf amaranth				Cooking Oil			
Other dark greens				Iodized Salt			

Adopted and modified from Swindale and Bilinsky (2006, p. 4).

Appendix B. Independent Variables/Household Characteristics Used in the Binary Logistic Regression Models Believed to Influence the Household Dietary Diversity Score (HDDS) and Food Consumption Score (FCS) Statuses

Theme	Variables	Indicators	Frequency	Percentage
Spatial	Subcounty*	Butansi	261	57.5
		Namasagali	193	42.5
	Where the household head lives*	Outside of the home	17	3.7
		Within the home village	437	96.3
Demographic	Household size*	> 5 members	236	52.0
		≤ 5 members	218	48.0
	Gender of household head**	Female	81	17.8
		Male	373	82.2
	Marital status***	Married	392	86.3
		Not married	62	13.7
	Religion***	Anglican, Catholic, etc.	357	78.6
		Muslim, Seventh-day Adventist	97	21.4
	Age***	35 and below	197	43.4
		36–50	221	48.7
		Over 50	36	7.9
Socio-economic	Education of household head**	Primary level or less	308	67.8
		Post primary	146	32.2
	Main occupation of household head*	Farming	360	79.3
		All others	94	20.7
	Membership of community organizations*	No	65	14.3
		Yes	389	85.7
	Participation in LEPs***	Yes	316	69.6
		No	138	30.4
WASH	WASH Cleanness*	Poor	202	44.5
		Good	252	55.5
	Time to collect water*	> 30 minutes	170	37.4
		< 30 minutes	284	62.6
Production	Households keep livestock*	No	88	19.4
		Yes	366	80.6
	Home essential items***	Less than three	250	55.1
		At least three	204	44.9
	Agricultural implements*	Less than four	271	59.7
		At least four	183	40.3
	Household food reserve**	None	27	5.9
		Food in store/house	382	84.1
		Food in garden	45	9.9
	Land access*	Less than four	61	13.4
		At least four	393	86.6
	Micronutrient vegetable gardens**	No	305	67.2
		Yes	149	32.8

* Factor used and was statistically significant, ** Factor used but was not statistically significant, *** Factor dropped due to compliance with Tolerance Value and/or Variance Inflation Factor criteria.

Appendix C. Linear Regression Testing for Multicollinearity of the Household Dietary Diversity Score (HDDS) Study Variables

Model	*R*	*R* Square	Adjusted *R* Square	Std. Error of the Estimate
1	.368[a]	0.136	0.108	1.605

ANOVA[a]

Model		S Squares	df	Mean Square	F	Sig.
1	Regression	177.570	14	12.684	4.925	< .001[b]
	Residual	1130.529	439	2.575		
	Total	1308.099	453			

Coefficients[a]

	Unstd Coeff.		Std Coeff.			95% C.I for B		Collinearity Statistics	
Model variables	B	SE	Beta	t	Sig.	LB	UB	TV	VIF
(Constant)	6.298	0.619		10.172	< .001	5.081	7.515		
Spatial									
Subcounty	−0.324	0.156	−0.094	−2.072	0.039	−0.631	−0.017	0.951	1.051
Where HH head lives	0.746	0.411	0.083	1.815	0.070	−0.062	1.553	0.933	1.072
Demographics									
Household size	0.220	0.158	0.065	1.395	0.164	−0.090	0.530	0.915	1.093
Gender of HH head	0.174	0.205	0.039	0.848	0.397	−0.229	0.576	0.923	1.083
Socio-economic									
Education of HH head	0.128	0.164	0.035	0.779	0.437	−0.195	0.451	0.962	1.040
Main occupation	−0.391	0.193	−0.093	−2.028	0.043	−0.770	−0.012	0.930	1.075
Membership to org	0.443	0.231	0.091	1.916	0.056	−0.011	0.897	0.896	1.154
WASH									
WASH Cleanliness	0.481	0.159	0.141	3.031	0.003	0.169	0.793	0.911	1.097
Time to collect water	0.336	0.160	0.096	2.096	0.037	0.021	0.651	0.944	1.059
Production									
HH keep livestock	0.245	0.200	0.057	1.225	0.221	−0.148	0.638	0.908	1.102
Ag implements	0.521	0.162	0.150	3.213	0.001	0.202	0.839	0.898	1.113
Type of food reserve	−0.142	0.329	−0.020	−0.433	0.665	−0.788	0.504	0.939	1.065
Land access	0.350	0.231	0.070	1.518	0.130	−0.103	0.804	0.916	1.092
Micro veg. garden	0.263	0.172	0.073	1.528	0.127	−0.075	0.600	0.891	1.148

[a] Dependent Variable: Household Dietary Diversity Score.
[b] Predictors: Constant and all predictor variables.
Unstd Coeff.: Unstandardized Coefficients.
HH: Household.
Org: Organizations.
Ag: Agriculture.

Appendix D. Linear Regression Testing for Multicollinearity of the Food Consumption Scores (FCS) Study Variables

Model	*R*	*R* Square	Adjusted *R* Square	Std. Error of the Estimate
1	.417[a]	0.174	0.147	11.5646

ANOVA[a]

Model		S. Squares	df	Mean Square	F	Sig.
1	Regression	12354.100	14	882.436	6.598	<.001[b]
	Residual	58711.653	439	133.740		
	Total	71065.753	453			

Coefficients[a]

	Unstd Coeff.		Std Coeff.			95% C.I for B		Collinearity Statistics	
Model variables	B	SE	Beta	t	Sig.	LB	UB	TV	VIF
(Constant)	20.00	4.46		4.483	<.001	11.234	28.773		
Spatial									
Subcounty	−0.438	1.126	−0.017	−0.389	0.698	−2.65	1.774	0.951	1.051
Where HH head lives	1.872	2.96	0.028	0.632	0.528	−3.947	7.69	0.933	1.072
Demographics									
Household size	0.756	1.136	0.030	0.666	0.506	−1.476	2.989	0.915	1.093
Gender of HH head	−1.415	1.475	−0.043	−0.959	0.338	−4.315	1.484	0.923	1.083
Socio-economic									
Education of HH head	1.462	1.185	0.055	1.234	0.218	−0.867	3.791	0.962	1.040
Main occupation	−3.548	1.389	−0.115	−2.554	0.011	−6.277	−0.818	0.930	1.075
Membership to org	4.765	1.665	0.133	2.862	0.004	1.493	8.037	0.866	1.154
WASH									
WASH Cleanliness	4.067	1.144	0.162	3.555	<.001	1.819	6.315	0.911	1.097
Time to collect water	1.944	1.154	0.075	1.684	0.093	−0.324	4.213	0.944	1.059
Production									
HH keep livestock	3.049	1.441	0.096	2.116	0.035	0.217	5.882	0.908	1.102
Ag implements	2.946	1.167	0.115	2.523	0.012	0.651	5.240	0.898	1.113
Type of food reserve	−1.119	2.369	−0.021	−0.472	0.637	−5.774	3.536	0.939	1.065
Land access	4.925	1.663	0.134	2.962	0.003	1.657	8.192	0.916	1.092
Micro veg. garden	2.591	1.239	0.097	2.092	0.037	0.157	5.026	0.871	1.148

[a] Dependent Variable: Food Consumption Score/Caloric Intake Score
[b] Predictors: Constant and all predictor variables.
Unstd Coeff.: Unstandardized Coefficients.
HH: Household.
Org: Organizations.
Ag: Agriculture.

Appendix E. Comparison of Food Groups in the Household Dietary Diversity Scores (HDDS) and Food Consumption Scores (FCS) by Affiliation to the Nutrition Education Centers (NECs)

HHDS FCS		NEC Clients (*n* = 253)	Non-NEC (*n* = 63)	Nonparticipants (*n* = 138)	Overall (*n* = 454)	*P*-Value
Percentage of HDDS Foods						
HDDS	Cereals	97.2	98.4	95.7	96.9	0.523
	Legumes	91.7	95.2	87.7	91.0	0.185
	Vegetables	99.6	98.4	98.6	99.1	0.460
	Tubers	81.8	90.5	81.2	82.8	0.219
	Fruits	49.8	66.7	46.4	51.1	0.023*
	Meats	18.2	34.9	16.7	20.0	0.006*
	Fish/seafood	21.3	25.4	24.6	22.9	0.669
	Eggs	26.1	28.6	17.4	23.8	0.098*
	Milk/dairy	58.1	65.1	58.7	59.3	0.594
	Sugar/honey	92.9	92.1	87.0	91.0	0.140
	Oils/fats	96.4	90.5	94.9	95.2	0.141
	Miscellaneous	100	98.4	100	99.8	0.045*
Mean FCS						
FCS	Main staples	$12.6^{b} \pm 5.068$	$11.9^{a,b} \pm 5.581$	$10.8^{a} \pm 4.556$	11.9 ± 5.046	0.003*
	Pulses	$7.0^{a,b} \pm 3.148$	$7.3^{b} \pm 3.085$	$6.2^{a} \pm 3.061$	6.8 ± 3.136	0.014*
	Vegetables	$4.4^{b} \pm 1.279$	$4.4^{b} \pm 1.439$	$3.8^{a} \pm 1.198$	4.2 ± 1.298	0.000*
	Fruits	$1.4^{a} \pm 1.298$	$1.9^{b} \pm 1.374$	$1.2^{a} \pm 1.338$	1.4 ± 1.336	0.002*
	Meats/fish	$5.5^{a,b} \pm 4.832$	$6.5^{b} \pm 5.850$	$4.8^{a} \pm 4.732$	5.4 ± 4.975	0.061*
	Milk	$2.9^{a} \pm 1.785$	$3.1^{a} \pm 1.676$	$2.9^{a} \pm 1.793$	2.9 ± 1.771	0.693
	Sugar	$0.5^{a} \pm 0.082$	$0.5^{a} \pm 0.148$	$0.5^{a} \pm 0.136$	0.5 ± 0.112	0.024*
	Oil	$0.5^{a} \pm 0.070$	$0.5^{a} \pm 0.107$	$0.5^{a} \pm 0.060$	0.5 ± 0.074	0.312

Superscripts $^{a \& b}$ depict significant mean differences between groups for caloric intake status.

Appendix F. Pathways to Food Access in Survey

Food Groups	Examples of foods accessed per group	Percent (n = 454)	How food was accessed in percentages				
			Home	Bought	Exchanged	Loaned	Gift
Vegetables	Sim-sim	20.3	13.2	5.3	0.2	—	1.5
	Carrots	4.2	1.5	2.4	—	—	0.2
	Tomatoes	97.4	16.3	80.6	—	—	0.4
	Onions	96.5	9.9	86.6	—	—	—
	Egg plants	76.0	37.4	35.9	0.4	—	2.2
	Cabbage	67.8	6.4	60.8	—	0.2	0.4
	Leafy amaranths	49.1	42.1	4.8	0.2	—	2.0
	Other green veges	53.5	50.2	2.4	—	—	0.9
Proteins	Grain amaranths	39.4	31.1	4.2	0.2	—	4.0
	Beans	92.1	79.7	9.5	0.2	0.2	2.4
	Soybean	63.0	51.1	6.8	—	0.2	4.8
	Ground nuts	73.6	48.9	19.2	0.4	—	5.1
	Beef	38.1	0.4	37.2	—	—	0.4
	Chicken	14.5	8.6	5.5	—	—	0.4
	Pork	9.3	1.1	8.1	—	—	—
	Goat meat	7.3	0.2	7.0	—	—	—
	Fish/sea foods	49.3	—	49.3	—	—	—
	Eggs	41.6	22.2	18.7	—	—	0.7
	Milk	76.7	17.2	57.9	—	—	1.5
Miscellaneous	Sugar	95.8	—	95.4	—	—	0.4
	Honey	5.9	0.4	5.5	—	—	—
	Cooking oil	98.0	0.2	97.8	—	—	—
	Iodized salt	100.0	—	100.0	—	—	—
Fruits	Mangoes	13.2	10.1	2.2	—	—	0.9
	Pawpaw	28.0	25.3	1.1	0.2	—	1.3
	Oranges	31.3	27.1	3.1	0.2	—	0.9
	Pineapples	14.8	2.0	12.6	—	—	0.2
	Passion fruits	22.9	7.7	14.8	—	—	0.4
	Jackfruits	52.2	45.2	3.5	0.4	—	3.1
Carbohydrates/ Energy/ Starch	Maize	97.6	91.0	4.2	0.2	—	2.2
	Millet	44.5	34.8	7.0	0.2	—	2.4
	Sorghum	21.1	17.0	4.0	—	—	0.2
	Rice	74.7	13.2	59.0	—	—	2.4
	Bread	42.5	0.4	41.6	—	—	0.4
	Chapatti	63.9	0.4	63.4	—	—	—
	Orange.F.S.Potatoes	24.7	21.6	2.0	—	—	1.1
	Pumpkins	47.6	41.6	2.2	0.2	0.4	3.1
	Sweet potatoes	80.0	68.7	7.9	0.4	—	2.9
	Cassava	63.4	47.6	11.2	0.2	—	4.4
	Yams	12.1	8.4	2.9	—	—	0.9
	Matooke/plantain	49.8	33.7	15.2	—	—	0.9

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Evaluating school-based food pantries using a health equity perspective

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Abstract

In the United States, the charitable food system is one source of support for households experiencing food insecurity. Previous studies have focused on the role of community food pantries in providing nutritious food for households, but few studies have focused on school-based food pantries, located inside or close to kindergarten through twelfth grade (K-12) schools. In this study, we conducted a landscape analysis of school pantries in Maryland and used a mixed-methods approach to evaluate the degree to which school pantries promote food access using a health equity perspective. We conducted a survey of 196 school pantries (87.9% response rate) and in-depth interviews and nutritional assessments with a subset of 22 pantries. We used the Getting to Equity framework to outline data collection methods and analysis. Like community pantries, our study sample's school pantries centered clients' needs, engaged clients, and promoted equity through providing foods that balance healthfulness and cultural relevance and adjusting offerings based on feedback from clients; provided nutrition education; used full choice models when possible; and connected clients with wraparound services and other resources. Additionally, pantry coordinators emphasized the strength of relationships and trust with students and parents, developed through frequent interactions. However, school pantries faced capacity

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Conflicts of Interest

The authors declare they have no conflicts of interest.

challenges because running the pantry was not the full-time job of coordinators. This study provides a model for food banks in other states to evaluate their school pantry programs with equity, community-engaged, and people-centered perspectives to ensure students and their families have a fair and just opportunity for food access.

Keywords
charitable food system, school-based food pantry, childhood food insecurity

Introduction

In the U.S., approximately one in eight households with children experiences food insecurity, defined as having limited or inconsistent access to enough food for an active, healthy life (Rabbitt et al., 2024). The charitable food system, also called the food banking system or emergency food system, is one source of support for households experiencing food insecurity. The charitable food system is a complex network of food banks, pantries, and congregate meal sites that provides food for over 50 million households experiencing food insecurity each year (Feeding America, 2024; Schwartz & Caspi, 2023). Although originally intended to provide support in emergency times, current evidence suggests that individuals rely on the charitable food system for chronic food support (UConn Rudd Center for Food Policy and Health, n.d.). Feeding America is the primary organizing entity for the charitable food system in the U.S. and has a network of around 200 food banks, 21 statewide associations, and 60,000 partner food pantries and meal programs across all 50 states, Washington, D.C., and Puerto Rico (Feeding America, 2022). In Maryland, the Feeding America food banks are the Maryland Food Bank (MFB) and Capital Area Food Bank (CAFB).

School-based food pantries, or simply, school pantries, are located inside or close to K-12 schools and provide free food to students and their families. The Feeding America network supports over 4,000 school pantries across the country through their School Food Pantry Program, which facilitates partnerships between schools and food banks (Feeding America, n.d.-a). In the 2023–2024 academic year, MFB provided food to 190 school pantries located in 22 jurisdictions including Baltimore City in Maryland. CAFB provided food to 27 pantries located in Prince George's and Montgomery counties. All Maryland schools may apply to have a pantry supported by MFB or CAFB, depending on the county. However, food banks have limited capacity to support school partners, as the program relies almost entirely on food banks' private fundraising efforts. MFB only considers adding new pantries to the program if data show significant community need, if there are few or no community pantries in the area, and if the school is deemed by the food bank to be a strong and accessible community institution (MFB, personal communication, January 8, 2025).

Several previous studies have focused on the role of food banks and community food pantries in providing nutritious food for households (Cooksey-Stowers et al., 2019; Levi et al., 2022; Schwartz & Caspi, 2023). However, few studies have focused on school pantries. In 2012, Snelling et al. used surveys and in-depth interviews to evaluate Feeding America-affiliated elementary school pantries and explored operations of school pantries with a specific focus on client satisfaction (Snelling et al., 2014). Using similar methods, Christner and Cotugna (2014) evaluated the programmatic outcomes of the Food Bank of Delaware's school pantry program. Only three studies have been published in the following decade: one that focuses on an intervention to help clients prepare healthy foods at a school pantry in Idaho (Lee et al., 2021), one that explores clients' experiences at school pantries in Indiana (Jones & Adkins, 2021), and most recently, one that sought to understand how school pantries in the Midwest adjusted to changes during the pandemic (Doll et al., 2023). However, there remain many unknowns about the School Food Pantry Program, and it is unclear if earlier evaluations reflect current practices or if practices differ across states or regions. There is a paucity of information about the characteristics, operations, and utilization of school pantries, such as geographic distribution, pantry location, types of service delivery models, to what extent pantries are advertised and utilized, and who utilizes them.

There is also a gap in knowledge regarding the nutritional quality of foods distributed by school

pantries. In recent years, food banks and food pantries have begun providing more nutritious foods following the creation and adoption of formal nutrition policies (Levi et al., 2020). For example, Feeding America encourages its partner food banks to offer a variety of foods to school pantries, including fresh fruits and vegetables, grains (e.g., bread, pasta, rice), meat and non-meat protein options, canned food (e.g., beans, soup), and pantry staples (e.g., pasta sauce, jam) (Feeding America, n.d.-a). However, there are no published reports or grey literature that outline what foods school pantries typically order and distribute, and what factors influence decision making.

Additionally, no studies have utilized health equity frameworks in their evaluations of school pantries. Health equity means that everyone has a fair and just opportunity to be as healthy as possible (Braveman et al., 2017). Historic and ongoing racial discrimination has led to immense variation in the quality of economic, social, and educational resources people of different racial and ethnic groups have access to, which corresponds to fewer opportunities to advance physical, social-emotional, and mental health (Yearby et al., 2022). In the context of food pantries, there are many barriers related to desirability (i.e., if clients *want* to use the pantry), such as stigma, fear, mistrust, and usability (i.e., if clients *are able* to use the pantry), such as lack of awareness, limited hours of operation, and inconvenient locations (Ginsburg et al., 2019). Because schools are familiar, geographically distributed, and visited frequently by parents and students, pantries located in schools may play an important role in reducing some barriers to accessing community pantries.

The goal of this study was to conduct a landscape analysis of school-based food pantries in Maryland partnering with two Feeding America affiliated food banks. We used a mixed-methods approach to evaluate the degree to which school pantries promote food access through a health equity perspective.

Materials and Methods

We used explanatory sequential mixed-methods to explore school food pantries in Maryland. We began by collecting and analyzing quantitative survey data, which helped us identify patterns and trends to explore in subsequent stages of the project. We used these findings to guide the collection of qualitative interview data to provide deeper insight and explanation of the quantitative results. We mixed the results of our quantitative and qualitative findings using the Getting to Equity framework. These methods are described in detail below.

Recruitment and Sample Population

This study includes information from school food pantries in Maryland. All school pantries were affiliated with either the MFB or CAFB during the 2023–2024 academic year. Prior to beginning the study, the first author met with staff from MFB and CAFB to discuss the study and determine mutual goals. The lead researcher and food bank staff co-created the recruitment emails, and food bank staff sent surveys to their respective school food pantry coordinators (for brevity: coordinators) in November 2023. Coordinators had three weeks to complete the survey, and each food bank sent two email reminders.

The last question of the survey asked if coordinators would be willing to conduct an in-depth interview and pantry visit with researchers, and 69% percent of coordinators responded that they would be willing to be contacted or would like more information before deciding. In January 2024, the research team used purposive sampling to select school pantries that would represent the distribution of pantries by food bank affiliation (MFB or CAFB), county, urbanicity (urban or non-urban, as defined by the USDA's Food Access and Research Atlas [USDA Economic Research Service [USDA ERS], n.d.]), and low-income, low-access (LILA) tract. LILA tracts are defined as U.S. census tracts having either a poverty rate of 20% or more or a median family income less than 80% of the statewide median family income, *and* where a significant number or share of residents is more than half a mile or 0.8 km (urban) or 10 miles or 16 kms (rural) from the nearest supermarket (USDA ERS, n.d.). We recruited coordinators on a rolling basis and stopped recruitment and data collection in May 2024, as many coordinators do not work during the summer break. For recruitment, we sent an initial email, then followed up with an additional

email and up to two phone calls. This study was ruled exempt through the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

Data Collection

We first collected survey responses from a large sample of school food pantries in Maryland (n = 196), then conducted in-depth interviews and nutritional assessments in a smaller subset of pantries (n = 22). We described our detailed methodology below.

Survey

The goal of the survey was to explore a wide range of information related to the operation and utilization of school food pantries in Maryland. The survey included six sections. In the first section, we asked general questions about the pantry, including county location, grade levels served (elementary, middle, high school, or a combination of grade levels), and whether the school was a community school. Community schools in Maryland receive funding from the Maryland Concentration of Poverty Grant if they have 75% of students who qualify for free or reduced-price meals and typically hire a community school coordinator to run programs related to food security, housing, and literacy (Blueprint for Maryland's Future, n.d.).

The next section of the survey asked questions about which service delivery models the pantry uses. School pantries use up to four types of service models to distribute food to clients: (1) designated space, which is a permanent location (e.g., inside a building or trailer) that is open during set hours and days, in which clients come to shop; (2) distribution events, which are large pop-up events that typically serve many clients within a short timeframe (e.g., scheduled drive-through or walk-up from 3–5pm on Thursdays); (3) backpack programs, in which pantries hand out pre-packed bags or backpacks for students to take home on weekends; and (4) home delivery, in which pantry staff deliver food directly to the homes of students. School pantries may operate one, multiple, or all these types of programs. Although all four programs are supported by MFB, CAFB encourages their school partners to choose either the designated space or distribution event as their primary service model.

The subsequent sections of the survey collected information about each selected service delivery model. Respondents were asked to answer questions about the location of the pantry or distribution event; operation hours, frequency, and time; sources of food outside the food bank (e.g., nonprofits, individual donations); types of food and non-food items served; eligibility and tracking systems; provision of informational resources (e.g., housing, financial literacy, and federal nutrition assistance); challenges related to funding, staffing, space, storage, and awareness; and client choice model. There are four client choice models: (1) no choice, in which every recipient receives the same, predetermined items; (2) limited choice, in which recipients can choose among a few types of prepacked bags or can combine a prepacked bag with choice of certain food items from a table or basket; (3) modified choice, in which recipients may select from a menu or tell staff what food items they want, and volunteers or staff pack the bag; and (4) full choice, in which recipients may shop for food like at a grocery store. Each of these four models may be used with any of the types of service delivery models described above.

Interviews

We conducted semi-structured in-depth interviews in-person with coordinators at the site of the pantry. We created the interview guide using a combination of the survey responses and the Getting to Equity (GTE) framework, as described below. Broadly, we asked questions on general pantry information, accessibility, food quality, informational resources provided by the pantry, food procurement, and barriers to operation and utilization. (See the complete in-depth interview guide in Appendix A.) As recommended in qualitative research, the interview guide was adjusted during the interview process to ensure that questions were understood the way they were intended, and to adjust to any emerging themes (McGrath et al., 2019). All interview participants provided oral consent at the time of the interview. We conducted interviews in a private location, in the pantry during off hours or in the coordinator's

office. The interviews lasted between 30 and 60 minutes, and participants received a US$30 gift card as compensation for their time.

Nutritional Assessment

Two members of the research team visited each pantry. While one researcher conducted the interview, the other researcher conducted a nutritional assessment of the pantry. For each unique item in the pantry, researchers filled out a Google Form with the following information: item name (Brand and food name; e.g., Campbell's Chicken Noodle Soup); saturated fat (g) listed on the nutritional label; sodium (mg); total sugar (g); added sugar (g); item weight (oz); number of items present in the pantry; and food category. Food categories were determined by the Healthy Eating Research Nutrition Guidelines for the Charitable Food System and include fruit and vegetables; grains; protein; dairy; non-dairy alternatives; beverages; mixed dishes; processed and packaged snacks; desserts; and condiments and baking and cooking staples (Levi et al., 2020). According to the guidelines, each food is characterized as green ("choose often"), yellow ("choose sometimes"), or red ("choose rarely") according to their nutrient profile, which differs for each food category. Item rankings are determined by the lowest tier of any nutrient. For example, a product that is ranked green for added sugar, yellow for sodium, and red for saturated fat would receive a final ranking of red. Because the nutritional content of the pantry can vary greatly depending on what items are available, we requested to visit only during times when the pantries were recently stocked (i.e., within one week of delivery).

Data Analysis

We conducted quantitative analysis of survey responses, followed by qualitative analysis of the in-depth interviews and quantitative analysis of the nutritional assessment data. Lastly, we mixed the results of our quantitative and qualitative analyses using the Getting to Equity framework. We describe our analysis methods in detail in the sections below.

Quantitative Analysis

We calculated univariate statistics for all survey variables and compared characteristics of survey participants with interview participants to ensure representativeness. Additionally, we compared survey variables across the two supporting food banks. We presented the final survey results to each food bank separately to receive feedback and make sure the responses aligned with their general understanding of food bank operations and utilization prior to conducting interviews.

We calculated Charitable Food Nutrition Index (CFNI) scores to assess the nutritional value of foods in each school pantry (Gombi-Vaca et al., 2022). CFNI was developed to calculate a continuous score from 0 (lowest) to 100 (highest) of overall nutritional quality that can be used to assess any assortment of foods, and it has a moderate-to-strong correlation with Healthy Eating Index scores (Gombi-Vaca et al., 2022). The score utilizes three numbers: the percentage of green, yellow, and red foods in an assortment of items, as defined by the Healthy Eating Research Nutrition Guidelines for the Charitable Food System described above (Levi et al., 2020). We calculated CFNI scores using R statistical program. First, we combined the weight of all green, yellow, and red items in each pantry and calculated the percent of total weight for each color category (e.g., 50% green, 40% yellow, 10% red). Next, we used the standardized equation for calculating CFNI scores by pantry: CFNI = ((((0.7773 * %green) + (0.5923 * %yellow) + (0.3753 * %red)) - 37.53) / 40.2) * 100 (Gombi-Vaca et al., 2022).

We calculated basic descriptive statistics for all CFNI scores. Additionally, we used the Wilcoxon Rank-Sum Test or Kruskal-Wallis test to compare CFNI scores to selected survey variables from each of the 21 schools that participated in the nutritional assessment. Nonparametric tests were chosen to account for small sample sizes. Variables included grade level (elementary, middle, high, elementary and middle, middle and high), pantry coordinator years of experience (0–1 year, 2–4 years, 5 or more years), challenges with storage (high vs. low barrier to pantry operations), challenges with space (high vs. low barrier to pantry operations), a binarized version of choice model (no/limited choice vs.

modified/full choice), and whether the pantry purchased food from sources other than the food bank. Additionally, we qualitatively coded all interviews to explore the question, "How do you decide what foods to order from the food bank?" and compared themes with CFNI scores above and below the mean CFNI score for all schools.

Qualitative Analysis and Mixing

We transcribed all audio recordings using a professional transcription service, de-identified them, and checked them for accuracy by simultaneously listening to the recording and reading through the transcription, correcting errors as needed. We used deductive and inductive methods to conduct a thematic analysis of data collected during interviews (Proudfoot, 2023). We developed an initial codebook based on the in-depth interview guides. Using the comments tool in Google docs, all three researchers initially coded two interview transcripts to test the initial codebook and inductively added codes. The researchers then double coded the remaining set of interview transcripts.

We used the Mural visual collaboration platform (https://www.mural.co/) to organize our results and collectively analyze the data. The Mural visual collaboration platform is a cloud-based application that allows teams to work simultaneously on projects. In this study, we used the platform as a virtual whiteboard to arrange codes, themes, and subthemes. First, we set up the board by creating sections for each code and moving each data point (i.e., a section of text assigned to a code) from the Google doc to the corresponding section on the board. Each data point was tagged with the research participant's code name. Then, each member of the research team was assigned two to four codes to categorize into smaller themes and, subsequently, larger umbrella themes. We categorized all umbrella themes under one of the four categories of the GTE framework. At this point, we reviewed the survey data and nutritional assessment data and added notes about relevant quantitative patterns next to each qualitative theme. After all data points had been assigned and quantitative data had been integrated, we compared and contrasted umbrella themes in each of the GTE domains. One member of the research team wrote summaries of these themes, and all researchers revised iteratively. Finally, we presented the qualitative results to staff at each food bank separately to ensure themes aligned with their general understanding of food bank operations and utilization and gathered additional insights for discussion.

Getting to Equity (GTE) Framework

This study utilized the Getting to Equity (GTE) in Obesity Prevention theoretical framework (Kumanyika, 2019). The GTE framework was originally designed to guide practitioners and researchers to develop and implement strategies that increase the equity impact of obesity prevention policy, system, and environment change interventions. However, the framework has been adapted for use in various food-related research settings, including evaluations of emergency school meal distribution programs during the COVID-19 pandemic (McLoughlin et al., 2020). The framework comprises four key domains: (1) *increase healthy options*, which describes interventions or approaches that address a specific problem; (2) *reduce deterrents*, which identifies circumstances or factors that might work against the effectiveness of the intervention; (3) *improve social and economic resources*, which focuses on extending individuals' financial stability and resources and reducing social needs, and supports the goals of the intervention; and (4) *build on community capacity*, which focuses on identifying and leveraging community-level assets and resources to support the intervention. These four domains are distinct but interconnected, and an intervention is most likely to advance equity when all four domains build on and reinforce each other. Additionally, the framework utilizes three foundational principles that provide the basis for the domains: the intervention should be approached with an equity lens (i.e., equity-focused), use community-engaged approaches, and maintain a people-centered perspective. In this study, we detailed the alignment of school food pantry efforts to each of the four quadrants of the framework using qualitative, quantitative, and mixed data. To do this, we adapted the GTE Framework: User Worksheet (Kumanyika, 2024) to evaluate school pantries retrospectively (Appendix B).

Results

Of the 223 school food pantries in Maryland, 196 (87.9%) responded to the survey, including 176 (92.1%) and 20 (62.5%) pantries affiliated with MFB and CAFB, respectively. (See Appendix C for the survey results.) Twenty-two (38.6%) of the 57 invited pantries participated in the interviews. Generally, interview participants' pantries were representative of survey respondents' in almost all characteristics, except interview respondents represented slightly more schools in low-income and LILA districts (Table 1, next page).

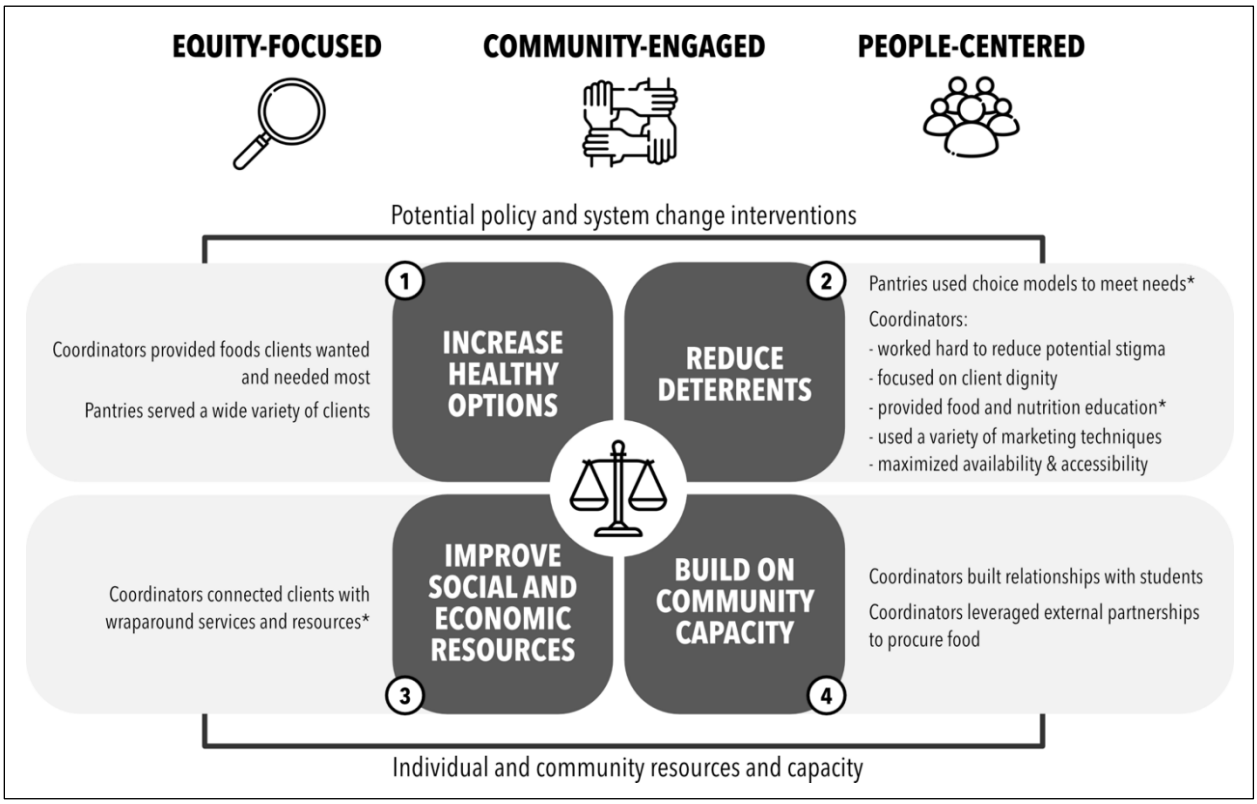
Most pantries (n = 142, 72.4%) were located in community schools, and approximately two-thirds of pantries (n = 131, 66.8%) served elementary schools, while just over one-third (n = 78, 39.8%) served middle schools, with even fewer (n = 33, 16.8%) serving high schools. Most survey respondents reported utilizing a designated space (n = 163, 83.2%) or distribution event (n = 120, 61.2%) as their main program type. Additionally, just over half (n = 103, 52.6%) of pantries used a weekend backpack program and approximately one-third of pantries (n = 68, 34.7%) used home delivery.

Getting to Equity Framework

In the following sections, we use the GTE framework (Figure 1) to describe specific approaches pantries used to improve food and nutrition security for households (Quadrant 1); factors that hindered success of the pantries and ways coordinators adapted operations to meet clients' needs (Quadrant 2); social and economic resources pantries provided to clients (Quadrant 3); and ways coordinators leveraged community capacity to improve the pantry effectiveness (Quadrant 4). Notably, some themes could fit under multiple GTE domains. For example, using specific choice

Figure 1. Getting to Equity Framework adapted from Kumanyika, 2019, and McLoughlin et al., 2020, and Grounded in In-depth Interviews Conducted with School Pantry Coordinators in Maryland

Text in each box describes themes related to pantry practices.



* Indicates approaches that are secondarily mapped to Quadrant 1.

Table 1. Characteristics of Maryland School-Based Food Pantries (Surveyed and Interviewed)

Characteristics	Survey Respondents (*n* = 196)	Interview Participants (*n* = 22)
Food bank affiliation		
MFB	176 (90%)	19 (86%)
CAFB	20 (10%)	3 (14%)
County (School code abbreviation for in-depth interviews) [a]		
Anne Arundel (Aa)	7 (4%)	1 (5%)
Baltimore City (Bc)	78 (40%)	7 (32%)
Baltimore County (Ba)	31 (16%)	2 (9%)
Caroline	1 (1%)	--
Carroll (Ca)	8 (4%)	1 (5%)
Cecil	2 (1%)	--
Dorchester (Do)	1 (1%)	1 (5%)
Frederick	8 (4%)	--
Harford	3 (2%)	--
Montgomery (Mo)	10 (5%)	2 (9%)
Prince George's (Pg)	10 (5%)	1 (5%)
Queen Anne's	1 (1%)	--
Somerset (So)	5 (3%)	1 (5%)
Talbot	1 (1%)	--
Washington (Wa)	11 (6%)	3 (14%)
Wicomico (Wi)	13 (7%)	1 (5%)
Worcester (Wo)	6 (3%)	1 (5%)
Grade Level(s)		
Elementary School	96 (49%)	6 (27%)
Elementary and Middle School	29 (15%)	4 (18%)
Middle School	28 (14%)	4 (18%)
Middle and High School	7 (4%)	1 (5%)
High School	34 (17%)	7 (32%)
All Grades	2 (1%)	--
Urbanicity [b]		
Urban	173 (88%)	18 (82%)
Non-Urban	23 (12%)	4 (18%)
Located in a Low-Income Tract [c]		
Yes	149 (76%)	19 (86%)
No	46 (23%)	3 (14%)
Located in LILA Area d		
Yes	103 (53%)	13 (59%)
No	93 (47%)	9 (41%)
U.S. Census Poverty Rate		
Mean poverty rate	17.5%	21.8%
Tracts higher than Maryland mean poverty rate (9.3%)	143 (73.0%)	16 (72.7%)
Tracts higher than U.S. mean poverty rate (12.5%)	125 (63.8%)	13 (59.1%)
U.S. Census Median Family Income (US$)		
Median family income	$64,576.70	$52,167.00
Tracts higher than Maryland median ($94,991)	31 (15.8%)	3 (13.6%)
Tracts higher than U.S. median ($74,580)	87 (44.4%)	8 (36.4%)

[a] Abbreviations are only used for schools in which in-depth interviews were conducted and are used in-text to indicate which participants provided quotes.
[b] Defined by the USDA's Food Access and Research Atlas (USDA Economic Research Service, n.d.).
[c] A tract with either a poverty rate of 20% or more, or a median family income less than 80% of the statewide median family income; or a tract in a metropolitan area with a median family income less than 80% of the surrounding metropolitan area median family income.
[d] Low-income census tracts where a significant number or share of residents is more than half a mile (0.8 km) (urban) or 10 miles (16 km) (rural) from the nearest supermarket.

models and providing food and nutrition education were mapped to Quadrant 2 because they addressed specific factors that could potentially hinder clients' utilization of pantries. However, these themes could also be mapped to Quadrant 1, as they describe specific approaches used by the pantries to improve food security. For clarity in this analysis, we categorized these themes based on which domain they addressed in the GTE Framework: User Worksheet.

Increase Healthy Options (Quadrant 1)

This section focuses on how coordinators worked to increase healthy options for pantry clients, aligning with Quadrant 1 of the GTE framework. Coordinators described a thoughtful and often challenging process of selecting foods that met their clients' preferences and nutritional needs, balancing healthy options with cultural relevance, student appeal, and ordering restrictions.

Coordinators Provided Foods Clients Wanted and Needed Most

Coordinators noted that the goal of school pantries was to provide immediate food support for households, particularly those with school-aged children. They aimed to improve nutritious food security by providing healthy, culturally appropriate, and desirable foods to households. There was a wide range of CFNI scores among the 21 schools who participated in the nutritional assessment (Table 2). The mean score was 70.2, with a range from 39.9 to 89.3 out of 100 points (standard deviation: 15.2). CFNI scores were not statistically significantly associated with grade level, years of coordinator experience, space constraints, storage constraints, or supplemental purchases, but pantries with higher CFNI scores were significantly more likely to have modified or full choice compared to those with limited or no choice ($p = 0.04$).

Coordinators described an intentional and nuanced process for deciding what items to order from the food bank. Coordinators from pantries with CFNI scores above the mean described ordering popular items that moved off the shelves quickly; staple items such as pasta and rice; mostly "green" items (referring to the stoplight metrics used on the food bank websites (Martin, Wolff et al., 2019)); and foods that matched clients' cultural preferences, such as dried beans and *masa (*corn flour). Conversely, four of the nine pantries with scores below the mean noted that one of their main criteria for choosing items was based on student feedback and/or what they thought students would want to eat, and they did not mention paying attention to what items were healthier on the website. For example, one pantry with a CFNI score of 45.1 noted:

> Most [adults] are looking for the vegetables and stuff. Our kids, they're high schoolers, so they aren't necessarily cooking a meal. They would rather have the Goldfish packs and ramen noodles, those kind of things. [Wo1]

Across the CFNI spectrum, nutritional quality of food was not the only priority for pantry coordinators when choosing what foods to order. Coordinators described building strong relationships with clients and school staff, which helped them decide what types of foods to order. More experienced coordinators gained knowledge through client observations, eliciting recommendations from teachers and other school staff, directly asking clients what they would like to see in the pantry, and through trial and error, such as noting what foods stayed on shelves for longer periods of time. They described using both informal conversations and formal mechanisms, such as surveys and feedback forms, to collect feedback. One pantry coordinator noted:

> Honestly, when it comes to things like pasta sauce, people won't take the less sodium [options]. They'll take the traditional, but as soon as it says less sodium across the top, I got a stack of them sitting on the table. Everybody is like, "Oh, you have any more pasta sauce?" I'm like, "There's some right there." "Oh, I don't want that." Same thing with brown rice, whole grain pasta noodles, … At a certain point, it's like, "I want to get what my families are going to eat." [Bc6]

Coordinators also described other factors they used in deciding what items to procure for the

Table 2. Charitable Food Nutritional Index Scores (CFNI) and Related Characteristics for Maryland School Food Pantries that Participated in the Nutritional Assessment (*n* = 21)

School Code	CFNI Score	% Green	% Yellow	% Red	Grade levels *	Years operating pantry	Space as an operational barrier	Storage as an operational barrier	Choice model	Pantry purchases food	If yes, amount used to purchase per month (US$)	How do you decide what to order? (Qualitative themes); FB=Food bank
Aa1	39.9	14	48	38	ES	2–4 years	Low barrier	High barrier	Full choice	Yes	$1,200	- Feedback from families - No canned items - Staple items
Wo1	45.8	28	33	39	HS	2–4 years	Low barrier	Medium barrier	Limited choice	No	N/A	- What coordinators think kids want
Bc2	47.8	37	20	43	ES/MS	0–1 year	Low barrier	Medium barrier	No choice	No	N/A	- What coordinators think kids want - High-priced items - What coordinators think people want
Do1	49.1	34	28	38	ES/MS	5+ years	Medium barrier	Low barrier	Limited choice	Yes	Not stated	- What coordinators think kids want - Best bang for buck on FB website
Bc3	59	45	26	29	MS/HS	0–1 year	Not an issue	Not an issue	Full choice	No	N/A	- What they think sounds good - What they think is healthy
Bc8	60.5	54	12	34	ES/MS	5+ years	Low barrier	Not an issue	Full choice	No	N/A	- Feedback from families
Wa2	61.9	50	22	28	MS	2–4 years	Not an issue	Not an issue	Full choice	No	N/A	- Balance of red, yellow, green - What coordinators think kids want
Bo2	67.5	59	14	28	MS	2–4 years	Medium barrier	Medium barrier	Full choice	Yes	$100	- What they think parents wants - Feedback from families
Wa3	68.6	55	27	17	HS	2–4 years	Medium barrier	High barrier	Full choice	No	N/A	- Getting staple items - What is healthy - What is filling
Wa4	71.8	68	7	25	MS	0–1 year	Not an issue	Not an issue	Full choice	No	N/A	- What sounds good - Cultural consciousness
So1	72.9	66	11	24	MS/HS	0–1 year	Low barrier	Not an issue	Limited choice	No	N/A	- Whatever is on the FB website
Wa1	75	70	11	18	MS	2–4 years	Low barrier	Medium barrier	Modified choice	No	N/A	- Getting staple items - What goes quickly
Bc7	77.2	74	6	20	ES/MS	0–1 year	High barrier	Not an issue	Modified choice	Yes	$1,300	- Feedback from families
Pg1	77.3	66	21	13	ES	0–1 year	Not an issue	Not an issue	Full	No	N/A	- Cultural consciousness
Mo1	82.2	71	19	11	ES	2–4 years	Not an issue	Medium barrier	Full	No	N/A	- What goes quickly - Staple items
Bc5	83.3	70	23	8	ES	2–4 years	Low barrier	Not an issue	Full choice	No	N/A	- Whatever sounds good
Ca3	84.4	79	10	11	HS	5+ years	Not an issue	Not an issue	Full choice	Yes	Varies	- What goes quickly - More substantial/filling things
Bc4	84.9	79	11	10	MS/HS	0–1 year	High barrier	High barrier	Modified choice	Yes	Not stated	- What goes quickly - What do kids want?
Bc6	87.7	87	3	9	ES/MS	2–4 years	Medium barrier	Low barrier	Full choice	Yes	Not stated	- Feedback from families - Staple items
Mo2	88.4	83	10	7	ES	2–4 years	Medium barrier	High barrier	Full	No	N/A	- What goes quickly
Wi1	89.3	87	6	6	HS	5+ years	Low barrier	Low barrier	Full choice	Yes	Not stated	- Choosing mostly green

* Grade levels: ES = Elementary school (generally grades K–5); MS = Middle school (generally grades 6–8); HS = High school (generally grades 9–12)

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pantry. Five coordinators described trying to stay stocked up on meat, eggs, and/or baby formula, because those items are sometimes too expensive for families to purchase at the grocery store. Other coordinators described wanting to provide the best quality food for families, ordering a variety of items so families would not receive the same foods over and over, and ordering a selection of filling foods to ensure the food would last.

However, coordinators commonly noted that it is sometimes difficult to order the items their clients wanted because the food bank ran out of popular items quickly. Many described competing with other schools to select foods the quickest, and that even when they would put items in their online basket, by the time they reached checkout the items would be unavailable. Additionally, coordinators noted that clients wanted to see more fresh fruits and vegetables and meats in the pantry, but that these items were either not offered or typically unavailable at the food banks. Only 21 pantries (10.7%) indicated on the survey that they purchased supplemental food in addition to their food bank orders. However, other pantries indicated that they received supplemental food from nonprofits (n = 35, 21.5%), churches (n = 20, 12.3%), businesses (n = 2, 1.2%), or local sororities (n = 4, 2.5%) (Appendix C).

Pantries Served a Wide Variety of Clients

Most pantries (90.8%) served both students and families, as well as community members (69.3%) and teachers and other school staff (63.2%). Some prioritized serving students and families over non-school community members, while others made it an explicit priority to serve community members. Even pantries that were not always open to the community typically allowed community members to come in at least occasionally. For example, of the pantries with a designated space, only 11 (6.6%) noted that they exclusively serve students. One coordinator summarized their philosophy around eligibility by saying:

> There are no rules of who can go in there and pull food. As long as the food is consumed, that is our only concern. I don't care who eats it. … If you're hungry, you qualify. [Wa3]

In elementary and middle schools, pantries rarely allowed students to attend by themselves without parents. Conversely, in high schools or combined middle and high schools, pantries were often available to students during the day or after school. Most often, coordinators reported that high school students stopped by to get snacks that they could eat in the middle of the day; however, some students also took bags of food home for their families after school.

Overwhelmingly, coordinators felt that their pantries served families that matched the racial and ethnic demographic of the school community and/or the surrounding community. In some cases, this meant serving a wide range of demographic groups, and other times this meant serving individuals from mainly the same demographic group (e.g., French-speaking, Spanish-speaking).

Reduce Deterrents (Quadrant 2)

In this section, we highlight how coordinators reduced deterrents to pantry use, aligned with Quadrant 2 of the GTE framework. Coordinators worked intentionally to reduce stigma, preserve client dignity, offer food and nutrition education, and improve accessibility through flexible scheduling and varied choice models.

Coordinators Worked Hard to Reduce Potential Stigma

Coordinators noted that stigma was a large barrier to clients utilizing the pantry and described numerous ways they aimed to reduce stigma for both adult and student clients. Coordinators paid special attention to details that would enhance clients' experiences. For example, coordinators used a variety of methods for tracking who visited the pantry. Two-thirds (n = 108, 66.3%) of pantries with a designated space and over half (n = 76, 63%) of those with distribution events reported using a sign-in sheet upon arrival. However, coordinators in the interviews described using tallies instead of writing down names and not requiring personal information or identification. Coordinators who did collect personal information noted that they either reported the information to the food bank or used it to contact clients in the future about distribution events or informational resources. Some coordina-

tors still believed that providing personal information to the food bank was required, although this requirement was rescinded in the past five years. During sign up, coordinators told clients what they were collecting and why, balancing logistics with discretion and understanding of clients' feelings and fears.

Additionally, coordinators whose clients shopped in the pantry were intentional about creating a physical space that felt warm and welcoming. Many emphasized that they wanted the pantry to be a place where clients felt comfortable, and that they would let clients shop on their own rather than "hovering around them" or micromanaging their experience.

Coordinators were particularly sensitive to the potential stigma experienced by students who visit the pantry. They often offered students options for how they would receive food–in a bag or directly into their backpacks–and would adjust the amount of food based on the response. Additionally, multiple coordinators worked to normalize use of the pantry by handing out bags of food to anyone who wanted them. Those coordinators noted that when students saw others taking them, they were more likely to stop by the pantry on a different day to get food.

> At lunchtime, after they finish their lunch, anybody that wants a bag gets it. … As the kids leave out [we ask], you want a bag? You want a bag? … Whoever wants a bag then takes a bag. [Do1]

Coordinators also noted that, after the COVID-19 pandemic, more students and families were familiar with using pantries than previously, because it was so common in their communities. They noted that there was less stigma and more positivity around the pantries in recent years.

Coordinators Focused on Client Dignity

Pantry coordinators noted that some clients did not want to take food from the pantries if they were dated past the date label (e.g., best by, sell by). Some clients, they explained, pointed out when foods were past their date label, noting that those items should be removed from the shelves. Currently, date labels are not federally standardized and do not provide information about food safety, but consumers often mistake foods past their date labels as inedible (Neff et al., 2025). Coordinators had varying levels of knowledge around what foods remained high quality and safe past their date labels. Some did not distinguish between types of date labels and noted that any foods past their date label should immediately be thrown away, while others acknowledged that those foods were still okay to eat. Approximately a quarter of the coordinators we interviewed were accurately informed about the differences in date labels and were aware that most foods in the pantry were able to be safely consumed even past the date.

Some coordinators tried not to serve foods that were past their date labels (e.g., best if used by, sell by, use by). This was a challenge for some pantries, because items that were less popular stayed on the shelves longer. Food going past date also occurred when coordinators accidentally ordered too much of a certain item or when they intentionally ordered too much food to meet the minimum amount required by the food bank for the month. Other coordinators—those who were more informed about date labeling practices—provided education to clients about date labels by handing out flyers or having in-person conversations. One client created stickers with a QR code that referred clients to educational websites about how to maximize the freshness and quality of items (e.g., USDA FoodKeeper app [FoodSafety.gov, 2019]) and handed out these stickers when shoppers visited the pantry.

Regardless of their knowledge on date labels, nearly all coordinators commented on being committed to providing high quality foods to their clients. As one coordinator noted:

> I don't want to give anyone something that I wouldn't eat myself. If I wouldn't serve it to my daughter, I wouldn't serve it to your sons or daughters. [So1]

Almost all coordinators described using a variety of methods to provide what they perceived as high quality food, including diligently rotating the items in the pantry, sorting through fresh produce

and throwing out items that were not fresh, giving past-date foods to farms for composting, donating close-to-past date foods to other schools, organizations, or churches for same-day distribution or putting those foods in the school lobby at pick-up time so parents could grab them without having to go to the pantry. Schools would also reach out to each other if they had extra food. A few coordinators mentioned that they would cook up hotdogs and burgers that were left over from the pantry and serve them to kids after school. Only two coordinators noted that they would add items into to-go bags and send them home with the families just to get rid of them, regardless of whether they thought clients would want them. They noted this was common with unpopular items such as cranberry sauce, canned vegetables, and low-sodium and low-fat items:

> Pg1: I'll give you an example. The cranberry sauce. That was the last thing on our list, and they've sent us 16 cases. … We throw it in a weekend bag because that's the only way we can get rid of it.
>
> Interviewer: Do you know if families are then just throwing it out?
>
> Pg1: I don't even ask after that point. What you do with it is your business. It takes up space here.

Coordinators Provided Food and Nutrition Education

Coordinators described lack of food, nutrition, and cooking education to be a barrier for some clients to use the pantry (i.e., they would not take items they were unfamiliar with) or for using the foods they received (i.e., they threw them out after receiving them). Three coordinators independently described finding items from the pantry scattered across the school parking lot or hearing that students left certain items on the buses instead of taking them home. To combat or avoid this situation, coordinators provided educational materials to clients, and in multiple languages. Some pantries sent out digital newsletters to all parents of students in the school, sharing nutrition facts and recipes that could be made with items from the pantry. Other pantries handed out flyers and recipe cards, and others provided in-person education to clients visiting the pantry. Approximately one quarter of coordinators noted that they prepared taste tests of certain items in the pantry. They found this particularly useful in helping students choose items with which they were unfamiliar. In addition to nutrition education, a few coordinators provided information about date labels, noting that this information helped parents feel more comfortable taking items that were close to the dates.

Coordinators Maximized Availability and Accessibility

At many schools, pantries are only open on designated days and times, which restricts some clients from using the pantry because of work schedules or other obligations. Coordinators described working hard to ensure that the pantries are available and accessible to clients. For example, both adult and student clients can request a pantry visit during a time when the pantry is not open, including evenings or on weekends. Coordinators noted that they sometimes change their schedules, work extra hours, and make multiple trips to the school on some days to accommodate these visits.

Although some pantries do have direct entry points from outside the school, schools with pantries accessible only from inside the building (i.e., through hallways inside the school) described this as a barrier for some clients to use the pantry. Schools have specific safety precautions for visitors and require all visitors to check in. This was a particular barrier for non-school affiliated community members, and especially undocumented individuals due to a misunderstanding of the sign-in process and/or fear of legal retribution for receiving services. Some pantry coordinators also asked clients to call ahead of time to make an appointment, so both the school and the pantry would be prepared. Although this was effective for some families, coordinators believed that these extra steps decreased participation and wished they had a way to provide service that did not require involvement from the school at large.

Even after maximizing availability and accessibility, coordinators described some existing barriers to pantry utilization. For example, they believed

that many potential clients lacked transportation to get to the pantry. Some clients do not have cars, which coordinators noted was especially problematic in rural areas where schools are not within walking distance from their homes and public transportation is not as widespread, reducing the number of clients who visit the pantries. In urban areas, many schools are located within walking distance of public transportation; however, coordinators noted that clients using public transportation tend to pick up fewer items from the pantry to make their travel easier. Coordinators felt that this barrier was out of their control but still expressed disappointment in not having the ability to reach potential clients.

Coordinators Use a Variety of Marketing Techniques

Approximately one-fifth (n = 41) of pantries surveyed described awareness of the pantry as a medium or high barrier to utilization. Coordinators spread awareness of the pantry through online marketing through social media, virtual classroom platforms (e.g., Google Classroom), and district websites and emails. Some schools also sent notifications to parents through text message or paper flyers. Around a quarter of coordinators interviewed noted that their schools had in-person events to help connect pantry clients with outside organizations or resources (e.g., housing, financial literacy). Coordinators often hosted a table at these events, handing out food and increasing awareness about the pantry. However, in the interviews, coordinators frequently stated that their current marketing tactics were not reaching as many people as they wanted to reach. Many coordinators said that they had capacity to increase the number of clients served, but did not know how best to inform families and community members. As one coordinator noted:

> How do we market? I've sent flyers. I've sent video messages. Again, it gets buried in yet another ding. … That's one of my biggest challenges. [Mo1]

Pantries use a Variety of Choice Models to Meet Clients' Needs

There is ample evidence that using full choice models decreases stigma and increases clients' willingness to visit a pantry (Martin et al., 2024). However, pantries in this study used varying levels of client choice, often to address barriers related to feasibility of running the pantry. Of those with a designated space, just over half (n = 91, 55.8%) utilized a full choice model, followed by no choice (n = 31, 19%), limited choice (n = 34, 20.9%), and modified choice (n = 16, 9.8%) models. For pantries with distribution events, an equal number used full choice (n = 44, 36.7%) and no choice (n = 46, 38.3%). Many coordinators, even those using no, limited, or modified choice, saw the importance of having students and families shop for their own food in the pantries. Those who strictly used a no choice model described mainly logistical barriers to offering choice, including serving many clients at once, wanting to make sure each family got similar types of foods, and/or wanting to provide a balanced distribution of items that would last multiple days. For example, one coordinator noted:

> That's a tough one. I have heard from families, like, "But it's 10 of us. Why can't I take three boxes of cereals?" [But] we have a hundred families in line. I'd rather have these one hundred families be able to go home with one box of cereal than just have 20 families take cereal. That one is always a tough one. [Bo1]

Numerous pantries used a combination of models. In these cases, coordinators would give families a set bag of food for the first time and then ask for feedback. In subsequent visits, coordinators used the feedback and knowledge gained from relationship-building to personalize bags. However, some coordinators noted that space was a constraint to allowing families to shop for themselves. Of all survey respondents, 17% (n = 32) reported that they had challenges with space. A few coordinators noted that they addressed space constraints by setting up tables and allowing clients to shop in a different space, such as the gym or cafeteria. This had drawbacks, however, as they were only available for shopping at very specific times and required effort to set up, run, and take down the event.

Improve Social and Economic Resources (Quadrant 3)

In this section, we describe how coordinators worked to improve social and economic resources, aligned with Quadrant 3 of the GTE framework. Coordinators connected families with wraparound services, referrals, and multilingual resources to provide support beyond food access.

Coordinators Connect Clients with Wraparound Services and Resources

Coordinators noted that, although they wanted to serve as many students and families as possible, the ultimate goal was for households to not need to use the pantries anymore. Coordinators also recognized that most families needed more than just food support, and almost all pantry coordinators connected clients with partners and resources outside of the school, such as organizations that offered housing services, banking services, and employment assistance. Many coordinators noted that these wraparound services were as important—if not more important—as providing food to clients. As one coordinator said:

> We're a school. I'm not a supermarket and I don't want to be a supermarket. How can I help to make those connections with partners so that families are getting what they need to be successful? [Aa1]

Coordinators connected clients through direct connections or referrals to other organizations, or by providing information to families through collated lists of resources. Additionally, some pantries had a designated area (e.g., table, wall) that highlighted additional resources. These were openly available to clients when they came to the pantry, but coordinators would also pass them out when they saw or heard about a specific need. Community school coordinators were most likely to know of and hand out resources, since this was part of their job separately from the food pantry. Around half of the coordinators noted that they provided multilingual resources.

Around a quarter of coordinators also described having in-person events to help connect pantry clients with outside organizations. These events were centered around non-food activities (e.g., literacy fair, family night), but there was almost always a food distribution component. Many coordinators described the relationships with outside partners as mutual and reciprocal; they helped connect pantry clients with other organizations and those organizations connected their clients with the school pantry.

Many, but not all, pantries provided information about how families could sign up for federal programs, such as the Supplemental Nutrition Assistance Program (SNAP) or the Special Supplemental Program for Women, Infants, and Children (WIC). None of the pantries we talked to directly assisted clients with signing up for these programs, although a few pantries were able to direct clients to partners who could assist them.

Build on Community Capacity (Quadrant 4)

In this section, we describe the strategies coordinators used to build on community capacity, aligned with Quadrant 4 of the GTE framework. Coordinators emphasized building trusting relationships with students and leveraging partnerships with local organizations, other schools, and individuals to aid pantry operations.

Coordinators Build Relationships with Students

In all interviews, we found that relationships are at the heart of school food pantry coordinators' work. In the older grades, coordinators worked hard to build rapport with students so they would feel comfortable utilizing the pantries. For example, coordinators mentioned keeping snacks in the pantry that students would want to eat during the day, having students volunteer in the pantry so they could promote it to their peers, and promoting the pantry to everyone (i.e., no income restrictions). They said this helped build relationships with students, brought in new students who might not have otherwise visited the pantry, and built general rapport in the school. One coordinator illustrated this by saying:

> The first couple times, students can be really intimidated. They're like, "Oh, my gosh, I can't believe I have to go here and get food for my family." But then they walk in [and] there's like

> 20-30 people hanging out, having a good time. I [tell my volunteers], "We don't say, 'Do you need this?' or things like that. It's just, 'Hey, we have this, would you like it?'" [Wi1]

Coordinators Leverage External Partnerships to Procure Food

Pantry coordinators built external relationships with local community organizations, libraries, churches, and nearby schools to supplement foods received from the food bank and acquire other nonfood items. Although they often had enough food to meet clients' needs, they worked to expand the variety of foods they offered, specifically high-demand items such as fresh produce, meat, and eggs. Most often, coordinators described receiving free items from local nonprofit organizations and churches. A few coordinators described receiving items from individuals, such as families that attend the school, community members that live near the school, and even school staff. Two coordinators noted that they sometimes received leftover produce or canned items from the cafeteria. Other coordinators purchased or received free items from farms or for-profit businesses. One coordinator noted that they specifically fundraise to purchase additional food from wholesalers, because they have more freedom to choose items they know students and families will want, or to provide special items for families such as birthday cake mixes. However, many pantries had limited funds to purchase food from outside businesses or organizations, and coordinators described continuously looking for funding and writing grants so they could consistently offer a wide selection of foods.

Coordinators often built informal relationships with partners outside of work, on weekends or in the evenings. None of the coordinators directly acknowledged that this was an important part of their work, but they did tell stories about how the personal connections made outside of work helped sustain the pantry financially (e.g., through monetary or food donations) and/or provided additional supports for clients.

Coordinators Faced Barriers to Building Capacity

However, connecting with external partners also posed challenges, as running the pantry was only one of many hats worn by coordinators. Fifty-six percent (n = 111) of survey respondents reported their main role as community school coordinators; 32% (n = 62) were counselors, 29% (n = 57) were volunteers at the school, 13% (n = 25) were teachers, and 6% (n = 12) were administrators. Many coordinators we spoke with had limited time during the day for capacity building with outside partners, and a quarter of survey respondents (n = 52, 27.5%) described lack of staffing as a high or medium barrier to their operations. Coordinators noted that these relationships were typically not documented, which would make it difficult to pass the information to succeeding coordinators. Indeed, multiple coordinators we spoke with worried that if they left their job, the pantry would shut down or, at the very least, run less efficiently and effectively.

Discussion

In this mixed-methods evaluation, we used the GTE framework to map the ways in which school-based food pantries in Maryland promoted equity through operations and utilization. School pantries sought to improve food security of households through providing desirable, culturally appropriate, and often healthy foods to a wide variety of adult and student clients (Quadrant 1). Coordinators recognized numerous factors that hindered pantry utilization and adjusted their approaches to increase desirability and usability for clients and feasibility for the coordinators themselves (Quadrant 2). Coordinators recognized the need to provide social and economic resources, such as information about other nutrition assistance programs as well as nonfood resources (Quadrant 3). Finally, coordinators built on community capacity by leveraging partnerships with external donors to expand their food options and forming relationships with students to reach a wider population (Quadrant 4).

Additionally, all pantries exemplified the three GTE foundational principles—promoting equity, engaging communities, and centering people. For example, coordinators emphasized the importance of listening to student and family preferences and responding to their needs. Through the act of listening to clients (community engagement), coordinators came to understand clients' goals at the pan-

try (centering people) and provided foods they would not have been able to access otherwise (providing equitable options). In general, pantry coordinators were essential to ensuring equitable implementation and, although not explicitly stated, they consistently looked for ways to advance equity in both operations and utilization. We often think of equity as creating opportunities that level the playing field between those with more wealth, resources, and opportunities and those who have less. Thus, food pantries themselves are an equitable intervention as they aim to alleviate financial strain on households and allow them to allocate their resources toward other essential needs. However, even within equity-targeted interventions, we must consider the extent to which equity is operationalized and implemented. Equitable implementation means that an intervention maximizes reach to the population of interest (i.e., inclusiveness, participation, utilization, destigmatization, operational flexibility, etc.); is sensitive to the needs and preferences of the population of interest; preserves dignity and affords an appropriate level of privacy; provides high quality resources and support (in this case, high quality, safe, and nutritious food); maximizes use of available resources and avoids waste that would work against overall program effectiveness; and works toward self-sufficiency (S. Kumanyika, personal communication, April 23, 2025).

In many ways, school pantries simply acted as community pantries located in schools. This was particularly true for elementary school pantries, which were primarily open to guardians and community members, and rarely allowed students to utilize the pantry on their own. School pantries also promote equity in some similar ways to community pantries. For example, pantry coordinators noted that they ordered foods with intention, balancing nutrition, cultural relevance, and convenience to provide items clients wanted to eat (Kinderknecht et al., 2023; Martin et al., 2021). Additionally, some school pantries in this study provided food and nutrition education (An et al., 2019; Hardison-Moody et al., 2015), used full choice models (Martin et al., 2024; Sanderson et al., 2020), leveraged external partnerships to procure food (Gibson et al., 2022; Lowrey et al., 2024), and connected clients with wraparound services and resources (Martin, Redelfs et al., 2019; Sanderson et al., 2020). Traditionally, it has been beyond the scope of the charitable food system to address root causes of food insecurity; however, within the past decade, many food banks began to engage in root cause work. For example, addressing the root causes of hunger is highlighted on both MFB's and CAFB's websites, and since 2018, has been part of MFB's strategic plan (Maryland Food Bank, n.d.) and research efforts (Sturm, 2024). In recent years, Feeding America has added goals to create partnerships with organizations to address underlying causes of hunger (e.g., poverty) and advocate for anti-hunger policies in addition to their primary goal of providing food with respect and dignity (Feeding America, n.d.-b).

However, in other ways, school pantries operated in unique and novel ways compared to community pantries. For example, school pantries can build stronger relationships with clients because they have more touchpoints with each client. As opposed to community pantries, where clients may visit weekly or monthly (Coleman-Jensen & Rabbitt, 2021), pantry coordinators at elementary schools may connect with students' guardians during pickup and drop-off times. In schools of all grade levels, teachers and other school staff connect with guardians regularly about students' academic progress. Additionally, teachers, counselors, and other school staff interact with individual students every day and often know what students are experiencing outside of school and what additional resources they may need for support (Thomas et al., 2019). School pantries also have the advantage of being able to advertise through existing school channels. In this study, coordinators noted that they used email, newsletters, and in-person events at the school to engage potential clients. Schools tend to have up-to-date contact information for parents and can also hand out paper fliers, which is important for low-income populations who may have inconsistent access to technologies such as phone and email (Vogels, 2021). Some coordinators in this study also noted that they accommodated clients if they were not able to come during regular hours. Limited hours of operation has been identified as a major barrier to access of commu-

nity pantries (Ginsburg et al., 2019). Because coordinators typically work at the school all day, even when the pantry is not open, they may have more flexibility compared to coordinators at community pantries, who may have to drive to the pantry on days it is not open.

School pantries are also uniquely positioned to support adolescents experiencing food insecurity. Studies have also shown that adolescents in households experiencing food insecurity often take responsibility for household food acquisition (Mmari et al., 2019; Popkin et al., 2016) and that adolescents wished there were more places near to school where they could acquire free food (Harper et al., 2022). In this study, we found that pantries located in high schools were often open to both adults and students and that coordinators used strategies to reduce stigma and increase student awareness. Still, it is unknown if school pantries reach the number of students who are in need. In 2018, the Risk Youth Behavior Survey found that 28% of high school students in Maryland experienced food insecurity, and that Black, Latino, and Indigenous students were at a disproportionately higher risk (Kelley, 2020). Involving students in the design, marketing, and outreach of the pantry may help increase engagement and awareness (Feeding America & Urban Institute, 2015). Involving students in the ordering process may also ensure foods in the pantry meet the specific needs of students and their households. However, it is important that pantries in high schools also continue outreach to students' parents and guardians to avoid "adultizing" students by giving them the primary responsibility of food acquisition (Harper et al., 2022). Additionally, a challenge for high school pantries is balancing the provision of healthy foods and foods students want to eat. Adolescents have the lowest diet quality of all age groups in the U.S. (Dietary Guidelines for Americans, 2022), and studies have found that adolescents often choose foods with high sodium, sugar, and saturated fat (Neumark-Sztainer et al., 1999). High school pantry coordinators in this study noted that they wanted to provide nutritious options, but that their top priority was ensuring students want to visit and feel comfortable visiting the pantry. Strategies such as taste tests and cooking demonstrations may help with students' willingness to try new foods (Nekitsing et al., 2019), but more research is needed in the context of school pantries.

School pantries of all grades in this study provided numerous healthy options for clients, reflected by the mean CFNI score of 70.1. However, there was large variability in CFNI scores for school pantries, with nearly half of the pantries scoring lower than 70 points. Although the CFNI was recently developed and there is limited information on typical or ideal pantry scores, an analysis of three USDA household nutrition programs found that scores ranging between 74.4 and 81.1 out of 100 points reflect "availability of healthy foods" (Gombi-Vaca et al., 2023). We did not explicitly ask about coordinators' perceptions of the nutritional quality of the foods offered in the pantries, though they discussed numerous reasons, and some challenges, for ordering specific items. Although the food banks list the nutritional ranking of each item on the website according to the Supporting Wellness at Pantries (SWAP) stoplight system (Martin, Wolff et al., 2019), there is no guidance for pantry coordinators about what ratio of green, yellow, and red items they should order. Feeding America may consider providing standardized guidance for food banks and pantries about recommended ranges for CFNI scores. Additionally, food banks may consider calculating CFNI scores for all pantry orders to increase awareness and encourage pantry coordinators to choose items that add up to overall higher scores. Ensuring nutritious foods are consistently available in school pantries will increase equitability of food access for students and families.

In this study, we identified challenges that may make operations more difficult for school pantries compared to community pantries. For example, running the pantry was often not coordinators' full-time jobs, and they had a distinct disadvantage when ordering foods. According to MFB staff, community pantries with full-time staff can monitor the food bank websites more often, so they often get first choice in what they are able to order. One way MFB is working to correct this is by introducing "cart protection" for online ordering, which will allow coordinators to place items in their carts without the risk of losing them if they

have to pause and come back later (MFB, personal communication, December 17, 2024). Overall, food banks can support school pantries by providing efficient, easy-to-use ordering platforms, using coordinator feedback to ensure the items available for order align with communities' needs, and helping coordinators brainstorm solutions to problems. Other challenges we identified in this study (which are not necessarily unique to school pantries) include lack of client transportation to reach the pantry; lack of pantry awareness; what to do with surplus food if they did not have connections to outside organizations or other schools who wanted to take it; logistical barriers to using full choice models; and barriers to building capacity, including wearing too many hats, lacking staff support, and sustainability of the pantry when coordinators left the position. To address these challenges, it may be beneficial to create communities of practice (Mercieca, 2017) or other collaborative spaces for school pantry coordinators across the state to share best practices, successes, challenges, and strategies for problem solving.

Strengths and Limitations

This study had many strengths, including the high response rate of survey respondents and using qualitative methods to explain survey results. Additionally, the researchers worked closely with MFB and CAFB throughout the research process, including question formation, study design, and tool creation. We presented results to the food banks and used feedback to help shape analysis and discussion. Additionally, this study utilized the GTE framework, which focuses heavily on implementation of interventions (in this case, school food pantries). Interventions are often complex and setting-specific, and effectiveness depends on implementers' ability to respond to challenges and adapt approaches to unique populations.

This study also had some limitations. This landscape analysis included only one state and two Feeding America food banks, and the results may not be generalizable elsewhere. Some counties were also over- and underrepresented in our analyses, and results may better reflect pantries with certain characteristics over others. Additionally, we were only able to conduct the nutritional assessment in 21 pantries, which was sufficient for providing a general overview of the pantries but not enough to conduct robust statistical analyses. We also recognize that the GTE is a two-dimensional logic model, and that some themes fit into two or more domains. However, as the scales of justice in the figure represent, efforts are most likely to advance equity when all four quadrants build on each other and reinforce each other in complementary ways. Future studies may consider pairing the GTE with systems mapping techniques, following the methods of Headen and colleagues (2025) to assess complex interventions and approaches to food access, nutrition, and obesity prevention (Headen et al., 2025).

Conclusions

This study described myriad ways school-based food pantries use equity to provide nutritious, dignified food access to low-income households with children. We found that there are many benefits to operating pantries within schools and, at the same time, school pantries face unique challenges that hinder their efficiency and effectiveness. The results of this study identified numerous equitable practices other school pantries may be interested to explore. However, we are left with numerous questions for further research: Do school pantry programs in other states promote equity in similar ways? What resources do schools need to support and promote the effectiveness of their pantries? What is the long-term impact of school pantries on food insecurity and student learning outcomes? A better understanding of school pantries, including how to leverage existing assets and address key barriers, will lead to more equitable food access for children, families, and communities.

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References

An, R., Wang, J., Liu, J., Shen, J., Loehmer, E., & McCaffrey, J. (2019). A systematic review of food pantry-based interventions in the USA. *Public Health Nutrition*, *22*(9), 1704–1716. https://doi.org/10.1017/S1368980019000144

Blueprint for Maryland's Future. (n.d.). *Community Schools & Concentration of Poverty Grants*. Maryland State Department of Education. Retrieved December 1, 2022, from https://blueprint.marylandpublicschools.org/community-schools-concentration-of-poverty-grants/

Braveman, P., Arkin, E., Orleans, T., Proctor, D., & Plough, A. (2017). *What is health equity?* Robert Wood Johnson Foundation. https://www.rwjf.org/content/rwjf-web/us/en/insights/our-research/2017/05/what-is-health-equity-.html

Christner, M. A., & Cotugna, N. (2014). Evaluation of a school food pantry program. *Journal of Hunger & Environmental Nutrition*, *9*(3), 362–371. https://doi.org/10.1080/19320248.2014.908451

Coleman-Jensen, A., & Rabbitt, M. P. (2021, November 8). *Food pantry use increased in 2020 for most types of U.S. households*. *Amber Waves*. USDA Economic Research Service. https://www.ers.usda.gov/amber-waves/2021/november/food-pantry-use-increased-in-2020-for-most-types-of-u-s-households?utm_source=chatgpt.com

Cooksey-Stowers, K., Martin, K. S., & Schwartz, M. (2019). Client preferences for nutrition interventions in food pantries. *Journal of Hunger & Environmental Nutrition*, *14*(1–2), 18–34. https://doi.org/10.1080/19320248.2018.1512929

Dietary Guidelines for Americans. (2022, December 9). *HEI across childhood & adolescence*. https://www.dietaryguidelines.gov/node/362

Doll, C. L., Millikan, R., & Neal, H. (2023). School-based food pantries & the COVID-19 pandemic: Pantry organizers suggest both challenges and opportunities. *Journal of Hunger & Environmental Nutrition*, *18*(5), 753–771. https://doi.org/10.1080/19320248.2023.2204814

USDA Economic Research Service [USDA ERS]. (n.d.). *Food Access Research Atlas*. Retrieved January 29, 2025, from https://www.ers.usda.gov/data-products/food-access-research-atlas/go-to-the-atlas

Feeding America. (n.d.-a). *School food pantry program*. Retrieved January 15, 2025, from https://www.feedingamerica.org/our-work/hunger-relief-programs/school-pantry

Feeding America. (n.d.-b). *Our work*. https://www.feedingamerica.org/our-work

Feeding America. (2022, June 15). *More than 53 million people received help from food banks and food pantries in 2021* [Press release]. https://www.feedingamerica.org/about-us/press-room/53-million-received-help-2021

Feeding America. (2024). *Charitable food assistance participation in 2023*. https://www.feedingamerica.org/sites/default/files/2024-11/Charitable%20Food%20Assistance%20Participation%20in%202023.pdf

Feeding America & Urban Institute. (2015). *Bringing teens to the table: A focus on food insecurity in America*. https://www.feedingamerica.org/sites/default/files/research/teen-hunger-research/bringing-teens-to-the-table.pdf

FoodSafety.gov. (2019). *FoodKeeper app*. https://www.foodsafety.gov/keep-food-safe/foodkeeper-app

Gibson, S'R., Metcalfe, J. J., McCaffrey, J., Allison, T., & Prescott, M. P. (2022). Nutrition environment at food pantries improves after fresh produce donation program. *Journal of Nutrition Education and Behavior*, *54*(5), 432–441. https://doi.org/10.1016/j.jneb.2021.09.005

Ginsburg, Z. A., Bryan, A. D., Rubinstein, E. B., Frankel, H. J., Maroko, A. R., Schechter, C. B., Cooksey Stowers, K., & Lucan, S. C. (2019). Unreliable and difficult-to-access food for those in need: A qualitative and quantitative study of urban food pantries. *Journal of Community Health*, *44*, 16–31. https://doi.org/10.1007/s10900-018-0549-2

Gombi-Vaca, M. F., Xu, R., Schwartz, M. B., & Caspi, C. E. (2023). Construct validity of the Charitable Food Nutrition Index. *Preventive Medicine Reports*, *36*, Article 102515. https://doi.org/10.1016/j.pmedr.2023.102515

Gombi-Vaca, M. F., Xu, R., Schwartz, M., Battista Hesse, M., Martin, K., & Caspi, C. E. (2022). Validating a nutrition ranking system for food pantries using the Healthy Eating Index-2015. *Nutrients*, *14*(19), Article 3899. https://doi.org/10.3390/nu14193899

Hardison-Moody, A., Bowen, S., Bloom, J. D., Sheldon, M., Jones, L., & Leach, B. (2015). Incorporating nutrition education classes into food pantry settings: Lessons learned in design and implementation. *The Journal of Extension*, *53*(6), Article 22. https://doi.org/10.34068/joe.53.06.22

Harper, K., Skinner, R., Martinez-Baack, M., Caulfield, L. E., Gross, S. M., & Mmari, K. (2022). Strategies to improve adolescent food security from the perspectives of policy advocates, parents, and adolescents. *Nutrients*, *14*(22), Article 4707. https://doi.org/10.3390/nu14224707

Headen, I. E., Eaton, T. M., & Kumanyika, S. K. (2025). Using system dynamics mapping to explore synergy in an equity-focused obesity prevention framework. *Frontiers in Public Health*, *13*, Article 1525224. https://doi.org/10.3389/fpubh.2025.1525224

Jones, C. L., & Adkins, K. (2021). Nutrition literacy, food preference, and food choices within a school-based choice food pantry. *Journal of Hunger & Environmental Nutrition*, *16*(3), 370–386. https://doi.org/10.1080/19320248.2021.1873882

Kelley, T. L. (2020). *Food insecurity among middle and high school students in Maryland*. No Kid Hungry Maryland, Maryland PTA, & Advocates for Children and Youth. Share Our Strength. https://state.nokidhungry.org/maryland/wp-content/uploads/sites/8/2020/08/Food-Insecurity-Among-Middle-and-High-School-Students-in-Maryland-Aug-27-2020.pdf

Kinderknecht, K., DiPiazza, B., Ogbuefi, C., Rampersad, G., & Odoms-Young, A. (2023). *Key considerations for nutrition education programs and interventions for individuals experiencing food insecurity: An evidence review of reach, implementation, adoption, effectiveness, maintenance, and equity*. Feeding America. https://www.feedingamerica.org/sites/default/files/2023-08/Nutrition%20Education%20Evidence%20Review%20_f.pdf Kumanyika, S. (2024, January 11). *Getting to Equity framework: User worksheet*. https://gtetoolkit.councilbh.org/wp-content/uploads/2024/02/Appendix-1-GTE-Worksheet_1.11.24-fillable.pdf

Kumanyika, S. K. (2019). A framework for increasing equity impact in obesity prevention. *American Journal of Public Health*, *109*, 1350–1357. https://doi.org/10.2105/AJPH.2019.305221

Lee, S. G., Manker, G., Ghimire, N., Frost, L., & Buck, J. (2021). School pantry cook-off: An approach to educate youth on food insecurity. *The Journal of Extension*, *59*(4), Article 9. https://doi.org/10.34068/joe.59.04.09

Levi, R., Schwartz, M., Campbell, E., Martin, K., & Seligman, H. (2022). Nutrition standards for the charitable food system: Challenges and opportunities. *BMC Public Health*, *22*, Article 495. https://doi.org/10.1186/s12889-022-12906-6

Levi, R., Schwartz, M., & Seligman, H. (2020). Healthy eating research nutrition guidelines for the charitable food system. *Journal of the Academy of Nutrition and Dietetics*, *120*(9, Suppl.), Article A68. https://doi.org/10.1016/j.jand.2020.06.036

Lowrey, J., Chandrasekaran, A., Headings, A., & Hyder, A. (2024). Toward health promotion and prevention: Evidence from a food and health partnership model of care. *Journal of Operations Management*, *70*(6), 1007–1038. https://doi.org/10.1002/joom.1321

Martin, K. S., Redelfs, A., Wu, R., Bogner, O., & Whigham, L. (2019). Offering more than food: Outcomes and lessons learned from a Fresh Start food pantry in Texas. *Journal of Hunger & Environmental Nutrition*, *14*(1–2), 70–81. https://doi.org/10.1080/19320248.2018.1512925

Martin, K. S., Reynolds, M., Brown, K. L., Rugg, G., Berger, B. M., Campbell, M., Schumacher, A., Johnson, C., Agboola, F., & Streett, G. (2024). Offering full choice in food pantries is feasible and improves pantry operations. *Journal of Hunger & Environmental Nutrition, 19*(6), 805–819. https://doi.org/10.1080/19320248.2023.2291049

Martin, K. S., Wolff, M., Callahan, K., & Schwartz, M. B. (2019). Supporting wellness at pantries: Development of a nutrition stoplight system for food banks and food pantries. *Journal of the Academy of Nutrition and Dietetics*, *119*(4), 553–558. https://doi.org/10.1016/j.jand.2018.03.003

Martin, K., Xu, R., & Schwartz, M. B. (2021). Food pantries select healthier foods after nutrition information is available on their food bank's ordering platform. *Public Health Nutrition*, *24*(15), 5066–5073. https://doi.org/10.1017/S1368980020004814

Maryland Food Bank. (n.d.). *Strategic plan*: *MFB 3.0 Strategic Plan*. Retrieved March 4, 2025, from http://mdfoodbank.org/hunger-in-maryland/strategic-plan/

McGrath, C., Palmgren, P. J., & Liljedahl, M. (2019). Twelve tips for conducting qualitative research interviews. *Medical Teacher*, *41*(9), 1002–1006 . https://doi.org/10.1080/0142159X.2018.1497149

McLoughlin, G. M., McCarthy, J. A., McGuirt, J. T., Singleton, C. R., Dunn, C. G., & Gadhoke, P. (2020). Addressing food insecurity through a health equity lens: A case study of large urban school districts during the COVID-19 pandemic. *Journal of Urban Health*, *97*, 759–775. https://doi.org/10.1007/s11524-020-00476-0

Mercieca, B. (2017). What is a community of practice? In J. McDonald & A. Cater-Steel (Eds.), *Communities of practice: Facilitating social learning in higher education* (pp. 3–25). Springer. https://doi.org/10.1007/978-981-10-2879-3_1

Mmari, K., Offiong, A., Gross, S., & Mendelson, T. (2019). How adolescents cope with food insecurity in Baltimore City: An exploratory study. *Public Health Nutrition*, *22*(12), 2260-2267. https://doi.org/10.1017/S1368980019001216

Neff, R., Broad Leib, E., Khan, A., & Gunders, D. (2025). *Consumer perceptions of food date labels: 2025 national survey*. Food Law and Policy Clinic, Harvard Law School; Johns Hopkins Bloomberg School of Public Health; ReFED. https://refed.org/uploads/consumer-perceptions-of-food-date-labels-2025-national-survey-policy-brief.pdf

Nekitsing, C., Blundell-Birtill, P., Cockroft, J. E., & Hetherington, M. M. (2019). Taste exposure increases intake and nutrition education increases willingness to try an unfamiliar vegetable in preschool children: A cluster randomized trial. *Journal of the Academy of Nutrition and Dietetics*, *119*(12), 2004–2013. https://doi.org/10.1016/j.jand.2019.05.012

Neumark-Sztainer, D., Story, M., Perry, C., & Casey, M. A. (1999). Factors influencing food choices of adolescents: Findings from focus-group discussions with adolescents. *Journal of the American Dietetic Association*, *99*(8), 929–937. https://doi.org/10.1016/S0002-8223(99)00222-9

Popkin, S. J., Scott, M. M., & Galvez, M. M. (2016). *Impossible choices: Teens and food insecurity in America*. Urban Institute. https://www.urban.org/research/publication/impossible-choices-teens-and-food-insecurity-america

Proudfoot, K. (2023). Inductive/deductive hybrid thematic analysis in mixed methods research. *Journal of Mixed Methods Research*, *17*(3), 308–326. https://doi.org/10.1177/15586898221126816

Rabbitt, M. P., Reed-Jones, M., Hales, L. J., & Burke, M. P. (2024). *Household food security in the United States in 2023* (ERR-337). U.S. Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/publications/pub-details?pubid=109895

Sanderson, J., Martin, K. S., Colantonio, A. G., & Wu, R. (2020). An outcome evaluation of food pantries implementing the More Than Food framework. *Journal of Hunger & Environmental Nutrition*, *15*(4), 443–455. https://doi.org/10.1080/19320248.2020.1748782

Schwartz, M. B., & Caspi, C. E. (2023). The charitable food system as a change agent. *Frontiers in Public Health*, *11*, Article 1156501. https://doi.org/10.3389/fpubh.2023.1156501

Snelling, A., Maroto, M., Jacknowitz, A., & Waxman, E. (2014). Key factors for school-based food pantries: Perspectives from food bank and school pantry personnel. *Journal of Hunger & Environmental Nutrition*, *9*(3), 350–361. https://doi.org/10.1080/19320248.2014.929549

Sturm, D. (2024). *Root causes of hunger research*. Maryland Food Bank. https://mdfoodbank.org/wp-content/uploads/2024/02/Maryland-Food-Bank-Root-Causes-of-Hunger-Research-Report.pdf

Thomas, M. S., Crosby, S., & Vanderhaar, J. (2019). Trauma-informed practices in schools across two decades: An interdisciplinary review of research. *Review of Research in Education*, *43*(1), 422–452. https://doi.org/10.3102/0091732X18821123

UConn Rudd Center for Food Policy and Health. (n.d.). *Charitable food system*. Retrieved on April 20, 2020, from https://uconnruddcenter.org/research/foodsecurity/charitable-food/

Vogels, E. A. (2021, June 22). *Digital divide persists even as Americans with lower incomes make gains in tech adoption*. Pew Research Center. https://www.pewresearch.org/short-reads/2021/06/22/digital-divide-persists-even-as-americans-with-lower-incomes-make-gains-in-tech-adoption/

Yearby, R., Clark, B., & Figueroa, J. F. (2022). Structural racism in historical and modern US health care policy. *Health Affairs*, *41*(2), 187–194. https://doi.org/10.1377/hlthaff.2021.01466

Appendix A. In-Depth Interview (IDI) Guide for School Pantry Coordinators

Background information

- Tell me a little bit about yourself. [Possible probes:
    - How long have you worked at the school / in this district?
    - How long have you been in charge of the pantry?
    - What first attracted you to work at the pantry?]

Pantry information

- You noted on the survey that you run [name all food distribution programs]. Are there any other programs you run or that the school runs that weren't listed on the survey?
    - [If yes] Tell me about them (e.g., location, reach, hours of operation, frequency, eligibility, choice model, utilization)
- Tell us a bit about the people who normally access the pantry.
    - e.g., English as first/second language, typical age, number of people in family, etc.
- Is the pantry open year round? (i.e., during summer and winter breaks as well as during the school year?)
- On the survey, you indicated that your pantry is open [time, frequency]. Does that seem to be sufficient for everyone who wants to use the pantry?

Accessibility *[Getting to Equity Framework (GTE) sector: Reduce Deterrents]*

- How do people normally get to the pantry? (e.g., bus, own car, carpool)
    - Is there a bus line close by?
    - For people who drive, is there a designated place for them to park?
    - Do you have any transportation challenges with clients accessing the pantry?
- How do you typically advertise or recruit people for the pantry?
- Do clients need documentation or ID in order to access the food pantry?
- Do you have a disaster-related plan for your food pantry (e.g., for inclement weather, other school closures)
    - If so, please describe it.
- For community members who use the pantry, how do they interact with the school? (e.g., do they have to go through security, where do they come in?)
    - Is this ever a barrier for people to use the pantry?
- Tell me a bit about who your pantry might be missing. In other words, are there people in the community you serve who are not currently accessing the pantry?
    - Are there specific reasons why these groups don't access the pantry?

Food quality *[GTE sector: Increase Healthy Options]*

- On the survey, you indicated that your pantry offers [name examples of foods]. Who makes the decisions about what foods are in the pantry?
- What are some challenges you face in stocking the pantry?
- [If not addressed above] Are you satisfied with the types of foods available in the pantry?
- On the survey you indicated you used [name choice model]. Tell me a little bit about your choice model.
    - Is there a specific reason why you use this type of model instead of another?
- What type of guidance, if any, do you provide to clients about the nutritional quality of the foods in the pantry?

Barriers to operation and utilization *[GTE sector: Reduce Deterrents]*

- On the survey, you noted that [name challenges] were challenges your pantry faces. Tell me more about these challenges.
    - e.g., storage, staffing, space, awareness, funding *(for Capital Area Food Bank [CAFB] partners, specifically probe about funding)*
- How are these barriers the same or different for different groups, such as parents, students, and non-school community members?
- You noted that [name any challenges that have already come up in the interview]. What are some other challenges you face when running the food pantry?
- What are some ways you've overcome those challenges?

Other types of assistance *[GTE sector: Improve Social and Economic Resources]*

- On the survey, you indicated that you provide [name other types of resources available]. Tell me a little more about those resources.
- [If applicable] Tell me more about the guidance you provide on accessing federal nutrition assistance programs.

Community partnerships *[GTE sector: Build on Community Capacity]*

- Tell me about how the surrounding community (outside the school) supports the school pantry.
    - Specific partnerships?
    - Outside resources?

Closing

- Is there anything else you'd like to share about the pantry?

Appendix B. Guide for Evaluating School Food Pantries Using the Getting to Equity (GTE) Framework

Problem Statement

1. What was the problem addressed by creating/utilizing school food pantries?

Quadrant 1: Increase Healthy Options

1. Describe school food pantries in depth. What approach or combination of approaches did pantries use to address the problem described above?
2. What assumptions did coordinators make about how different populations could access the pantries, with respect to reach, participation, feasibility, or sustainability?

Quadrant 2: Reduce Deterrents

1. What community, policy, organizational, and sociocultural factors hindered success of the pantries with regards to…
    a. Whether the target population *wanted* to use the pantries (Desirability)?
    b. Whether the target population *could use* the pantries (Usability)?
    c. Whether the pantries were *able to be implemented* (Feasibility)?
2. How did the pantries address each of the factors above?

Quadrant 3: Social and Economic Resources

1. What type(s) of assistance or resources outside of the scope of the pantries could help address the problem outlined above?
2. In what ways did the pantries help connect the target population with those resources and other types of assistance?

Quadrant 4: Building On Community capacity

1. How did partnerships or advocacy help improve the likelihood that the pantries would be effective in addressing the problem at hand? What did the pantries gain from these partnerships or perspectives?
2. What community assets enhanced the work of the pantries? What existing networks and infrastructures were beneficial?

Systems Perspective

1. What were some of the potential positive side effects (“co-benefits”) of the pantries? In other words, what were some unintended benefits that fostered health or social equity in other ways?
2. What were some of the potential negative side effects of the pantries? How did coordinators manage these?

Appendix C. General Characteristics of Survey Respondents (*n* = 196) and Characteristics Based on School Food Pantry Type

	All pantries (*n* = 196) n (%)	Maryland Food Bank (*n* = 176) n (%)	Capital Area Food Bank (*n* = 20) n (%)
GENERAL CHARACTERISTICS			
Total respondents (response rate)	196 (87.9)	176 (92.1)	20 (62.5)
Community school			
Yes	142 (72.4)	124 (70.5)	18 (90)
No	43 (21.9)	41 (23.3)	2 (10)
Not sure	11 (5.6)	11 (6.3)	0 (0)
Grade levels served [a]			
Elementary	131 (66.8)	114 (64.8)	17 (85)
Middle	78 (39.8)	74 (42)	4 (20)
High	33 (16.8)	33 (18.8)	0 (0)
Pantry coordinator job title			
School administrator	10 (5.1)	9 (5.1)	1 (5.0)
Teacher	14 (7.2)	14 (8.0)	0 (0)
Volunteer	4 (2.1)	4 (2.3)	0 (0)
Counselor or social worker	42 (21.5)	42 (24.0)	0 (0)
Community school coordinator	89 (45.6)	72 (41.1)	17 (85.0)
Other	36 (18.5)	34 (19.5)	2 (10.0)
0–1 year	64 (32.8)	59 (33.7)	5 (25.0)
2–4 years	92 (47.2)	77 (44.0)	15 (75.0)
5 or more years	39 (20.0)	39 (22.3)	0
PANTRY MODEL: DESIGNATED SPACE			
***N* (% of total respondents)**	163 (83.2)	143 (81.3)	20 (100)
Access [a]			
Appointment	20 (12.3)	13 (9.1)	7 (35)
Invitation	19 (11.7)	16 (11.2)	3 (15)
Referral	2 (1.2)	2 (1.4)	0 (0)
Open access	88 (54.0)	74 (51.7)	14 (70)
Other	38 (23.3)	38 (26.6)	0 (0)
Frequency			
Less than once a month	3 (1.8)	3 (2.1)	0 (0)
Once a month	39 (23.9)	39 (27.3)	0 (0)
A few times a month	32 (19.6)	29 (20.3)	3 (15)
Once a week	26 (16.0)	25 (17.5)	1 (5)
A few times a week	33 (20.2)	22 (15.4)	11 (55)
Every day	13 (8.0)	12 (8.4)	1 (5)
Other	17 (10.4)	13 (9.1)	4 (20)

continued

	All pantries (*n* = 196) n (%)	Maryland Food Bank (*n* = 176) n (%)	Capital Area Food Bank (*n* = 20) n (%)
Time			
Morning only	8 (4.9)	8 (5.6)	0 (0)
Morning and afternoon	75 (46.0)	62 (43.4)	13 (65)
Afternoon only	39 (23.9)	38 (26.6)	1 (5)
Afternoon and evening	17 (10.4)	13 (9.1)	4 (20)
Other (e.g., during school day)	21 (12.9)	19 (13.3)	2 (10)
Average number of households served on a typical day			
0–10	45 (27.6)	40 (28)	5 (25)
11–30	49 (30.1)	38 (26.6)	11 (55)
31–50	29 (17.8)	28 (19.6)	1 (5)
51–100	34 (20.9)	31 (21.7)	3 (15)
>100	6 (3.7)	6 (4.2)	0 (0)
Choice model			
Full	91 (55.8)	75 (52.4)	16 (80)
Modified	16 (9.80)	15 (10.5)	1 (5)
Limited	25 (15.3)	23 (16.1)	2 (10)
No choice	31 (19.0)	30 (21)	1 (5)
Tracking use of the pantry [a]			
No tracking	22 (13.5)	21 (14)	1 (5)
Sign-in sheet	108 (66.3)	95 (49.7)	13 (65)
Sign-up ahead of time	24 (14.7)	18 (9.1)	6 (30)
Other	28 (17.2)	23 (11.9)	5 (25)
Eligibility [a]			
Students only	11 (6.7)	10 (7)	1 (5)
Students and families	148 (90.8)	134 (93.7)	14 (70)
Families	14 (8.6)	7 (4.9)	7 (35)
Community members	113 (69.3)	101 (70.6)	12 (60)
Teachers/school staff	103 (63.2)	91 (63.6)	12 (60)
Food source [a]			
Food bank	163 (100.0)	142 (99.3)	20 (100)
Nonprofit	35 (21.5)	34 (23.8)	1 (5)
Business	2 (1.2)	2 (1.4)	0 (0)
Church	20 (12.3)	17 (11.9)	3 (15)
Sorority	4 (2.5)	4 (2.8)	0 (0)
Purchased	21 (12.9)	20 (14)	1 (5)
PANTRY MODEL: DISTRIBUTION EVENT			
***N* (% of total respondents)**	120 (61.2)	111 (63.1)	9 (45)
Frequency			
1 per month	91 (75.8)	88 (79.3)	3 (33.3)
2 per month	14 (11.7)	13 (11.7)	1 (11.1)
3+ per month	15 (12.5)	10 (9)	5 (55.6)

continued

	All pantries (*n* = 196) n (%)	Maryland Food Bank (*n* = 176) n (%)	Capital Area Food Bank (*n* = 20) n (%)
Time [a]			
Weekday mornings	30 (25.0)	24 (21.6)	6 (66.7)
Weekday afternoons	84 (70.0)	78 (70.3)	6 (66.7)
Evenings	26 (21.7)	23 (20.7)	3 (33.3)
Weekends	5 (4.2)	5 (4.5)	0 (0)
Average number of households served per event			
0–10	8 (6.7)	8 (7.2)	0 (0)
11–30	29 (24.2)	24 (21.6)	5 (55.6)
31–50	34 (28.3)	33 (29.7)	1 (11.1)
51–100	38 (31.7)	38 (34.2)	0 (0)
>100	11 (9.2)	8 (7.2)	3 (33.3)
Model			
Full	44 (36.7)	37 (33.3)	7 (77.8)
Modified	12 (10.0)	12 (10.8)	0 (0)
Limited	18 (15.0)	17 (15.3)	1 (11.1)
No choice	46 (38.3)	45 (40.5)	1 (11.1)
Tracking use of the event [a]			
No tracking	21 (17.5)	20 (18)	1 (11.1)
Sign-in sheet	76 (63.3)	71 (64)	5 (55.6)
Sign-up ahead of time	17 (14.2)	13 (11.7)	4 (44.4)
Other	19 (15.8)	17 (15.3)	2 (22.2)
Eligibility [a]			
Students only	7 (5.8)	7 (6.3)	0 (0)
Students and families	111 (92.5)	102 (91.9)	9 (100)
Families	9 (7.5)	9 (8.1)	0 (0)
Community members	82 (68.3)	75 (67.6)	7 (77.8)
Teachers/school staff	68 (56.7)	62 (55.9)	6 (66.7)
Food source [a]			
Food bank	120 (100.0)	110 (99.1)	9 (100)
Nonprofit	31 (25.8)	29 (26.1)	2 (22.2)
Business	1 (0.8)	1 (0.9)	0 (0)
Church	16 (13.3)	14 (12.6)	2 (22.2)
Sorority	3 (2.5)	3 (2.7)	0 (0)
Purchased	21 (17.5)	20 (18)	1 (11.1)
PANTRY MODEL: BACKPACK PROGRAM			
***N* (% of total respondents)**	103 (52.6)	97 (55.1)	6 (30)
Frequency			
1 per month	2 (1.9)	1 (1)	1 (16.7)
2 per month	11 (10.7)	10 (10.3)	1 (16.7)
4 per month	78 (75.7)	75 (77.3)	3 (50)
Other	12 (11.7)	11 (11.3)	1 (16.7)

continued

	All pantries (*n* = 196) n (%)	Maryland Food Bank (*n* = 176) n (%)	Capital Area Food Bank (*n* = 20) n (%)
Average number of bags distributed per month			
0–50	47 (45.6)	43 (44.3)	4 (66.7)
51–100	20 (19.4)	19 (19.6)	1 (16.7)
101–500	30 (29.1)	29 (29.9)	1 (16.7)
>500	6 (5.8)	6 (6.2)	0 (0)
Tracking use of the program			
No tracking	9 (8.7)	9 (9.3)	0 (0)
Sign-in sheet	25 (24.3)	21 (21.6)	4 (66.7)
Sign-up ahead of time	50 (48.5)	48 (49.5)	2 (33.3)
Other	28 (27.2)	27 (27.8)	1 (16.7)
Eligibility [a]			
Students only	60 (58.3)	56 (57.7)	4 (66.7)
Students and families	43 (41.7)	41 (42.3)	2 (33.3)
Families	1 (1.0)	1 (1)	0 (0)
Community members	7 (6.8)	5 (5.2)	2 (33.3)
Teachers/school staff	12 (11.7)	11 (11.3)	1 (16.7)
Food source [a]			
Pack our own	53 (51.5)	50 (51.5)	3 (50)
Receive from another source	50 (48.5)	47 (48.5)	3 (50)
PANTRY MODEL: HOME DELIVERY			
***N* (% of total respondents)**	68 (34.7)	66 (37.5)	2 (10)
Average number of deliveries per month			
0–10	60 (88.2)	58 (87.9)	2 (100)
11–30	3 (4.4)	3 (4.5)	0 (0)
31–50	3 (4.4)	3 (4.5)	0 (0)
51–100	2 (2.9)	2 (3)	0 (0)
Tracking use of home delivery [a]			
No tracking	12 (17.6)	11 (16.7)	1 (50)
Sign-in sheet	27 (39.7)	26 (39.4)	1 (50)
Sign-up ahead of time	18 (26.5)	18 (27.3)	0 (0)
Other	14 (20.6)	14 (21.2)	0 (0)
Eligibility [a]			
Students only	4 (5.9)	4 (6.1)	0 (0)
Students and families	56 (82.4)	54 (81.8)	2 (100)
Families	8 (11.8)	8 (12.1)	0 (0)
Community members	14 (20.6)	14 (21.2)	0 (0)
Teachers/school staff	6 (8.8)	6 (9.1)	0 (0)

[a] Survey option to "Select all that apply"

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Exploring college student experiences with little pantries: A qualitative study addressing campus food insecurity

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Abstract

Food insecurity is a growing concern among college students, affecting academic success, physical health, and mental health. Food pantries are the most common intervention in higher education to address this issue; however, students often face barriers such as a lack of information about pantry locations and feelings of shame or resistance when seeking assistance. This study evaluates the Little Ram Pantries program, an innovative model developed in collaboration with community food banks and an existing campus pantry. The program provides nonperishable food items in compact containers strategically placed in public campus locations to enhance food access. Using exploratory qualitative methods, we conducted three focus

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Conflict of Interest

The authors declare they have no conflicts of interest to disclose.

groups with 13 college students at a public university in 2022. Thematic analysis was performed to explore students' experiences with the program. Findings indicate that the Little Pantries improved access to food assistance by offering barrier-free, quick access to essential items. Their placement in multiple public locations helped reduce the social stigma associated with pantry use and increased awareness of campus pantry services. Participants also noted that the visibility of the Little Pantries validated food insecurity as a common challenge among students, normalizing the experience. These results suggest that the Little Pantries program may be a promising way to complement traditional food initiatives and address systemic food insecurity through nonstigmatizing support services. Researchers, community practitioners, and policymakers are encouraged to advocate for and implement similar programs in campus and community settings to improve food access for marginalized and underserved populations.

Keywords
College food pantry, little pantries, food insecurity, focus group, stigma, higher education

Introduction

Food insecurity is becoming an epidemic in college. Approximately one in three college students experiences food insecurity, while the statistics vary to over 50% by college type, location, and characteristics of their student populations (Brito-Silva et al., 2022; El Zein et al., 2018, 2022; Government Accountability Office [GAO], 2018). The transition into the college years leads to financial stressors with educational investment and independent living. Food-insecure students often struggle to meet other basic needs, such as housing and daily essential payments, and face systemic obstacles to food security and academic growth (Kim & Murphy, 2024). Rising tuition and living costs continue to exceed available financial aid (Goldrick-Rab et al., 2017). A large body of research shows that these interconnected insecurities have negative impacts on their academic success, physical health, and mental health (Kim & Murphy, 2023; Leung et al., 2021; Taylor et al., 2019). There is wide recognition across academic, practitioner, and political spheres about the necessity of providing students with meals to ensure their academic achievement and healthy development for decades ahead (Fisher, 2017; Jyoti et al., 2005; Winicki & Jemison, 2003). The first national-scale effort to feed K-12 school students was the Truman administration's creation of the National School Lunch Program (NSLP) in 1946, followed by other programs, such as the National School Breakfast Program (SBP) in 1966 (U.S. Department of Agriculture, Food and Nutrition Service [USDA FNS], 2017, 2024a). These services and programs are not available once students leave high school. When young adults attend college, they face unexpected barriers to utilizing the benefits from the Supplemental Nutritional Assistance Program (SNAP), historically referred to as food stamps (Freudenberg et al., 2019; USDA FNS, 2024b).

Recently, greater scholarly focus has led to numerous research and programmatic interventions to mitigate this problem and its impacts. Food pantries on college campuses are the most common programmatic intervention in higher education, similar to community food banks in community settings. Since the Michigan State University Student Food Bank was founded in 1993, there has been a notable increase in the number of college pantries nationwide and students' utilization of campus pantries, with instances of usage even tripling at some universities (Callahan, 2018; Gammon et al., 2023; Schweitzer et al., 2022). Research has documented the significant benefits of college pantries in buffering food insecurity and its negative impacts (Gilbert, 2021; Gupton et al., 2018; Mooney et al., 2023).

While growing in presence across the nation, campus food pantries are not without their challenges. A systematic review reports that college pantries tend to be frequented most by students experiencing food insecurity, having a racial/ethnic minority identity, being a first-generation student, having an international student status, living off-campus, lacking a stable living arrangement, or relying on student loans (Idehai et al., 2024). Despite students' significant need for food assistance, research consistently identifies common barriers that hinder their utilization of campus pantries. The studies show that students do not have

adequate information about their campus-based pantries, need help understanding the logistical operations and policies of pantries, and feel resistance or shame about seeking this form of assistance (Brito-Silva et al., 2022; El Zein et al., 2018; Idehai et al., 2024; Jefferson et al., 2024). Also, college pantries face several challenges encompassing deficiencies in inventory management, inadequate funding, and insufficient staffing allocation (Daugherty et al., 2019; Goldrick-Rab et al., 2018; Jones et al., 2022; Schweitzer et al., 2022). These barriers lead to concerns regarding privacy, stigma, and the consequent underutilization of services (Idehai et al., 2024). To address the barriers, research suggests the necessity for convenient access through well-located and operational pantries, diverse food choices, and enhanced awareness of pantry services (Brito-Silva et al., 2022; Idehai et al., 2024).

Little Ram Pantries

Our prior research has found that approximately 35% of students at our institution experienced food insecurity (Kim & Murphy, 2023, 2024). To promote food access for college students, this study developed an innovative pantry model in 2021, the Little Ram Pantries Program (hereafter, Little Pantries). Like many other universities, our institution operates a central food pantry, the Ram Pantry (hereafter, Main Pantry). The Main Pantry is open Tuesdays to Fridays from 11 a.m. to 4:30 p.m. and provides perishable (fresh and frozen) and nonperishable foods in addition to non-food items (e.g., hygiene products). The Little Pantries seek to (1) increase pantry access by deploying miniature food pantries in campus buildings and (2) lower the potential stigma students might feel from utilizing food assistance. The Little Pantries program is inspired by the Little Neighborhood Library movement (Little Free Library, 2023). These miniature food pantries are small receptacles that resemble a newspaper stand. This study team launched the Little Pantries program with five satellite pantries in October 2021 and added eight more in March 2022 (Jones et al., 2024). The Little Pantries offer access to food 24 hours a day, seven days a week, at geographically dispersed points across the university, allowing for near-complete user anonymity. All pilot Little Pantries were deployed inside official university buildings, most in academic or communal buildings on campus, such as the library and gym, with one pantry in the lobby of a residence hall.

The Main Pantry is the logistical distribution center for the Little Pantries. The Main Pantry acquires food through a combination of direct donations from interested individuals and purchases from the regional food bank, FeedMore. Volunteers and student workers regularly pick up prepacked nonperishable dry food and hygiene products from the Main Pantry and then distribute them to the satellite locations of the Little Pantries. The research team attempted to standardize weekly distributions for each Little Pantry and maintain the flow and variety of the available items. For example, item restocking occurs weekly on Wednesdays, and the weekly allocated items are set in terms of quantity, types, and nutrition options. Also, signage on the Little Pantries informs students, faculty, and staff on how to place their donated items in the small stands directly. Student workers monitor and report safety issues (e.g., the presence of unapproved food, damaged food, and vandalism). The Little Pantries program represents a community engagement model through collective efforts from students, volunteers of staff/faculty, and community partnerships.

Methods

The current study is a formative evaluation conducted as part of a larger pilot project that develops and implements the Little Ram Pantries program on a public, urban college campus. We aimed to explore students' experiences with the pilot Little Pantries and incorporate the gathered data to inform on-campus pantry programs. This study conducted qualitative research utilizing focus groups because the program was in the pilot stage. The main research questions were: (1) How do students utilize the Little Pantries and campus resources? and (2) What do students suggest for enhanced food access on campus?

Procedures and Participants

The study's principal investigators (PIs) received approval from their university's Institutional

Review Board (IRB) in fall 2021. We recruited diverse undergraduate and graduate college students using a purposive sampling method in the spring of 2022 (*N*=13). The study participants were recruited via fliers posted across campus, university listserv emails, and word of mouth by their peers, campus staff, administrators, faculty, and instructors. Participants were eligible for the study if they were students at theuniversity, had experienced some level of food insecurity during the current academic year, and had used the Little Pantries on campus. Interested participants completed an initial screening survey to confirm eligibility and provide general background information. To assess the level of food insecurity, the screening survey included two questions: During the academic year, "I worried whether my food would run out before I got money to buy more," and "I have cut the size of one or more meals or skipped meals because I didn't have enough money to buy additional food." The study selected the participants if they responded "often true" or "sometimes true" to either question. To identify college pantry use, the screening survey also inquired about whether and how often Little Pantries were used and what other resources they usually relied on to meet their food needs (e.g., Main College Pantry, off-campus food pantry).

The research team utilized the screening data to ensure a purposeful and informed selection of participants, both to enhance the relevance of the findings for the Little Pantries program and to contribute insights for broader college food pantry initiatives. The selection process involved a multistep approach. First, we identified students at high risk of food insecurity, prioritizing those who responded "often true" or "sometimes true" to at least one of the validated food insecurity screening questions. From this pool, we prioritized individuals who reported regular and frequent use of Little Pantries, as their experiences would offer deeper insights into program engagement and effectiveness. Finally, we selected participants from diverse sociodemographic backgrounds, including variations in race/ethnicity, gender, and first-generation status, to capture a wide range of perspectives and lived experiences. The university serves a diverse student population and is designated as a Minority-Serving Institution by the U.S. Department of Education. Over 40% identify as white, around 20% as Black, close to 15% as Asian, and 10% as Hispanic; additionally, over two-thirds identify as female and more than 35% are first-generation college students (College Factual, n.d.; Data USA, n.d.; Virginia Commonwealth University, n.d.). Once deemed eligible and prioritized, the research team emailed individual participants to schedule focus group meetings.

We conducted three in-person focus groups, each consisting of four to five participants (*N* = 13), using a semi-structured interview guide. The guide was developed based on our prior research on food insecurity; input from faculty, pantry staff, and students; and pilot testing (Kim & Murphy, 2023, 2024; Kim et al., 2024). To refine the instrument, we piloted it with three undergraduate students who resembled the study's target group and had an interest in campus food insecurity. Their feedback helped us improve the flow of questions and clarify the role of facilitators. Each focus group began with informed consent, the establishment of group norms to foster a safe and open discussion environment, and a confidentiality agreement. The sessions then proceeded with a warm-up question about how participants typically meet their food needs before transitioning to two primary discussion topics: their experiences with the Little Pantries and their engagement with other campus food resources. Specific questions included (1) How did you first learn about the Little Pantries? (2) How have you used the Little Pantries (e.g., frequency, day, location, items)? How do you feel when using the Little Pantries? (3) What are the positive aspects of the Little Pantries? (4) What concerns or barriers have you experienced in using the Little Pantries? (5) What improvements would make the program more effective? and (6) We'd like to hear about what you all know and think about other resources for food on campus and in local communities. We used detailed prompts as needed to encourage participants to elaborate on their experiences and suggestions, fostering a comprehensive discussion. Each focus group meeting concluded with a debrief and reflection session.

Two of the authors served as primary and cofacilitators, while one of the PIs acted as a sup-

porting moderator and observer. After the completion of three focus groups, the research team conducted a debriefing and determined that data saturation had been reached, as no new information emerged. This aligns with qualitative research guidelines on sample adequacy and data saturation (Hennink et al., 2019; 2022). Each session lasted approximately 90 minutes and included a light meal. Participants received a US$30 incentive for their time. Discussions were audio-recorded and transcribed by a professional third-party service. To protect confidentiality, all collected data were securely stored in a locked cabinet in the PI's office and on password-protected computers.

Analysis

Three of the authors completed a thematic analysis via Braun and Clarke's (2021) steps for thematic analysis. After a third party transcribed all data, they reviewed the transcripts along with audio-recordings for accuracy. All personal, identifiable information was removed from each transcript, and participants' names were replaced with pseudonyms. Next, two authors read through transcripts to familiarize themselves with the data, noting any initial thoughts and codes. They then developed codes for the data line by line, meeting to discuss any discrepancies. The two authors then worked together to generate themes that supported the data and represented the lived experiences of all focus group members. They then met with a third research member to review all codes and themes.

Table 1. Sample Characteristics (*N* = 13)

Characteristics	*n* / Mean
Age (years)	23
Gender	
Cis Gender Male	5
Cis Gender Female	7
Transgender Male	1
Race/Ethnicity	
Asian	4
Hispanic/Latina/o/X	3
White/Caucasian/Western European	6
Academic Status	
Undergraduate	12
Graduate	1
First-Generation Student	
No	7
Yes	6

Results

The study participants included 13 college students with diverse backgrounds, as shown in Table 1. Half of the participants identified as female (53.85%) or first-generation college students (46.15%), and 46.15% self-identified as white and 30.77% as Asian. The average age of the participants was 23 (*SD* = 7.91), and the majority were undergraduate students (92.31%).

Our focus group analysis identified two central themes related to the utilization of Little Pantries (Research Question 1): notable distinctions from the traditional college pantry model and the perceived myth of resource scarcity. Also, the focus groups offered consistent suggestions for enhancing the visibility of college pantry resources (Research Question 2). We present a summary of these findings, accompanied by representative direct quotes, in Table 2 and provide the detailed results below.

Difference from Traditional College Pantries

Participants shared several benefits of having the Little Pantries. One of the primary benefits was how accessible they were for students. The Little Pantries are placed in academic and event spaces across campus. Participants largely shared that using the satellite pantries is barrier-free and quicker. Using the Main Pantry takes time because of the required forms to fill out and extra travel time by walking or finding transportation. Participants frequently reported limited time and ability to travel to grocery stores or the Main Pantry. Participants highlighted the strengths: "There is no barrier to entry. You don't have to sign up for anything to access it. You can just go and get something"; "Convenience. They're posted in a lot of places I go"; "Yeah, the accessibility and convenience. I start my day every morning at Little Pantries. So, I am able to swing by the [Little] pantry pretty easily"; "Accessible right now, things that I

can just tear open and eat right now"; and "Getting out from here [is] like back to the freeway so I can get home. It does take me scheduling and planning my week out to come to the pantry here [Main Pantry] at the campus." The Little Pantries gave many participants the ability to grab a quick snack between classes to curb their hunger and support their ability to focus. Participants stated, "The first time I used it, I think I got a granola bar out of there. I was in the library, and I was, actually, really hungry and having a hard time focusing. … It, actually, helped power me through, so it was nice"; "More grab-and-go type items show up in the Little Pantries because they can be an immediate like 'I need this today'"; "Having items in there like a granola bar that I can just snack on until I can get food makes it really nice. It makes it really nice. And then, I'm able to concentrate better."

Table 2. Themes and Sample Quotes

Research Question / Theme	Quotes
Question 1	
Differences from Traditional College Pantries	"There is no barrier to entry. You don't have to sign up for anything to access it. You can just go and get something."
	"convenience. They're posted in a lot of places I go."
	"Yeah the accessibility and convenience. I start my day every morning at Little Pantries. So, I am able to swing by the [Little] pantry pretty easily."
	"Accessible right now, things that I can just tear open and eat right now."
	"Getting out from here [is] like back to the freeway so I can get home. It does take me scheduling and planning my week out to come to the pantry here [Main Pantry] at the Campus."
	"To me you only go to the little pantry when you need something right now but versus going to the big pantry. I'm getting stuff, everything I need for the week."
	"… another thing about convenience is that you don't actually have to show a form to see what you want to get. So, you just pick it out from what you see."
	"The small ones are maybe more on-the-go kinds of things. And the big one is for like groceries. I feel like that's how it is right now."
Myth of Scarcity	"I don't want to overuse it because I feel like I know that there is so much food insecurity on campus. So I'm like yeah. I leave it like for the other people."
	"If there's a lot in it, I'll take something. If there's not, I'm leaving it alone."
	"… making sure there is that food so that if it gets low, people don't feel bad taking it."
	"If it's overstocked, I feel a lot better about taking something out because then, I feel like there is still a good amount for anybody else."
Question 2	
Hidden and Invisible College Pantries?	"I told my mentees, they're all first-generation students, I told them about the main pantry [in the student commons]. No one wanted to go. So, then I said I can go with you if you are worried about being judged for going to the pantry. And one student was like 'yeah, I would go if you came with me'."
	"I don't really know the process of getting to it and then, actually, getting the food out of it. So, I would say that's a big one for me. I knew there was one but I didn't know where it was or how to get to it, how to access it."
	"The pantry is so hidden away. It almost feels like I'm making that walk of shame passed [it]."
	"Part of why I feel weird using it sometimes is because the university has never actually put up a sign that says here is the pantry, come and get food if you need it."
	"I think to break this stigma is to make the Little Pantry [and Main Pantry] be more used. If you see more people using it, you will feel comfortable about using it because most of the time, I have the feeling that I'm the only one who is using it."

While appreciating the easy access, students spoke to the limited capacity of the Little Pantries in food options and quantity, which differs from the Main Pantry, where students typically find fresh or frozen products and other items used to make meals in a kitchen. Students wished for more options at the Little Pantries that would benefit their health, especially in academic buildings, the library, or the gym. A student said, "Sometimes, I check to see something interesting or different from the Main Pantry. I could stand [want to see] a box of protein bars." A few students shared their experiences of questioning about food in Little Pantries, saying, "I think it was odd; one day, I went to the little pantry, and it had [blueberry and apple] pie filling [in cans]. ... And I was like, that's awesome. ... And I know they have to go off of what's donated to them. But I thought it was really weird to have—I don't classify that as food [because I cannot make a full meal only with it]. So, that was sort of surprising. It seems like the Little Pantry has such limited space; you'd only want to put very generic things in there. And you'd want to have the more, different, or varied items at the Main Pantry instead. It was just sort of weird that they would have that in and have taken up the space in the little pantry with that, I think is where my head went" ; and "Actually, some of the stuff is expired. So, you have to be careful. ... I guess I'm like, it sucks, but it's free, so you can't complain." Also, students indicated that an increased number of Little Pantries would make them more comfortable using them. For example, one participant shared, "The more of them there are, I feel like the less insecure you feel about taking from the whole stash. Like, if you see them everywhere, then you're not going to be like, oh, this is the only one." This observation resonates with the following section.

Perceived Myth of Scarcity

Participants showed interesting perceptions and behaviors in utilizing the Little Pantries. Participants illustrated a common behavior of limiting what they took from the Little Pantries based on how many items were present, displaying a perception of scarcity of food resources. Some participants went as far as to wonder if there were enough food resources to stock the Little Pantries, commenting, "Sometimes, it looks like the Little Pantry might run out of food." They consistently described being more hesitant to take items if the pantries appear less well-stocked. One participant shared, "If there's a lot in it, I'll take something. If there's not, I'm leaving it alone." This tendency was highly connected to students wanting to ensure that other students would also have access to food. For example, one participant commented, "I don't want to overuse it because I feel like I know that there is so much food insecurity on campus. So, I'm like, yeah. I leave it like for the other people." Another participant agreed by commenting, "You can just picture the person showing up to the [little] pantry after six people, and you have taken something, and them opening it and there is nothing. That fear in my head, I think, if I leave something, then somebody has something. So, I always feel like I have to leave it [for other students]."

Students expressed a desire to ensure that they would not take away food from others, which also led to fears that they might not "deserve" the food. One participant said, "I think I also feel guilty because what if someone else needs it more than me." Students struggled with balancing their own needs with the needs of others when they perceived that supplies were scarce. One student described this struggle: "I would say concern that somebody else needs it more. I mean, I definitely do feel like I need it, but I don't know. I'm always going to think that, I'm always going to feel sort of guilty for using it." Students consistently reported being more comfortable taking food if the Little Pantries were more fully stocked. One student commented, "If it's overstocked, I feel a lot better about taking something out because then, I feel like there is still a good amount for anybody else."

Hidden and Invisible College Pantries?

Participants frequently spoke about their limited knowledge of the Little Pantries and the Main Pantry. Participants described difficulties finding out about the Main Pantry and the available resources on campus: "I have been going to my professors asking for help for the past year and a half. And it was not until this past semester, in November, that someone told me about the Main Pantry. And it just happened to be by happenstance. So, that was

a this is a resource that was not made available to me because I did not know that it existed."; "If it was in the syllabus, if it was actively publicized by the university, it would legitimize it." One participant described his experience asking multiple university employees, "I just started asking people. There's not a clearly defined organizational tree around student support. … I asked just everybody that I could find what resources—is there anything that I can get to help? And no one could provide me guidance." This was particularly true among first-generation students, who had limited information about campus resources. One participant explained, "I definitely felt at a disadvantage compared to my friends who already were pretty well educated [by their informal network] on all of the resources that the school had to offer. I just kind of like am slowly figuring it out." Another participant shared their experience in a first-generation student mentoring program for first-year students, where they discussed the Little Pantries with the new students and took them to one so that they could use them: "I told my mentees, they're all first-generation students, I told them about the Main Pantry [in the student commons]. No one wanted to go. So, then I said I can go with you if you are worried about being judged for going to the pantry. And one student was like, "Yeah, I would go if you came with me."

Student participants associated a feeling of frustration with inadequate advertising and limited institutional support. Students described that the college pantries are not advertised enough for students, and the university appears not to be actively advertising. One participant noted, "It's something that's available, but it's not publicized. [I think] the university itself doesn't encourage using it." Another participant echoed this sentiment: "The university actively does not want people to find the pantries because they're doing nothing to help us find them." They suggested the need to increase advertising and institutional support for college pantries with physical advertisements and signage on campus. Specifically, one participant shared, "I feel like signage is a big one. You could even have signs on the doors to buildings that there's the main pantry inside that building, potentially a sign pointing towards it, definitely towards the main pantry because that one is hard to find."

Students further pointed out that a lack of advertising and institutional support contributed to the stigma around food pantry use. They said it was rare to hear their close peers and university staff discuss the pantries. One participant shared, "Part of why I feel weird using it sometimes is because the university has never actually put up a sign that says, 'Here is the pantry; come and get food if you need it." They spoke to the importance of making the pantries widely used and normalized to reduce the stigma. One participant shared, "Eventually, if it has more signs and is more noticeable, and where it is, and the more people use it, eventually, it won't be as much stigma." Another participant shared, "I think to break this stigma is to make the Little Pantry [and Main Pantry] be more used. If you see more people using it, you will feel comfortable about using it because most of the time, I have the feeling that I'm the only one who is using it." Also, participants suggested that peer support could be a way to increase knowledge of the resource, whether through additional information during first-year student orientation or through a campus club that promoted the campus food pantry and its satellite pantries. For example, a participant stated, "One random thought that came to my head about being able to get Little Pantry or the Main Pantry out more is a club because you'd be surprised how many students, if they learned that there is a club that is here to actively promote and help with food insecurity, how many students would actually do that." They also commented that they believed that the pantries should be a source of pride for the university community: "It also should be a selling point of the university. It should be part of the bull horning announcements." Students underscored that they felt care from the community through sharing and donating food to the pantry.

Discussion

This study is among the first to focus on the on-campus Little Pantries program. Overall, the findings provide invaluable insights into how the Little Pantries may improve food access for college students and offer recommendations for more inclusive practices in addressing systemic food insecurity. This formative evaluation provides solid

evidence of the distinct contributions of Little Pantries to pantry models in college contexts.

First, our research underscores key advantages of Little Pantries over traditional college pantry models, particularly in their ability to improve food availability and accessibility. Focus groups consistently noted that the Little Pantries are "available" in multiple locations across campus, supplying grab-and-go style food in addition to the Main Pantry. Also, focus group participants frequently testified that the Little Pantries help make food easily "accessible" in several ways. The geographic proximity of multiple Little Pantry locations enables students to quickly alleviate hunger between classes. The findings demonstrate that Little Pantries enhance accessibility further by providing an administration-free supply, that is, 24 hours a day without prior planning, administrative check-ins, or direct interactions with pantry staff. These features are distinctly different from traditional campus pantries, which usually demand some level of time commitment and proactive engagement for food assistance. Previous studies document that the primary barriers to pantry utilization include limited knowledge about the presence and daily operations of their campus pantry and lack of time and transportation to visit (Brito-Silva et al., 2022; Dave et al., 2017; El Zein et al., 2022; Kim et al., 2024). The majority of the focus groups affirmed that students do not have adequate knowledge about the Main Pantry or hesitate to visit it and that the Little Pantries helped reduce those barriers.

Second, the increased accessibility of Little Pantries seems to reduce the stigma associated with pantry use. As discussed in community-based pantry research, the literature on college pantries reports that many students hesitate to visit college pantries due to feelings of embarrassment and shame (Brito-Silva et al., 2022; Ginsburg et al., 2019; Mooney et al., 2023). Our focus groups suggest that such feelings are often observed among first-generation and minority students, who disproportionately lack adequate information and access to campus resources. Our data also support that Little Pantries' visibility in common campus areas increases the awareness of campus food assistance, particularly for students who did not know about or rarely visited the Main Pantry. We note that the convenient placement of the Little Pantries in public areas contributes to validating food insecurity as a prevalent challenge among students and normalizing both pantry use and food insecurity.

Third, this study suggests several important considerations for enhancing the Little Pantries model. We note that students experience limited food availability in the Little Pantries in terms of options and amount. Although the Little Pantry provides compact container space, the study suggests that students would like a greater range of food items with additional healthy options, such as nutritious protein bars. Another is to improve food availability by maintaining a consistent and adequate food supply. Students expressed feelings of guilt and hesitation about using Little Pantries when stock levels were low. A limited supply led them to question whether pantry resources were scarce, whether they deserved food assistance, or whether they should defer to other students who they perceived as more food insecure. Prior studies have documented similar psychological barriers to food assistance participation, especially among individuals who see themselves as less deserving compared to others in greater need (McArthur et al., 2020; Parks, 2021). Our findings align with this research, revealing uncertainty among students about their eligibility for food assistance.

This study also extends the literature by demonstrating that perceived scarcity itself can influence resource utilization. This insight highlights an important area for further research, both in academic and programmatic contexts. Given that our pilot implementation relied on a combination of service-learning, volunteers, student workers, and research team members to restock the Little Pantries once a week, logistical challenges, such as managing decentralized locations, may have contributed to delays in replenishment and supply inconsistencies. These findings point to the need for administrative systems that ensure steady food availability and reduce psychological barriers to accessing these resources.

Fourth, we note a finding related to food acceptability. Although not many, a couple of students commented about food quality, for example, finding items with expired labels or items of questionable use. Literature on food pantries shows

that poor food quality discourages clients from using pantries and leaves them with concerns, dissatisfaction, and feelings of rejection (Long et al., 2023; Yamashiro et al., 2023). Our Little Pantries program allows community members to donate food items directly into Little Pantries, based on community trust. This finding suggests a need for the pantry's administrative team to monitor acceptable food and donation items and also provide guidelines about expiration dates (e.g., "best if used by" or "sell by").

Fifth, focus group discussions overwhelmingly emphasize the roles of higher education institutions in addressing campus food insecurity. The study finds overall agreement that the lack of publicity and institutional support for college pantries not only discourages students from utilizing campus food resources but also eventually contributes to increased stigma and shame around food insecurity. Students in our focus groups wanted to translate pantries into a visible source of university pride, not a hidden charity. Originating from student-led movements, many college pantries face understaffing and fund constraints and rely on volunteers and donations (Daugherty et al., 2019; Hale, 2020). Our focus group participants reiterated the importance of university support to promote public awareness and resources, consistent with previous studies (Brito-Silva et al., 2022; El Zein et al., 2018; Idehai et al., 2024). College students face systemic barriers to food security and academic success, as rising tuition and living costs outpace financial aid (Goldrick-Rab et al., 2016; 2017). Addressing structural inequalities in higher education requires stronger institutional support to meet basic needs and ensure student well-being and success. To grow food pantries into more than an emergency safety net, our study recommends advertising public information about the satellite and Main Pantry with an easily accessible map through the university website, social media, and advertisements; providing the information at the student orientations and in class syllabi; training university staff and faculty for identifying at-risk students and referring them to campus resources; and coordinating an integrated service structure that addresses food insecurity (e.g., food pantries, assistance with SNAP application, and healthy eating) with other co-occurring challenges (e.g., financial management, housing, mental health). These efforts will help normalize food insecurity, decrease stigma and self-isolation, and encourage students to seek services for their basic needs.

Limitations

This study is not free from limitations. As this study represents a formative evaluation of a pilot program using qualitative methods, the results should be interpreted with attention to the emerging program context rather than as broadly generalizable conclusions. First, a more representative sample would be desirable to include diverse voices, although our study does not aim to generalize the findings. We attempted to recruit diverse students who might resemble the student population. However, our sample did not include Black students. We recommend future research to have a better recruitment strategy for Black students. Second, our analysis reached satisfactory saturation from three focus groups with a total of 13 participants. Yet, we do not rule out the possibility that data from more focus groups or a larger group size might enrich the findings. Future research should address these potential limitations to improve the transferability of findings and to inform the development of more effective strategies for successful program implementation.

Conclusion

Our findings indicate that students view the Little Pantries program as a promising complementary strategy to traditional campus food pantry initiatives. This emerging model offers valuable, context-specific insights that may inform broader community efforts aimed at addressing poverty and promoting food justice. The findings highlight the potential benefits of an inclusive, community-engaged approach that prioritizes accessible, non-stigmatizing support services. While the program shows promise, its applicability may vary across settings, and further research is needed to explore its effectiveness in diverse contexts. Community-based food initiatives, such as mobile food trucks and micro-pantries, have gained attention as effective ways to address food insecurity (Arnold, J. M. (2004; Wilson et al., 2022). The Little Pantries pro-

gram demonstrates one such approach that may enhance food access in college settings and inform similar initiatives in other communities. Notably, the strength of the Little Pantries lies not only in providing additional food resources but also in reducing common barriers and fostering a sense of mutual aid and trust within the community. Addressing food insecurity requires layered efforts across the pantry, institutional, and policy levels. We recommend that universities and colleges adopt the Little Pantries model as part of broader food justice initiatives, in partnership with community partners, to enhance program effectiveness and create equitable access to basic needs for students.

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References

Arnold, J. M. (2004). *Charity food programs that can end hunger in America*. Second Harvest Gleaners Food Bank of West Michigan, Inc. https://www.endhungerinamerica.org/publications/charity-food-programs-that-can-end-hunger-in-america/chapter-three-making-sure-that-food-distribution-agencies-are-accessible-to-the-needy/

Braun, V., & Clarke, V. (2021). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology, 18*(3), 328–352. https://doi.org/10.1080/14780887.2020.1769238

Brito-Silva, F. de K., Wang, W., Moore, C. E., Warren, C., Miketinas, D. C., Tucker, W. J., & Davis, K. E. (2022). College campus food pantry program evaluation: What barriers do students face to access on-campus food pantries? *Nutrients, 14*(14), Article 2807. https://doi.org/10.3390/nu14142807

Callahan, C. (2018, February 16). *College food pantries keep students from choosing between food and books*. Feeding America. https://www.feedingamerica.org/hunger-blog/choosing-between-books-or

College Factual. (n.d.). *Virginia Commonwealth University: Student life – Diversity*. Retrieved April 7, 2025, from https://www.collegefactual.com/colleges/virginia-commonwealth-university/student-life/diversity/

Data USA. (n.d.). *Virginia Commonwealth University profile*. Retrieved April 7, 2025, from https://datausa.io/profile/university/virginia-commonwealth-university

Daugherty, J. B., Birnbaum, M., & Clark, A. (2019). *"Having enough"*: Students' understanding of food insecurity and campus food pantry use. *Journal of Poverty, 23*(7), 600–620. https://doi.org/10.1080/10875549.2019.1652721

Dave, J. M., Thompson, D. I., Svendsen-Sanchez, A., McNeill, L. H., & Jibaja-Weiss, M. (2017). Development of a nutrition education intervention for food bank clients. *Health Promotion Practice, 18*(2), 221–228. https://doi.org/10.1177/1524839916681732

El Zein, A., Mathews, A. E., House, L., & Shelnutt, K. P. (2018). Why are hungry college students not seeking help? Predictors of and barriers to using an on-campus food pantry. *Nutrients, 10*(9), Article 1163. https://doi.org/10.3390/nu10091163

El Zein, A., Vilaro, M. J., Shelnutt, K. P., Walsh-Childers, K., & Mathews, A. E. (2022). Obstacles to university food pantry use and student-suggested solutions: A qualitative study. *PLoS ONE, 17*(5), Article e0267341. https://doi.org/10.1371/journal.pone.0267341

Fisher, A. (2017). *Big hunger: The unholy alliance between corporate America and anti-hunger groups*. The MIT Press.

Freudenberg, N., Goldrick-Rab, S., & Poppendieck, J. (2019). College students and SNAP: The new face of food insecurity in the United States. *American Journal of Public Health, 109*(12), 1652–1658. https://doi.org/10.2105/AJPH.2019.305332

Gammon, C., Van Camp, C., Harkema, J., Summers, J., Leighton, P., & Moraniec, H. (2023). Establishing a university food pantry: Growth, changes in shopper characteristics and recommendations. *Journal of American College Health, 71*(1), 211–220. https://doi.org/10.1080/07448481.2021.1888736

Gilbert, K. C. (2021). *College student perspectives of food insecurity during the COVID-19 pandemic: A photo-elicitation narrative inquiry* (Publication No. 28801931) [Doctoral Dissertation, 28801931]. ProQuest Dissertations & Theses.

Ginsburg, Z. A., Bryan, A. D., Rubinstein, E. B., Frankel, H. J., Maroko, A. R., Schechter, C. B., Cooksey Stowers, K., & Lucan, S. C. (2019). Unreliable and difficult-to-access food for those in need: A qualitative and quantitative study of urban food pantries. *Journal of Community Health, 44*, 16–31. https://doi.org/10.1007/s10900-018-0549-2

Goldrick-Rab, S. (2016). *Paying the price: College costs, financial aid, and the betrayal of the American dream*. University of Chicago Press.

Goldrick-Rab, S., Cady, C., & Coca, V. (2018). *Campus food pantries: Insights from a national survey* (ED628059). The Hope Center for College, Community, and Justice. ERIC. https://files.eric.ed.gov/fulltext/ED628059.pdf

Goldrick-Rab, S., Richardson, J., & Hernandez, A. (2017). *Hungry and homeless in college: Results from a national study of basic needs insecurity in higher education* (ED610982). Association of Community College Trustees; ERIC. https://files.eric.ed.gov/fulltext/ED610982.pdf

Gupton, J. T., Trost, J. L., & Collins, K. (2018). Food pantries as a gateway for academic enhancement and basic needs support. *New Directions for Community Colleges, 2018*(184), 61–71. https://doi.org/10.1002/cc.20328

Hale, J. A. (2020). Campus food pantries: An emergent student resource. *The Community College Enterprise, 26*(1), 58–76. https://bbaddins.schoolcraft.edu/addins/cce/26.1.60-76.pdf

Hennink, M., & Kaiser, B. N. (2022). Sample sizes for saturation in qualitative research: A systematic review of empirical tests. *Social Science & Medicine, 292*, Article 114523. https://doi.org/10.1016/j.socscimed.2021.114523

Hennink, M. M., Kaiser, B. N., & Weber, M. B. (2019). What influences saturation? Estimating sample sizes in focus group research. *Qualitative Health Research, 29*(10), 1483-1496. https://doi.org/10.1177/1049732318821692

Idehai, O. V., Mbaya, P., Chung, T., & Bhurosy, T. (2024). A systematic review of factors associated with student use of campus food pantries: Implications for addressing barriers and facilitating use. *BMC Public Health, 24*(1), Article 97. https://doi.org/10.1186/s12889-023-17583-7

Jefferson, S., Cafer, A., & Mann, G. (2024). Food pantry offerings and awareness at a southeastern public university. *Journal of American College Health, 72*(5), 1575–1582. https://doi.org/10.1080/07448481.2022.2086006

Jones, J. C., Christaldi, J., & Cuy Castellanos, D. (2022). The acorn squash problem: A digestible conceptualisation of barriers to emergency food assistance. *Public Health Nutrition, 25*(4), 1045–1049. https://doi.org/10.1017/S1368980021003748

Jones, J. C., Linkous, L., Mathews-Ailsworth, L., Vazquez-Miller, R., Chance, E., Carter, J., & Saneda, I. (2024). Smart little campus food pantries: Addressing food insecurity at Virginia Commonwealth University. *Journal of Agriculture, Food Systems, and Community Development, 13*(3), 135–151. https://doi.org/10.5304/jafscd.2024.133.016

Jyoti, D. F., Frongillo, E. A., & Jones, S. J. (2005). Food insecurity affects school children's academic performance, weight gain, and social skills. *The Journal of Nutrition, 135*(12), 2831–2839. https://doi.org/10.1093/jn/135.12.2831

Kim, Y., & Murphy, J. (2023). Mental health, food insecurity, and economic hardship among college students during the COVID-19 pandemic. *Health & Social Work, 48*(2), 124–132. https://doi.org/10.1093/hsw/hlad006

Kim, Y., & Murphy, J. (2024). Food insecurity and economic hardship of college students: Before and during the COVID-19 pandemic. *Journal of Poverty, 28*(2), 134–149. https://doi.org/10.1080/10875549.2022.2128976

Kim, Y., Murphy, J., Craft, K., Waters, L., Gooden, B. I. (2024). "It's just a constant concern in the back of my mind": Lived experiences of college food insecurity. *Journal of American College Health, 72*(3), 980–987. https://doi.org/10.1080/07448481.2022.2064714

Leung, C. W., Farooqui, S., Wolfson, J. A., & Cohen, A. J. (2021). Understanding the cumulative burden of basic needs insecurities: Associations with health and academic achievement among college students. *American Journal of Health Promotion, 35*(2), 275–278. https://doi.org/10.1177/0890117120946210

Little Free Library. (2023, March 22). *Home.* https://littlefreelibrary.org/

Long, C. R., Bailey, M. M., Cascante, D. C., Purvis, R. S., Rowland, B., Faitak, B. M. S., Gittelsohn, J., Caspi, C. E., English, E. S., & McElfish, P. A. (2023). Food pantry clients' needs, preferences, and recommendations for food pantries: A qualitative study. *Journal of Hunger & Environmental Nutrition, 18*(2), 245–260. https://doi.org/10.1080/19320248.2022.2058334

McArthur, L., Fasczewski, K. S., Farris, A., & Petrone, M. R. (2020). Use and perceptions of a campus food pantry among food insecure college students: An exploratory study from Appalachia. *Journal of Appalachian Health, 2*(2), 7–23. https://doi.org/10.13023/jah.0202.02

Mooney, G., Drake, T., & Vollmer, R. L. (2023). A qualitative analysis of eating behaviors among food insecure college students. *Journal of Nutrition Education and Behavior, 55*(7), 531–540. https://doi.org/10.1016/j.jneb.2023.04.009

Parks, D. (2021). *Marketing to food insecure college students: An investigation into the University of Mississippi's food pantry* [Unpublished undergraduate thesis]. University of Mississippi.

Schweitzer, Z., Tonhu Nguyen, C., Sumekh, R., & Wang, M. (2022). *College campus food pantries: Learnings from a 2021 survey*. Swipe Out Hunger. https://www.swipehunger.org/wp-content/uploads/2022/05/College-Campus-Food-Pantries-Learnings-from-a-2021-Survey.pdf

Taylor, L. C., Delavega, E., Jin, S. W., Neely-Barnes, S. L., & Elswick, S. E. (2019). The prevalence and correlates of food insecurity among students at a multi-campus university. *Journal of Poverty, 23*(7), 621–633. https://doi.org/10.1080/10875549.2019.1656141

U.S. Government Accountability Office. (2018). *Food insecurity: Better information could help eligible college students access federal food assistance benefits*. https://www.gao.gov/assets/gao-19-95.pdf

Virginia Commonwealth University. (n.d.). *VCU achieves federal MSI status*. Office of the Vice President for Research and Innovation. Retrieved April 7, 2025, from https://research.vcu.edu/resources/msi/

Wilson, N. L. W., Calancie, L., Adkins, J., & Folta, S. C. (2022). Understanding micro-pantries as an emergency food source during the COVID-19 pandemic. *Journal of Nutrition Education and Behavior, 54*(4), 299–310. https://doi.org/10.1016/j.jneb.2021.11.002

Winicki, J., & Jemison, K. (2003). Food insecurity and hunger in the kindergarten classroom: Its effect on learning and growth. *Contemporary Economic Policy, 21*(2), 145–157. https://doi.org/10.1093/cep/byg001

Yamashiro, C. M., Davis, S., & Crutchfield, R. M. (2023). Positive and negative experiences of undergraduate students accessing a campus food pantry. *Journal of Student Affairs Research and Practice, 60*(5), 594–607. https://doi.org/10.1080/19496591.2022.2133608

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Food insecurity and social connections among university food pantry users before and during COVID-19

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Abstract

Student food insecurity is a significant concern on college campuses in the United States and beyond. While demographic risk factors for food insecurity are well-documented, the influence of social factors, such as social relationships and social support, remains less understood. This study aimed to explore the experiences of college food pantry users in relation to food insecurity and social connections. Participants included 53 student food pantry users from a university in the southeastern United States. The study used a mixed-methods approach, incorporating a quantitative survey to assess food insecurity, social support, social isolation, and demographics, alongside eight qualitative interviews to explore experiences before and during the COVID-19 pandemic. Findings indicated that 47% of participants reported very low food security on the U.S. Adult Food Security Questionnaire, and 30% reported low food security, signifying that together 77% of the sample had experienced food insecurity within the past 12 months. On average, moderate levels of both social support and social isolation were reported, with considerable variation among participants. A key finding is that past food insecurity or adverse life events in the previous year increased the likelihood

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of very low food security. Qualitative themes included the impact of the pandemic on food security and food pantry access, the role of social connections, and the challenges of resource navigation. The qualitative findings emphasize the importance of social connections in securing access to food and the impacts of social isolation on food security and general well-being. Drawing from these insights, food insecurity may be viewed as a traumatic experience. Therefore, it is recommended that university food pantries adopt a trauma-informed approach to service delivery and screen students for critical risk factors such as past food insecurity and adverse life events. By implementing these strategies, food pantries can foster a safe and supportive environment and integrate social support resources and programs within their spaces.

Keywords
college students, food insecurity, food pantry, social support, resources, trauma-informed approach, COVID-19

College Student Food Insecurity

Food insecurity affects a significant proportion of college students in the United States and beyond (Bruening et al., 2017; Nikolaus et al., 2020). Its prevalence is so notable that it has been described as a syndemic—a set of interconnected health and social issues (Zhong & Xie, 2025). Food insecurity is defined as having "inadequate access to safe, nutritious food to sustain an active and healthy lifestyle" and is classified as either very low or low food security scores on the U.S. Adult Food Security Questionnaire (U.S. Department of Agriculture, Economic Research Service [USDA ERS], n.d.). Meta-analyses estimate food insecurity rates on college campuses to range from 32.9% (Bruening et al., 2017) to 41% (Nikolaus et al., 2020). These figures are considerably higher than national food insecurity trends, which have generally declined from 14.6% in 2008 to 10.2% in 2021, although the rate increased to 12.8 % in 2022 to 13.5% in 2023 (Rabbitt et al., 2024; USDA ERS, 2022). This disparity indicates that college students face a heightened risk of food insecurity compared to the general population. Research during the COVID-19 pandemic revealed a sharp rise in food insecurity among students, driven by changes in financial support, employment, and housing stability (Mialki et al., 2021; Rafferty et al., 2023; Soldavini et al., 2021). Notably, these elevated rates persisted in the aftermath of the pandemic (Zhong & Xie, 2025).

Consequences and Correlates of College Student Food Insecurity

The impacts of food insecurity on college students are evident across multiple dimensions of holistic well-being. Students experiencing food insecurity are more likely to suffer from anxiety and depression (Mukigi et al., 2019) and report higher levels of stress and poorer sleep quality (El Zein et al., 2019) compared to students without food insecurity. The consequences of food insecurity also poorly affect academic performance (Bruening et al., 2017), including decreased attention and concentration (Mukigi et al., 2019), lower grade point averages (El Zein et al., 2019; Morris et al., 2016; Patton-López et al., 2014), lower classroom attendance rates, and an increased likelihood of failing or withdrawing from courses (Silva et al., 2017). A qualitative study by Meza et al. (2019) found that food-insecure students often have poorer academic performance and elevated stress levels when experiencing hunger. As such, the specific experiences of hunger and very low food security are two separate but related concerns within the broader context of food insecurity, and both are particularly concerning issues for college students. Hunger is defined as "a potential consequence of food insecurity that, because of prolonged, involuntary lack of food, results in discomfort, illness, weakness, or pain that goes beyond the usual uneasy sensation" (USDA ERS, 2025b). While it is difficult to measure hunger using survey methods, studies show that very low food security is associated with hunger and the symptoms of hunger (Carlson et al., 1999; Kendall et al., 1996).

Food insecurity disproportionately affects students of color in U.S. universities (Bruening et al., 2017; El Zein et al., 2019; Morris et al., 2016). Socioeconomic factors contributing to this issue include lower income levels (Patton-López et al., 2014) and parental education limited to a high school diploma or less (El Zein et al., 2019). Para-

doxically, employed students are more likely to experience food insecurity (Patton-López et al., 2014), perhaps due to insufficient external financial resources. Research indicates that a lack of parental financial support or financial independence is strongly associated with food insecurity (Bruening et al., 2017; Gaines et al., 2014), whereas financial support from family improves food security outcomes (Soldavini et al., 2021). Younger students who are newly independent and students who are parents themselves face a heightened risk of food insecurity (Bruening et al., 2017). Living arrangements also play a significant role, as students who live alone or off campus are more likely to experience food insecurity (El Zein et al., 2019; Morris et al., 2016). During the COVID-19 pandemic, one study revealed that students who lived alone or remained in their pre-pandemic housing were more likely to encounter barriers to food access (Davitt et al., 2021).

Social Connections and Food Insecurity

Adequate social connections are beneficial for health and well-being (Berkman, 2000; Holt-Lunstad, 2022). Social relationships also play a pivotal role in facilitating a healthy adjustment to college life (Taylor et al., 2014; Vidal et al., 2022). Support from various sources has been shown to counteract stress, loneliness, and depression while improving physical health among college students (Lee et al., 2018). However, limited research exists on how social factors, such as social support and social isolation, may influence students' food insecurity or act as protective or risk factors (Bruening et al., 2017). While two studies investigating the relationship between social support and food security in community samples did not find significant associations (Chhabra et al., 2014; De Marco & Thorburn, 2009), research on college students has only addressed the relationship between social connections and food security indirectly. Qualitative studies suggest that food-insecure students may avoid social activities, such as going out with friends, due to financial constraints (Mukigi et al., 2019). Similarly, students may struggle to develop meaningful relationships because they cannot afford to dine out and often feel embarrassed or reluctant to seek help (Meza et al., 2019). Despite these insights, few studies have thoroughly examined how social relationships affect food security among college students.

External resources, including material and psychosocial support from friends and family, are critical factors influencing food insecurity (Gaines et al., 2014). A lack of external resources or supportive social connections can increase students' risk of food insecurity. Similarly, experiencing an unusual or disruptive life event may heighten this risk by directly affecting the availability of these resources. Such exogenous shocks may include financial hardships or major health issues, such as a serious illness or the death of a loved one (Gaines et al., 2014; Mukigi et al., 2019). These events can also lead to shifts in social connections, further influencing access to necessary resources and supports. Moreover, the transition from adolescence to young adulthood during the college years involves significant adjustments, as students learn to navigate life challenges independently. Experiencing an exogenous event during this critical developmental period may impair students' ability to effectively respond to their circumstances. Studies show that experiencing adverse childhood experiences (ACEs) is associated with food insecurity in emerging adults (Larson et al., 2023; Royer et al., 2022). Furthermore, the complex experience of food insecurity, whether as children or adults, may be viewed as a form of trauma, suggesting the need to view food insecurity through a trauma-informed lens (Hecht et al., 2018; Larson et al., 2023). Trauma is defined as "an experience that is emotionally painful, distressful, or shocking, and one that often has long-term negative mental and physical (including neurological) consequence" (Straussner & Calnan, 2014, p. 323). Hecht et al. (2018) link food insecurity with trauma, such that "given the painful nature of food insecurity and the physical and mental health consequences that often accompany it[,] … for many, food insecurity creates trauma" (p. 1962).

The literature on food security among college students is limited in several ways. First, a review of food-insecurity studies found that few measured food insecurity with and without hunger, thus restricting the ability to draw comprehensive conclusions about student outcomes (Cady, 2014).

Also, many studies did not include diverse student populations, such as graduate and professional students, students in rural areas, or nontraditional students, including international students (Bruening et al., 2017). Finally, little is known about how social relationships may serve as risk or protective factors for college student food security.

Current Study

This study explores the relationship between social connections, demographic factors, and food insecurity in a diverse sample of student users of a university-sponsored food pantry. It adopts a mixed-methods approach, utilizing a quantitative survey conducted before the COVID-19 pandemic and a qualitative interview phase that took place incidentally during the pandemic. The study addresses the following research questions: (1) What are the characteristics of student food pantry users, including their food security levels, social connections, and demographic characteristics? (2) Is food insecurity associated with social connections, such as social support and social isolation, or other demographic characteristics? and (3) How did students who are food pantry users experience and utilize social connections to navigate food insecurity before and during COVID-19? By investigating these questions, this study seeks to deepen the understanding of the factors influencing food insecurity. The findings may be used to enhance the trauma-informed provision of services for students facing these challenges, particularly in the context of external disruptions, such as the COVID-19 pandemic.

Applied Research Methods

The following subsections describe the sampling procedures, measurement strategies for quantitative and qualitative data collection, and data analysis approaches for the study.

Procedure and Participants

All study procedures were approved by the Institutional Review Board at Auburn University (#20-328 EX). This mixed-method study followed a sequential design, beginning with a quantitative phase followed by a qualitative phase. In the first phase, a web-based survey was administered to a sample of students who had used the campus food pantry. The food pantry manager, independent of the research team, emailed a study information letter and survey link to a list of recent food pantry users. To ensure anonymity, no identifying information was collected. Participants were offered a US$20 gift card as an incentive to complete the survey, with this incentive provided separately to ensure it was unlinked to their survey responses. Survey data collection occurred between December 2019 and February 2020. Of the 110 students contacted, 53 completed the survey, yielding a 48% response rate. All surveys were collected before the beginning of the COVID-19 pandemic. The second phase involved follow-up qualitative interviews conducted between March and April 2020 with survey respondents who expressed interest. Due to COVID-19 restrictions, the university closed and began remote course delivery in March, and coincidentally, all interviews took place in the first two months of the pandemic. To add context for the study, there were several disruptions to campus operations, including the closure of dining facilities and dormitories during the spring semester and decreased availability of campus food pantry and transportation services. Within this context, all 53 survey respondents were invited to participate in this phase, with 8 participants completing the interviews, each receiving an additional US$20 incentive payment. The interviews, conducted virtually by the first and second authors, averaged 50 minutes and were recorded for transcription.

Measures

The following subsections describe the operationalization and measurement of quantitative study variables, including measures of demographic characteristics, food security, and social connections. Qualitative interview data collection procedures are also discussed, followed by procedures for data analsyis for both quantitative and qualitative data.

Demographic Variables

Sociodemographic information collected included participants' age, race, ethnicity, sex, gender identity, domestic or international student status, aca-

demic level, current grade point average, employment status, residence (on- or off-campus), marital status, relationship status, children in household, and access to reliable transportation. Participants were asked if they had experienced any adverse financial or health-related circumstances within the past 12 months. Additionally, a range of financial resources was assessed through a series of yes/no questions. Participants indicated whether they received Supplemental Nutrition Assistance Program (SNAP) benefits; financial support from parents, guardians, or relatives; grants or scholarships; and if they were employed. They also reported whether they had a credit card, carried credit-card debt, and had the ability to use their credit card to purchase food.

Food Security Measures

Food security was assessed using the 10-item U.S. Adult Food Security Questionnaire (AFSQ), the most widely used measurement tool (Nikolaus et al., 2020; USDA ERS, 2025a). The questionnaire consists of a series of yes/no questions (e.g., Did you ever cut the size of your meals or skip meals because there wasn't enough money for food?) and frequency-based follow-up questions (e.g., If yes, how often did this happen?). Yes responses were scored as 1 point each, with total scores ranging from 0 to 10, categorized into four levels as follows: high food security (0), marginal food security (1–2), low food security (3–5), and very low food security (6–10) (USDA ERS, 2021). For this study, the variable was also collapsed into two categories: "very low food security" and "all other levels" to better assess risk factors that may be associated with hunger. Participants were asked to report their experiences over the past 12 months. While first-year students are sometimes excluded from similar studies to avoid potential bias due to the transition from high school to college (Gaines et al., 2014), they were intentionally included in this research to capture their experiences, since they may be particularly vulnerable during this transition. Additionally, lifetime prevalence of food insecurity was evaluated with the question: "Before 12 months ago, were there times when the food for you and your family just did not last and there was no money to buy more?"

Social Connections Measures

Social connection variables in this study included measures of social support and social isolation. Social support was assessed using the 19-item Medical Outcomes Study Social Support Scale (MOS-SSS) (Sherbourne & Stewart, 1991). This measure was chosen because it has been validated in college student populations, and it seemed to be most appropriate for a study on food security. Participants indicated their perceived level of support across various types of assistance, responding on a five-point Likert scale ranging from *none of the time* to *all of the time*. Example items included: "Someone to give you information to help you understand a situation," "Someone to take you to the doctor if you needed it," "Someone who shows you love and affection," and "Someone to do something enjoyable with." For the purposes of this study, the means for the total social support scores across 19 items were calculated, resulting in possible mean scores of 1–5, and categorical thresholds were identified as follows: low social support (1–2), moderate social support (2.1–3.5), and high social support (3.6–5). The means for the four subscales of social support—tangible support, emotional support, affection, and positive social interaction—were also calculated with the same thresholds.

Social isolation was measured using a three-item Social Isolation Scale (Hughes et al., 2004). Participants reported how often they felt that they lacked companionship, were isolated from others, and were lonely within the past year. Participants rated their responses on a three-point Likert scale ranging from *hardly ever* to "*often*, and scores were summed, with higher scores indicating greater social isolation, resulting in a possible range of 3–9.

Qualitative Measures

A semi-structured interview guide was used to elicit students' perspectives on key study concepts before and during the COVID-19 pandemic. Open-ended questions were designed to encourage individual elaboration, with additional probing questions used to obtain further details when needed. The topics explored included participants' social connections, the nature and extent of any changes in their social relationships, the influence of social connections on food insecurity before

and during the pandemic, and how participants navigated resources—such as the campus food pantry and other available services—to meet their food needs.

Data Analysis

For the survey data analysis, univariate statistics (e.g., means and frequencies) were used to describe the sample, and bivariate statistics (e.g., chi-square tests and independent *t*-tests) were used to identify differences between food-security groups. All statistical analyses were conducted using SPSS version 26. For the interview data, an inductive content analysis approach was utilized to generate broad codes relevant to the research questions and was based on a thorough review of each transcript by the three authors (Hsieh & Shannon, 2005). Similar codes were grouped into categories, which were then used to build themes that connected participant interviews. To ensure consistency and reliability, the authors met regularly to discuss codes, review coding consistency, and reach consensus on the emerging themes.

Results

The following subsections begin with a description of the quantitative results from the survey, including demographic characteristics and bivariate statistics regarding potential associations between food security and key study variables. This is followed by a description of qualitative findings from semi-structured interviews with a subsample of participants.

Descriptive Statistics

This section outlines demographic characteristics of the participants and descriptive data regarding the levels of food security and social connections reported by participants.

Demographic Characteristics

The demographics of the study sample are summarized in Table 1. Compared to the university's overall student population, this sample was notably diverse. A greater proportion of students identified as people of color (46%), compared to white students (54%). More participants identified as women (60%) rather than men (34%) and 5.7% of students identified as gender nonconforming or transgender. The sample included a higher percentage of graduate and professional students (57%) compared to undergraduates (43%) and a significant number of international students (47%) compared to domestic students (53%). The average age of participants was 26.3 years (SD = 5.4; range = 18–45). Among the sample, 19% were married, another 7% were in a committed relationship, and 11% had children. Academically, 76% had a GPA of 3.0 or higher. Most participants lived off-campus (94%), had reliable transportation (68%), and shared their living spaces with others (70%). Nearly half of the participants (47%) reported experiencing an exogenous event in the past year, such as a major financial setback or an adverse health-related circumstance (prior to COVID-19). Regarding financial resources, a minority of students received SNAP benefits (21%), parental or guardian financial assistance (34%), or student loans (38%). However, the majority received grants or scholarships (66%), were employed part-time (55%) or full-time (15%), and owned a credit card (76%).

Food Security

Statistics on food security among participants are also shown in Table 1. Participants were categorized into the following USDA food security levels: 47.2% reported very low food security, 30.2% low food security, 18.9% marginal food security, and 3.8% high food security. Overall, 77% of respondents were classified as food insecure (very low or low food security), while 23% fell into the marginal or high food security categories. Additionally, 47% of the participants reported experiencing very low food security within the past 12 months, and half of the participants indicated having ever experienced food insecurity at some point *prior to* the past year.

Social Connections

Participants reported moderate levels of both social support and social isolation, with mean scores shown in Table 1. The mean score on the MOS Social Support Scale was 3.3 (SD = 1.04), above the midpoint (3) on the scale of 1–5, indicating moderate overall social support. Subscale scores showed variation, with tangible social support

items averaging 2.8, below the midpoint but still considered moderate and lower than emotional support (3.4), affection support (3.5), and positive social interaction (3.5), all of which were moderate. Individual responses varied widely, with some participants reporting minimal social support and others indicating high levels of social support, resulting in moderate overall average scores. Similarly, social isolation scores averaged 6.2 (*SD* = 1.85; range = 3–9), aligning with the midpoint (6) on the scale, which indicates that participants experienced moderate levels of social isolation.

Bivariate Analysis

Chi-square analyses and independent *t*-tests used to identify risk and/or protective factors are summa-

Table 1. Descriptive Characteristics (*N* = 53)

	N/Mean	%/SD
Demographics		
Age	26.28	5.39
Gender		
Female	32	60.4
Male	18	34.0
Gender non-conforming or trans	3	5.7
Race		
Asian	6	11.3
Black/African American	8	15.1
White	28	52.8
Biracial or multiracial	6	11.3
Other	4	7.6
Hispanic ethnicity		
Yes	17	32.1
No	36	67.9
International student		
Yes	25	47.2
No	28	52.8
Academic level		
Freshman	1	1.9
Sophomore	1	1.9
Junior	4	32.1
Senior	17	32.1
Graduate or professional	30	56.6
Grade point average		
0.00-1.99	1	1.9
2.00-2.99	12	22.6
3.00-3.99	25	47.2
4.00	15	28.3
Marital status		
Single, never married	39	73.6
Married	10	18.9
Divorced or separated	4	7.6
In committed relationship		
Yes	14	26.4
No	39	73.6
Living situation		
Alone	16	30.2
With roommate(s)	22	41.5
With significant other	11	20.8
With family members	4	7.5
Children in household		
Yes	6	11.3
No	47	88.7
Receive grants or scholarships		
Yes	35	66.0
No	18	34.0
Have student loans		
Yes	20	37.7
No	33	62.3
Employed		
Yes	37	69.8
No	16	30.2
Have credit card	40	75.5
Yes	13	24.5
No	13	24.5
Able to use credit card for food (*n* = 40)		
Yes	35	87.5
No	5	12.5
Food Security Status		
Food security level		
High food security	2	3.8
Marginal food security	10	18.9
Low food security	16	30.2
Very low food security	25	47.2
Past 12 months		
Not very low food security	25	52.8
Very low food security	25	47.2
Ever food insecure (prior to the last 12 months)		
Yes	25	50.0
No	25	50.0
Social Connections		
Social Support Scale	3.3	1.04
Tangible (sub-scale)	2.8	1.19
Emotional (sub-scale)	3.4	1.10
Affection (sub-scale)	3.5	1.14
Positive social interaction (sub-scale)	3.5	1.07
Help get your mind off things (single item)	3.3	1.35
Social Isolation Scale	6.2	1.85
Exogenous Event		
Experienced adverse event in last 12 months		
Yes	25	47.2
No	28	52.8

continued

Table 1, continued.

	N/Mean	%/SD
Reliable transportation		
Yes	36	67.9
No	16	30.2
Receive SNAP benefits		
Yes	11	20.8
No	42	79.2
Receive parent or guardian financial assistance		
Yes	18	34.0
No	35	66.0

Note. *N* = 52 for race and transportation; *N* = 50 for sex & ever food insecure; *N* = 40 for able to use credit card for food

rized in Tables 2 and 3. Among the demographic variables commonly associated with student food insecurity—such as younger age, racial or ethnic minority status, living alone or off-campus, or being employed or financially independent—none was found to be a significant predictor in this sample.

Chi-square analyses revealed two factors that are significantly related to having very low food security: past experiences of food insecurity and experiencing an exogenous negative event (see Table 2). Participants who had experienced an adverse financial-related or health-related event within the past 12 months were more likely (76%) to experience very low food security compared to those who had not (24%); $p < 0.001$. Similarly, those who indicated that they had experienced a time when they could not afford to purchase food prior to the past 12 months were much more likely to have very low food security (69.6%) compared to those who had not (33.3%); $p < 0.01$. An unexpected finding was that the social connection variables—social support and social isolation—were not significantly associated with very low food security. However, tangible support approached statistical significance at $p = 0.054$ (see Table 3).

Qualitative Findings

The purpose of the qualitative interview phase of the study was to give voice to the perspectives of students and their experiences with food insecurity and social connections. Since the interviews occurred during the COVID-19 pandemic, responses reflected experiences prior to and during the pandemic. The following overarching and interconnected themes emerged:

Theme 1: Impact of pandemic on food security and food pantry access

Participants shared a range of experiences related to how the COVID-19 pandemic affected their access to food. They discussed a variety of pandemic-related limitations, including the transition from on-campus to virtual classes, work-related changes, income changes, transportation challenges, and alterations to the operations of the university food pantry. These limitations naturally led to hardships for some but led to improved circumstances for others. For example, an African American female student compared her food access before and during the pandemic as follows: "It was spotty. I'd use the food pantry when it just wasn't enough, and I needed something else to tide me over. But for the most part, I've missed meals, I missed meals regularly pre-COVID, too." She had used the food pantry on a regular basis, but during the pandemic, she only used it once because "it was really hard to get to it" even though she wished she could still use it. For one international female graduate student, the barriers to food access substantially increased to the point where she was not able to use the food pantry or go to the grocery store at all during the early pandemic in March and April 2020. She reported stopping using any supportive services for fear of virus exposure. Another female student explained that access to food during COVID-19 became "just another barrier and another layer of stress that definitely impacted the process of getting food securely."

Table 2. Chi-Square Differences in Food Security by Select Demographic Factors (*N* = 53)

	Not Very Low Food Security		Very Low Food Security		X^2	*p*
	n	%	*n*	%		
Gender						
Female	17	63.0	15	65.2	0.027	0.869
Male	10	37.0	8	34.8		
Race						
White	16	57.1	12	50.0	0.265	0.606
Non-white	12	42.9	12	50.0		
Hispanic ethnicity						
Yes	11	39.3	6	24.0	1.416	0.234
No	17	60.7	19	76.0		
International student						
Yes	14	50.0	11	44.0	0.191	0.662
No	14	50.0	14	56.0		
Academic Level						
Undergraduate	11	39.3	12	48.0	0.408	0.523
Graduate/professional	17	60.7	13	52.0		
Living Situation						
Alone	7	25.0	9	36.0	0.758	0.384
With others	21	75.0	16	64.0		
Experienced exogenous event						
Yes	6	21.4	19	76.0	15.784	**0.000**
No	22	78.6	6	24.0		
Ever food insecure						
Yes	9	33.3	16	69.6	6.522	**0.011**
No	18	66.7	7	30.4		
Parent/guardian financial assistance						
Yes	11	39.3	7	28.0	0.750	0.386
No	17	60.7	18	72.0		
Have student loans						
Yes	12	42.9	8	32.0	0.663	0.416
No	16	57.1	17	68.0		
Employed						
Yes	20	71.4	17	68.0	0.074	0.786
No	8	28.6	8	32.0		
Member of community organization						
Yes	5	17.9	9	36.0	2.237	0.135
No	23	82.1	16	64.0		

Table 3. *T*-test Differences in Food Security by Age and Social Connections (*N* = 53)

					95% CI	
	t	*df*	*p*	*M Diff*	Lower	Upper
Age	−0.562	51	0.577	−0.81	−3.72	2.10
Social Support Scale	1.297	51	0.201	0.37	−0.20	0.94
Tangible	1.975	51	0.054	0.63	−0.01	1.27
Emotional	0.994	51	0.325	0.30	−0.31	0.91
Affection	0.572	51	0.570	0.18	−0.45	0.81
Positive social interaction	1.196	51	0.237	0.35	−0.24	0.94
Help get your mind off things	1.342	51	0.186	0.50	−0.25	1.24
Social Isolation Scale	−1.405	51	0.166	−0.71	−1.72	0.30

Logistical changes in food pantry days and pickup times affected several students, with three students reducing their use accordingly and one student maintaining her pre-pandemic use of the food pantry by altering her routine to accommodate those changes. Finally, one student shared how she unexpectedly had

> greater access to food now and since COVID-19 than before, because [due to reduced work hours beginning two and half months before] I was able to start receiving food assistance from the state and [due to having a less-restrictive class schedule with no in-person classes] actually use the food pantry program more.

Theme 2: Impact of pandemic on social connections

Participants shared a range of social changes due to the pandemic, with some severely impacted, one temporarily more isolated, while others paradoxically were able to increase contact and reconnect with family. A Black female student intimated one of the more detrimental social circumstances as she described the major changes she experienced. She explained, "It was just really hard, emotionally, mentally, socially. And a lot of my social relationships kind of dissolved because of it. … The weight of the whole thing. And it's kind of hard trying to keep a friendship together while you're also trying to keep yourself together." An international male student stated his social connections were "affected greatly" during the pandemic. He explained that he took precautions very seriously and avoided the social outlets that he and his spouse and young child normally benefited from, including going to the park and having meetings with others from his home country. While he said he felt much more isolated during the pandemic, he reported increased family connections back home because he was able to communicate with them more via FaceTime and share concerns about the mutual pandemic experience.

A white female student, who had previously sought support for long-term mental health difficulties, elaborated on some of the social challenges she faced during the pandemic:

> I felt like before COVID-19 I was doing a good job with therapy and finding more personal security and when COVID-19 happened, the people I was seeing had to get a lot smaller. So, it's definitely been more challenging to continue to dig into relationships, to express needs, to meet other people's needs. I still definitely have a very small bubble of people that I directly interact with.

She explained that despite those limitations, she wanted to protect her social relationships by "focusing on the people around me, that we share love and support and realizing that everyone is in a similar boat, and it doesn't make you strange or weird or crazy to be struggling." She went on to say she made a conscious choice "to push myself in that direction so that I didn't allow the pandemic to collapse my social support." Another participant, an international female student, stated that other than being socially isolated during extensive lockdowns at the onset of the pandemic, she was only temporarily affected and quickly resumed in-person social interactions, despite social distancing recommendations. Finally, a white female student shared how pandemic stressors led to reconnecting and mending her relationship with estranged parents. She explained that the unusual pandemic circumstances necessitated reaching out for help, and her family agreed to do so. She also reported developing a closer relationship with her partner, who helped her navigate the uncertain experience. Overall, participants alluded to their social connections as being instrumental in their access to resources, further emphasized in the next theme.

Theme 3: Navigation of social resources

All interview participants elaborated on the importance of social connections for addressing their food security and other basic needs during the pandemic. Out of necessity, participants described being highly self-reliant, resourceful, and creative in their efforts to meet basic needs, utilizing multiple resources. Clearly, receiving services from the campus food pantry was a crucial resource, but it often served as a catalyst for accessing additional resources. For example, one white female explained, "I just think that once I had the access to the initial

campus food pantry resource, things just kind of took off from there in a positive way. I started researching more, more opportunities, more just things that are going around." She went on to say that contacts at the food pantry enabled additional resources, such as "being able to get an EBT card [electronic benefit transfer card, for cash and food assistance programs] and getting some information about the community food bank." Another female student noted her resourcefulness, "I just sort of routinely keep a Word document with a list of resources. … So, I just kind of keep a running list of counseling, food sources … whatever is going on that's available in the community." She also related:

> I've always utilized resources. Even as a child, I was going to food banks and asking churches and continued to do that through my young adult life. … I started looking for food for my family at a very young age, so I understood there were resources. I knew how to apply for food stamps by the time I was 10. I think I grew up understanding that if you didn't have food, you had to find a way to get it and there was support for that.

The previous passage is not only about self-reliance and navigating resources, but also highlights the idea that past food insecurity and adversities have a direct influence on how a person adapts to current circumstances. She noted that it seemed simple for her to navigate resources because of her experience, but recognized that "for a lot of students, there's a lot of barriers to taking that step."

A Black female student discussed relying on family and friends who were willing to help her financially on a temporary basis. This participant's experience reveals the interplay between navigating resources and social connections, as she explained, "… socially, my everything, food, bills, all of that was positively impacted due to social connections and getting help from friends, whether it's financial help. But just talking to them to get resources." Indeed, several of the participants indicated they learned of the campus food pantry directly from social connections such as friends, faculty advisors, or university staff. They emphasized the importance of awareness of services and that social awareness among students should be expanded.

Discussion

This study examines the multifaceted experiences of students with food insecurity, incorporating diverse demographic characteristics and social relationships. To achieve this, the study surveyed students before the COVID-19 pandemic and then gathered in-depth perspectives from those willing to share their experiences with food insecurity and intersecting factors, both before and during the pandemic. As a mixed-methods study of food pantry users at a southeastern U.S. university, it provides valuable insights into the challenges faced by college students dealing with food insecurity. The following sections highlight the study's novel contributions and connect its findings to existing literature.

Food Insecurity and Student Characteristics

Findings revealed that most students using the campus food pantry experienced food insecurity, with the largest proportion reporting very low food security—a result unsurprising given the sample. This observation aligns with prior studies on student food insecurity (Nikolaus et al., 2020). Intuitively, students with prior experiences of food insecurity were the most likely to report very low food security. This finding parallels results from other qualitative studies where students recounted childhood food insecurity experiences (Mukigi et al., 2019; Zigmont et al., 2021). Mukigi and colleagues (2019) reported that approximately half of the college students interviewed had experienced food insecurity in the past, while the other half was experiencing it for the first time (Mukigi et al., 2019). Similarly, in our survey, half of the students had experienced food insecurity in the past, and that group was significantly more likely to report current very low food security. This was reinforced in interviews in which some students discussed childhood food insecurity and its connection to their current concerns.

The demographic composition of the participants also distinguished this sample from the broader university student population and from

those represented in some other studies. The sample was quite diverse, including higher proportions of students of color, international students, upperclassmen, and graduate students relative to the overall campus composition. These sample characteristics are similar to those observed in a Canadian university study (Farahbakhsh et al., 2015), providing more evidence that nontraditional students (international students, graduate students, students with families) and/or students of minority status may be more likely to use campus food pantry services. Interestingly, we discovered that despite the high degree of diversity within this group on many characteristics (age, race, ethnicity, academic level, marital status, etc.), none of those demographic factors was significantly associated with very low food security. Consequently, a key takeaway is the importance of avoiding generalized assumptions about which student demographic groups are at the greatest risk of food insecurity. Instead, it is essential to carefully assess and consider the intersectional and multidimensional experiences that contribute to students' risk of food insecurity.

Food Insecurity and Social Connections

A notable contribution of this study is its broader examination of social relationship factors and their connection to student food security. Quantitatively, participants' responses displayed considerable variation, ranging from very low levels to quite high levels of support across multiple subtypes. Despite this diversity, the social support scale did not show a significant association with food insecurity. Although some students experienced high levels of social isolation and low levels of social support, these patterns were not reflected in the bivariate analyses of food insecurity. These null findings may stem from measurement issues, including choosing the best tool from a variety of competing social support and isolation instruments. For example, instead of using the MOS-SSS, employing a different validated measure of social support, such as the Social Support Questionnaire or the Multidimensional Scale of Perceived Social Support, may have yielded different results.

The qualitative phase of our study revealed details related to social connections and food insecurity that the survey could not detect. Students reported a range of experiences related to social connections, both negative and positive, that clearly affected their access to resources and support during the pandemic. Our qualitative findings align with and extend the findings of other studies related to college student food insecurity. A qualitative study by Manboard and colleagues (2021) revealed that students adopted various strategies for dealing with pandemic food challenges, including using food pantries, relying on social supports such as food sharing, and seeking help from community support programs. In another interview study, Mukigi et al. (2019) found an important role of support systems in negotiating food insecurity, such as using a food pantry and asking for help from informal supports. More studies of college students are needed to further understand how social relationships influence food security in this special population.

In addition, in the pre-pandemic survey, students experiencing very low food security were more likely to report having had an exogenous event in the past 12 months and having less access to financial support. One possible explanation is that the disruptive event may have stressed, strained, or dissolved possible social relationships that otherwise could have offered financial assistance. Interviews occurring during the pandemic revealed how COVID-19, as a collectively experienced exogenous event, led to sequential events that directly affected participants' lives in holistic ways, including food security, social interactions, and resources.

Intersecting Influences Before and During Pandemic

Students addressed food insecurity issues before and during the COVID-19 pandemic in a variety of ways. Notably, not all students experienced negative consequences of the pandemic; in fact, some were able to access more resources and improve their social connections despite the stressors of the ongoing event. Prior experiences affected several students' responses and actions. Some students persevered through food insecurity by using various community resources and skills they developed to identify, request, and secure assistance. Others, however, found that the pandemic only weakened

their limited social support and hindered access to needed resources. After experiencing an exogenous or disruptive event, distinct types of responses emerged. Some respondents developed new skills and strategies, while others found that their coping skills decreased or diminished. This is especially evident in maintaining social connections and asking for support. This study reveals that there are multiple pathways and outcomes for students experiencing food insecurity. It also supports a need for further exploration of the events affecting students' college trajectories.

Past research shows that food insecurity in adulthood is not only linked with facing food insecurity as a child, but also with the experience of additional and multiple adverse childhood experiences (Becker et al., 2018; Chilton et al., 2015). This study did not account for the adverse experiences that occurred prior to the most recent 12 months, meaning those who reported a disruptive event in recent months may also have a history of childhood adversity. This is important, as these childhood experiences may significantly impact the students' ability to cope, their access to financial support and social connections, and their overall physical and psychological health. The combination of past and recent negative experiences may be experienced as trauma because the difficulties emerging from the events exceed the capacity of an individual to cope with them. As such, it is necessary to acknowledge when students are struggling with food insecurity because it may occur alongside or in addition to other difficult or traumatic life events. Services could be developed to not only address food insecurity but also address the relational, physical, and mental health concerns these students are facing (Becker et al., 2018; Chilton et al., 2015).

When addressing past and current trauma, several protective factors can help mitigate the consequences, including fostering a sense of purpose and building interpersonal connections (Hamby et al., 2020, 2021). Students highlighted that the campus food pantry serves not only as a source of food but also as a connection to additional resources. The campus food pantry has the potential to function as an access point for holistic intervention and as a space for fostering community among students who may be struggling. Hecht and colleagues (2018) propose that food insecurity itself constitutes a form of trauma, whether it occurs as a single event or repeatedly, resulting in severe physical, social, and psychological consequences. Our study reinforced this notion, finding that students experiencing very low food security were also more likely to have experienced a disruptive event within the past 12 months, signifying an additional major life stressor alongside food insecurity. Furthermore, research indicates that adults facing food insecurity are often more likely to have endured one or more adverse childhood events. The cumulative impacts of these factors underscore the value of college food pantry services adopting a trauma-informed approach.

Policy and Practice Implications

Based on the findings, recommendations to enhance the services of university food pantries include adopting a trauma-informed approach and incorporating social connection opportunities alongside food programs. A trauma-informed approach to food insecurity services requires a fundamental understanding of the prevalence of past and present trauma and its profound impact on those seeking assistance. This would involve staff and volunteers being aware of the concepts of trauma, trauma-informed care, and food insecurity as a form of trauma. This could be accomplished through a brief in-person or video educational training as part of an existing staff or volunteer orientation. To improve assessment of student circumstances and needs, staff could screen for past food insecurity and adverse events that increase student risk for continued food insecurity. This could involve asking an additional two questions at intake, which would not substantially increase the amount of time required or the burden to the assessment process for staff or consumers. Even if a food pantry does not have an intake or assessment process, simply understanding the potential for trauma and its reciprocal impact on food security and providing support from that standpoint would be beneficial.

Trauma-informed food insecurity services could ensure a safe, supportive, and nonjudgmental environment where students can build meaningful

connections with peers and staff, address mental and physical health challenges, and access additional resources. This could include creating inviting spaces to host small group interactions with peers. Additional strategies to enhance social connections within food pantries include facilitating peer support groups for sharing experiences and coping strategies, creating peer mentoring programs for new food pantry users, hosting engaging social events at the food pantry to raise awareness and build community, and promoting social campaigns that normalize discussions about food insecurity and reduce the stigma of seeking assistance. Since food insecurity is linked to the experience of trauma and mental health concerns, it is important that campus food pantries ensure they have close connections with mental health and counseling support services that are available to students through the institution. Food pantry staff could refer students to mental health resources and professionals as needed.

Inviting students' perspectives and experiences through satisfaction surveys is essential for identifying areas of improvement and tailoring services to best meet their needs. Gardiner and Harvey (2024) illustrate this with their survey findings, which revealed students' desire for additional campus food pantry support, including school supplies, hygiene and toiletry items, cooking utensils, information on other emergency resources, financial assistance, and recipes. Together, these approaches align with a trauma-informed framework and help address social risk factors commonly linked to food insecurity.

Study Limitations

Although this study had numerous strengths, particularly its simultaneous examination of student food insecurity and social support, it also had several limitations. The study had a small sample size of 53 participants who used a food pantry at a single large university in the U.S. Southeast. Therefore, the findings are not generalizable to all food pantry users, the larger student body, or other institutions. While the sample was relatively diverse, it may not have captured the full diversity of experiences of all campus food pantry users and is likely different from non-campus food pantry samples. The campus location and socioeconomic context, along with the uniqueness of this campus food pantry, limit its applicability to pantry operations or universities in other regions or populations. The time-period in which the study took place also limits the findings since the survey responses occurred before the COVID-19 pandemic and the interviews were conducted in the first two months of the pandemic. Students' experiences could have changed significantly in later stages and after the pandemic. Additionally, the inclusion of all food pantry users, regardless of whether their needs had been met, may have included students whose food insecurity or social needs had already been resolved. Another limitation was focusing only on food pantry users, combined with the lack of a comparison group of students who were not using the food pantry. While only eight interviews were conducted, the in-depth responses provided valuable insights, highlighting both shared circumstances and the unique experiences of students facing food insecurity before and during the pandemic. The diversity in responses may also explain some of the null findings from the quantitative phase. Despite these limitations, this case study at one campus food pantry can be used as an example of methodology and recommendations for researchers and practitioners who are exploring college students' social connections and food security.

Conclusions

Addressing food insecurity among college students requires a comprehensive and multifaceted approach. This study's findings emphasize that campus food pantries and their staff serve a broader role beyond providing access to food, aligning with strategic recommendations for addressing campus food insecurity (Freudenberg et al., 2019; Peterson & Freidus, 2020). Food pantries might consider including more assessment and consideration of students' previous experiences of food insecurity, the impact of exogenous factors that create hardships during college, the associations of food insecurity with trauma, and the availability of social support resources. Interviews conducted during the COVID-19 pandemic revealed significant challenges faced by students and highlighted the influence of social connections on their

food security status. Future research could delve deeper into the exploration of how social relationships may serve as protective factors against food insecurity among college students. Recommendations for university food pantries include adopting a trauma-informed approach to service delivery and integrating opportunities for social connection alongside providing resources and addressing students' basic food needs.

References

Becker, C. B., Middlemass, K., Johnson, C., Taylor, B., Gomez, F., & Sutherland, A. (2018). Traumatic event exposure associated with increased food insecurity and eating disorder pathology. *Public Health Nutrition*, *21*(16), 3058–3066. https://doi.org/10.1017/S1368980018001738

Berkman, L. F. (2000). Social support, social networks, social cohesion and health. *Social Work in Health Care*, *31*(2), 3–14. https://doi.org/10.1300/J010v31n02_02

Bruening, M., Argo, K., Payne-Sturges, D., & Laska, M. N. (2017). The struggle is real: A systematic review of food insecurity on postsecondary education campuses. *Journal of the Academy of Nutrition and Dietetics*, *117*(11), 1767–1791. https://doi.org/10.1016/j.jand.2017.05.022

Cady, C. L. (2014). Food insecurity as a student issue. *Journal of College and Character*, *15*(4), 265–272. https://doi.org/10.1515/jcc-2014-0031

Carlson, S. J., Andrews, M. S., & Bickel, G. W. (1999). Measuring food insecurity and hunger in the United States: Development of a national benchmark measure and prevalence estimates. *The Journal of Nutrition, 129*(2), 510S–516S. https://doi.org/10.1093/jn/129.2.510S

Chhabra, S., Falciglia, G. A., & Lee, S.-Y. (2014). Social capital, social support, and food insecurity in food pantry users. *Ecology of Food and Nutrition*, *53*(6), 678–692. https://doi.org/10.1080/03670244.2014.933737

Chilton, M., Knowles, M., Rabinowich, J., & Arnold, K. T. (2015). The relationship between childhood adversity and food insecurity: 'It's like a bird nesting in your head.' *Public Health Nutrition*, *18*(14), 2643–2653. https://doi.org/10.1017/S1368980014003036

Davitt, E. D., Heer, M. M., Winham, D. M., Knoblauch, S. T., & Shelley, M. C. (2021). Effects of COVID-19 on university student food security. *Nutrients*, *13*(6), Article 1932. https://doi.org/10.3390/nu13061932

De Marco, M., & Thorburn, S. (2009). The relationship between income and food insecurity among Oregon residents: Does social support matter? *Public Health Nutrition*, *12*(11), 2104–2112. https://doi.org/10.1017/S1368980009990243

El Zein, A., Shelnutt, K. P., Colby, S., Vilaro, M. J., Zhou, W., Greene, G., Olfert, M. D., Riggsbee, K., Morrell, J. S., & Mathews, A. E. (2019). Prevalence and correlates of food insecurity among U.S. college students: A multi-institutional study. *BMC Public Health*, *19*(1), Article 660. https://doi.org/10.1186/s12889-019-6943-6

Farahbakhsh, J., Ball, G. D. C., Farmer, A. P., Maximova, K., Hanbazaza, M., & Willows, N. D. (2015). How do student clients of a university-based food bank cope with food insecurity? *Canadian Journal of Dietetic Practice and Research*, *76*(4), 200–203. https://doi.org/10.3148/cjdpr-2015-020

Freudenberg, N., Goldrick-Rab, S., & Poppendieck, J. (2019). College students and SNAP: The new face of food insecurity in the United States. *American Journal of Public Health*, *109*(12), 1652–1658. https://doi.org/10.2105/AJPH.2019.305332

Gaines, A., Robb, C. A., Knol, L. L., & Sickler, S. (2014). Examining the role of financial factors, resources and skills in predicting food security status among college students: Food security and resource adequacy. *International Journal of Consumer Studies*, *38*(4), 374–384. https://doi.org/10.1111/ijcs.12110

Gardiner, K. D., & Harvey, S. P. (2024). Are we meeting student needs? Developing a measure for college food pantry satisfaction. *Journal of Agriculture, Food Systems, and Community Development*, *13*(3), 165–176. https://doi.org/10.5304/jafscd.2024.133.027

Hamby, S., Elm, J. H. L., Howell, K. H., & Merrick, M. T. (2021). Recognizing the cumulative burden of childhood adversities transforms science and practice for trauma and resilience. *American Psychologist*, *76*(2), 230–242. https://doi.org/10.1037/amp0000763

Hamby, S., Taylor, E., Mitchell, K., Jones, L., & Newlin, C. (2020). Poly-victimization, trauma, and resilience: Exploring strengths that promote thriving after adversity. *Journal of Trauma & Dissociation*, *21*(3), 376–395. https://doi.org/10.1080/15299732.2020.1719261

Hecht, A. A., Biehl, E., Buzogany, S., & Neff, R. A. (2018). Using a trauma-informed policy approach to create a resilient urban food system. *Public Health Nutrition*, *21*(10), 1961–1970. https://doi.org/10.1017/S1368980018000198

Holt-Lunstad, J. (2022). Social connection as a public health issue: The evidence and a systemic framework for prioritizing the "social" in social determinants of health. *Annual Review of Public Health*, *43*(1), 193–213. https://doi.org/10.1146/annurev-publhealth-052020-110732

Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, *15*(9), 1277–1288. https://doi.org/10.1177/1049732305276687

Hughes, M. E., Waite, L. J., Hawkley, L. C., & Cacioppo, J. T. (2004). A short scale for measuring loneliness in large surveys: Results from two population-based studies. *Research on Aging*, *26*(6), 655–672. https://doi.org/10.1177/0164027504268574

Kendall, A., Olson, C. M., & Frongillo Jr., E. A. (1996). Relationship of hunger and food insecurity to food availability and consumption. *Journal of the American Dietetic Association, 96*(10), 1019–1024. https://doi.org/10.1016/S0002-8223(96)00271-4

Larson, N., Mason, S. M., Bruening, M., Laska, M. N., Hazzard, V. M., & Neumark-Sztainer, D. (2023). Adverse childhood experiences and food insecurity in emerging adulthood: Findings from the EAT 2010–2018 study. *Public Health Nutrition*, *26*(11), 2343–2354. https://doi.org/10.1017/S1368980023001349

Lee, C.-Y. S., Goldstein, S. E., & Dik, B. J. (2018). The relational context of social support in young adults: Links with stress and well-being. *Journal of Adult Development*, *25*(1), 25–36. https://doi.org/10.1007/s10804-017-9271-z

Manboard, M., Biediger-Friedman, L., Thornton, H., Walling, K., & Padilla, V. (2021). O36 college students cope to achieve food security during the COVID-19 pandemic. *Journal of Nutrition Education and Behavior*, *53*(7, Suppl.), Article S17. https://doi.org/10.1016/j.jneb.2021.04.045

Meza, A., Altman, E., Martinez, S., & Leung, C. W. (2019). "It's a feeling that one is not worth food": A qualitative study exploring the psychosocial experience and academic consequences of food insecurity among college students. *Journal of the Academy of Nutrition and Dietetics*, *119*(10), 1713–1721.e1. https://doi.org/10.1016/j.jand.2018.09.006

Mialki, K., House, L. A., Mathews, A. E., & Shelnutt, K. P. (2021). COVID-19 and college students: Food security status before and after the onset of a pandemic. *Nutrients*, *13*(2), Article 628. https://doi.org/10.3390/nu13020628

Morris, L. M., Smith, S., Davis, J., & Null, D. B. (2016). The prevalence of food security and insecurity among Illinois university students. *Journal of Nutrition Education and Behavior*, *48*(6), 376–382.e1. https://doi.org/10.1016/j.jneb.2016.03.013

Mukigi, D., Thornton, K., Binion, A., Brown, K., Church, M., Cook, M., Henry, D., Hopkinson, J., Masucci, C., Pruett, J., Rogers, M., Singleton, O., Vichi-Miller, V., Wofford, R., & Brown, O. (2019). Food insecurity among college students: An exploratory study. *Journal of Nutrition and Health Sciences*, *5*(1), Article 106. https://doi.org/10.15744/2393-9060.5.106

Nikolaus, C. J., An, R., Ellison, B., & Nickols-Richardson, S. M. (2020). Food insecurity among college students in the United States: A scoping review. *Advances in Nutrition*, *11*(2), 327–348. https://doi.org/10.1093/advances/nmz111

Patton-López, M. M., López-Cevallos, D. F., Cancel-Tirado, D. I., & Vazquez, L. (2014). Prevalence and correlates of food insecurity among students attending a midsize rural university in Oregon. *Journal of Nutrition Education and Behavior*, *46*(3), 209–214. https://doi.org/10.1016/j.jneb.2013.10.007

Peterson, N. D., & Freidus, A. (2020). More than money: Barriers to food security on a college campus. *Culture, Agriculture, Food and Environment*, *42*(2), 125–137. https://doi.org/10.1111/cuag.12252

Rabbitt, M. P., Reed-Jones, M., Hales, L. J., & Burke, M. P. (2024, September 4). *Household food security in the United States in 2023*. U.S. Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/publications/pub-details?pubid=109895

Rafferty, F., Schusler, T. M., & Valencia Mestre, M. C. (2023). College student food security during the COVID-19 pandemic. *Journal of Agriculture, Food Systems, and Community Development*, *12*(2), 79–96. https://doi.org/10.5304/jafscd.2023.122.019

Royer, M. F., Ojinnaka, C. O., Zhang, X., Thornton, A. G., Blackhorse, K., & Bruening, M. (2022). Food insecurity and adverse childhood experiences: A systematic review. *Nutrition Reviews*, *80*(10), 2089–2099. https://doi.org/10.1093/nutrit/nuac029

Sherbourne, C. D., & Stewart, A. L. (1991). The MOS social support survey. *Social Science & Medicine*, *32*(6), 705–714. https://doi.org/10.1016/0277-9536(91)90150-B

Silva, M. R., Kleinert, W. L., Sheppard, A. V., Cantrell, K. A., Freeman-Coppadge, D. J., Tsoy, E., Roberts, T., & Pearrow, M. (2017). The relationship between food security, housing stability, and school performance among college students in an urban university. *Journal of College Student Retention: Research, Theory & Practice*, *19*(3), 284–299. https://doi.org/10.1177/1521025115621918

Soldavini, J., Andrew, H., & Berner, M. (2021). Characteristics associated with changes in food security status among college students during the COVID-19 pandemic. *Translational Behavioral Medicine*, *11*(2), 295–304. https://doi.org/10.1093/tbm/ibaa110

Straussner, S. L. A., & Calnan, A. J. (2014). Trauma through the life cycle: A review of current literature. *Clinical Social Work Journal, 42*, 323–335. https://doi.org/10.1007/s10615-014-0496-z

Taylor, Z. E., Doane, L. D., & Eisenberg, N. (2014). Transitioning from high school to college: Relations of social support, ego-resiliency, and maladjustment during emerging adulthood. *Emerging Adulthood*, *2*(2), 105–115. https://doi.org/10.1177/2167696813506885

U.S. Department of Agriculture, Economic Research Service [USDA ERS]. (n.d.). *Food and nutrition assistance*. Retrieved August 28, 2023, from https://www.ers.usda.gov/topics/food-nutrition-assistance/

USDA ERS. (2022). *Food security in the U.S. - Key statistics & graphics*. Retrieved August 28, 2023, from https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/key-statistics-graphics/#foodsecure

USDA ERS. (2025a, January 8). *Food security in the U.S.—Measurement.* https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/measurement#hunger

USDA ERS. (2025b, January 10). *Food security in the U.S.—Definitions of food security.* https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/definitions-of-food-security

Vidal, C., Silverman, J., Petrillo, E. K., & Lilly, F. R. W. (2022). The health promoting effects of social flourishing in young adults: A broad view on the relevance of social relationships. *The Social Science Journal*, *59*(2), 221–235. https://doi.org/10.1016/j.soscij.2019.08.008

Zhong, B., & Xie, L. (2025). The syndemic nature of food insecurity among U.S. college students: Findings from national samples. *Journal of American College Health*. Advance online publication. https://doi.org/10.1080/07448481.2025.2467320

Zigmont, V., Linsmeier, A., & Gallup, P. (2021). Understanding the why of college student food insecurity. *Journal of Hunger & Environmental Nutrition*, *16*(5), 595–610. https://doi.org/10.1080/19320248.2019.1701600

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Buying into waste: The role of consumer food purchasing behaviors, knowledge, attitudes, and opinions concerning food date labels

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Abstract

Food waste is a growing global issue with significant consequences, including the intensification of food insecurity, the exacerbation of climate change, and environmental degradation. Efforts to address the problem, particularly at the consumer level, have not been effective. This is mainly because consumer food waste and reduction efforts are influenced by multiple interacting and highly contextual factors, including purchasing behaviors, and consumer opinions, attitudes, and understanding of food date labels, of which there are about 50 in the U.S. There is uncertainty and persistent misunderstanding abound regarding the meaning of food date labels. This requires investigating the causes of the misunderstandings to determine how they can be better addressed. We explored the food purchasing attitudes, knowledge, and opinions of U.S. consumers regarding food date labels using quota

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sampling. Data was collected through a survey completed by 742 respondents. Many U.S. consumers still do not understand the difference between *best before* and *use by* dates, as well as the primary purpose of *best by, use by,* and *sell by* dates. The date labels were conflated with food safety, leading to food waste when a food item passes its *best by, sell by,* or *use by* date. The *sell by* date was misunderstood as implying food quality. The *use by* date was the most likely to be misunderstood and misrepresented by U.S. consumers. We identified how this confusion could be addressed and how U.S. food retailers can contribute to reducing consumer food waste by offering price discounts for individual food items, rather than promotions that encourage the bulk purchasing to receive discounts.

Keywords
food waste; food date labels; food purchasing; best by date; use by date; sell by date; consumer knowledge, attitudes, and opinions

Introduction

Food waste is a growing global problem with enormous consequences, including the intensification of hunger, food insecurity, and climate and environmental change. In its 2021 Food Waste Index Report, the United Nations Environment Program (UNEP) estimated that 931 million tons of food are wasted annually. Global food loss and waste are valued at $936 billion annually (World Economic Forum (WEF) and McKinsey & Company, 2020). The amount of food wasted globally equals 1 billion meals per day (World Food Program (WFP), 2024). The majority of wasted food comes from households (569 million tons, 61%), followed by food service (244 million tons, 26%), and then retail (188 million tons, 13%) (UNEP, 2021). Given these staggering figures, it is imperative to explore and develop a better understanding of the causes of consumer food wasting and how they can be addressed.

Despite increasing awareness and education about the problem, consumer food wasting seems to be worsening, especially in the United States (Shanker, 2023). This suggests that the issue requires further empirical scrutiny, which underpins the rationale for conducting this study to investigate consumer food waste in the U.S. Among 35 high-income countries, the U.S. has the highest consumer food waste (ReFED, 2021) and the highest food waste per capita (95.1 kg) (Economist Intelligence Unit, 2018).

In the U.S., about 35% to 40% of the food produced is wasted or lost annually (Environmental Protection Agency (EPA), 2019). This amounts to 130 billiono meals and an economic loss valued at $285 billion (ReFED, 2021). Most of the wasted food in the U.S. ends up in landfills (Environmental Protection Agency [EPA], 2019). Landfilled food waste accounts for 58% of U.S. methane emissions, the third-largest source in the country (EPA, 2024; Povich, 2021).

Furthermore, U.S. households and consumer-facing businesses, such as retailers and food service establishments, are responsible for the majority of the wasted food in the country. In 2019, 37% (30 million tons) of the wasted food in the U.S. was attributed to consumers and households, while consumer-facing businesses contributed 28% (23 million tons) (ReFED, 2021). Confusing food labels exacerbate the problem of food wasting among consumers in the United States (Povich, 2019).

U.S. consumers are often confused about and tend to misunderstand multiple retail food date labels, such as *sell by, use by,* and *best by* (Neff et al., 2019; Patra et al., 2022a; Wilson et al., 2017, 2018). Most of these labels indicate peak food quality and freshness, not food safety (MITRE-Gallup, 2023). The *sell by* date specifies how long food items should be shelved for sale. As indicated by the U.S. Department of Agriculture (USDA, 2025), *sell by* has nothing to do with food safety. Meanwhile, the *use by* date is the last day manufacturers suggest consuming a food item, after which the quality begins to decline. Except for infant formula, the *use by* date is not connected to food safety (USDA, 2025). The *best by* date indicates when consumers should consume food for peak quality or flavor. These food date labels are neither federally regulated (USDA, 2025) nor science-based (Patra et al., 2022b).

Food date labels intertwine with and exacerbate consumer food wasting (Patra et al., 2020,

2022b). Despite growing scholarly attention to the topic (Kavanaugh & Quinlan, 2020), food labels remain a leading factor in U.S. consumers' food buying and waste decisions (MITRE-Gallup, 2023; Patra et al., 2022b). In their survey of 9,259 Americans, MITRE-Gallup (2023) found that 10% of food wasted in the U.S. was due to continued and increased consumer misunderstanding and confusion over food date labels. This underscores the need for more research on U.S. consumers' perceptions, knowledge, and understanding of food date labels to determine whether they still misunderstand and misinterpret their meaning. Moreover, there is a lack of nationally representative data on the subject matter (MITRE-Gallup, 2023), further justifying this study.

Against the above backdrop, this survey-based study was conducted to explore U.S. consumers' perceptions, knowledge, and understanding of *best by, best before*, *use by,* and *sell by* date labels, as well as the gaps in their understanding. We also explored how U.S. consumers use food date labels to determine whether a food is suitable for consumption or should be discarded. In doing so, this study aims to contribute to an improved understanding of how misconceptions about food date labels influence consumer food waste in the U.S. Another goal is to determine whether there has been an improvement in U.S. consumer understanding of food date labels.

Additionally, consumer food wasting is associated with overbuying driven by retail marketing strategies such as price discounts on individual food items, multibuy promotions, and whether food items are sold loose or prepackaged (Calvo-Porral et al., 2017; Quested et al., 2013; WRAP, 2022). The effect of selling food items either loose or prepackaged on consumer food waste also varies depending on the type of food items (WRAP, 2022). The intersection of these retail-related factors with consumer food waste is poorly understood (Tsalis et al., 2021; WRAP, 2022), and existing evidence is ambiguous and mixed (Calvo-Porral et al., 2017; Tsalis et al., 2021). For example, some studies reported positive and negative relationships between price discounts for food items and consumer food waste (Tsalis et al., 2021; Tsalis et al., 2024). Other studies, such as Katajajuuri et al. (2014) and Giordano et al. (2019), found no correlation between purchasing food at discounts and consumer food waste. This underscores why this study also examined how sales offers and the format in which food is sold—whether loose or prepackaged—influence U.S. consumer food purchasing behaviors. Additionally, we examined the relationship between the retail factors and the wasting of various types of food.

Food wasting and food waste reduction by consumers involve a high level of complexity due to multiple interacting and highly contextual factors (Quested et al., 2011, 2013). For example, a consumer's decision to throw away food may be motivated by insights derived from food date labels and personal judgment of whether the food appears expired or has a bad taste (Ahmed et al., 2021; Gong et al., 2022). Additionally, the reduction of food wasting by consumers can be influenced by habitual social factors, values, and motivations, such as a desire to manage their homes effectively, eagerness to save money, and concerns for environmental and climate health (Ahmed et al., 2021; Diaz-Ruiz et al., 2018; Lyndhurst and Waste and Resources Action Program (WRAP), 2011; Patra et al., 2020; Quested et al., 2013). Moreover, the impact of consumers' understanding of food date labels on food waste is best examined within the broader context of their food practices—attitudes, values, habits, and behaviors (Quested et al., 2011; Quested et al., 2013; Lyndhurst & WRAP, 2011). Therefore, we also examined how such consumer food practices affect food waste and U.S. consumers' waste reduction efforts. Our investigation also examined the perceived importance of including information on food labels, such as storage, freezing, defrosting, packaging, and the optimal time to consume opened canned food to help consumers reduce food wasting.

To achieve our underlying research objectives, we addressed the following questions: (1) How much food do American consumers waste at the household level, and how does this vary by food type? (2) How do sales promotions and the format in which food is sold—loose versus prepackaged—affect U.S. consumer purchasing habits, and what impact do these factors have on the waste of dif-

ferent types of food? (3) Do Americans still misunderstand food date labels, and do their perceptions, understanding, and use of these labels contribute to food waste? How does this vary by food type and socio-demographic factors? (4) Could including information on storage, freezing, and defrosting alongside food date labels help reduce consumer food waste in the U.S.? (5) What would motivate Americans to reduce food waste at home, and how do financial, emotional, practical, and environmental factors influence their behavior?

Methods

Data was collected in the Fall of 2019 using a virtually deployed Qualtrics survey collaboratively designed by researchers from different disciplines. The sustainability-focused survey was divided into various parts that aligned with gaps in scholarship and questions the participating researchers wanted to explore. These questions included topics such as food waste, climate change, ecological restoration, and sustainability knowledge, with each researcher responsible for populating their survey section with relevant questions. The food waste section of the survey, which informed this study, comprised questions on the following topics: household food preparation, estimated food thrown away, food shopping and wasting behaviors, reasons for food waste, feelings about wasted food, motivation to reduce food waste, and understanding of food date labels. To allow comparison with existing studies, some questions were adopted from previous food waste surveys (Aktas et al., 2018; Lyndhurst & WRAP, 2011; Neff et al., 2015). Respondents stated their agreement with certain measurement items on a five-point Likert scale (e.g., *strongly disagree*, *disagree*, *somewhat disagree*, *agree*, and *strongly agree*).

We used Qualtrics to deploy the survey. Quotas were used to ensure that the final sample matched U.S. census data for age, sex, race, education, and whether the participant self-identified as living in an urban or rural area. Pew Research Center data was used to identify national trends in political affiliation. Screening participants and data collection were conducted on a rolling basis until Qualtrics had collected enough individuals who met the quota requirements and were not excluded due to poor data quality. Respondents with more than 15% of their responses missing were not included in the data analysis. The threshold was determined through ex-post data collection. SPSS was used to analyze the 742 responses that met our inclusion criteria. Descriptive statistics (e.g., frequencies, percentages) were computed for socio-demographic variables such as age, gender, income, and ethnicity. Spearman's rank correlation was used to estimate bivariate relationships between variables, such as food waste and sales offers, perceived understanding of food date labels and educational status, and food waste and food date labels. A two-tailed p-value <0.05 or <0.01 was considered statistically significant.

Results

Most respondents identified as women (n = 477), white or Caucasian (n = 526), and married (n = 310). Approximately 28.8% (n = 214) indicated that they had completed high school, while another 41.7% (n = 185) reported having some college education or an associate's or other 2-year college degree (Table 1). Only 25.7% of respondents had a bachelor's or another 4-year college degree (n = 116) or a graduate degree (n = 75, 10.1%). More respondents identified as not employed (n = 325, 43.8%) than those working full-time (n = 321, 43.3%), with a significantly higher number than part-time workers (n = 96, 12.9%). At the 0.05 alpha level, a positive and statistically significant relationship (p = 0.079, p = 0.031) existed between respondents' employment status and household food preparation.

About 76% of respondents (n = 562) were responsible for purchasing perishable foods, such as meat, vegetables, fruits, dairy, and bread, for their household. Only 9.6% (n = 71) indicated that they shared the responsibility almost equally with their partners, roommates, or parents. Most respondents (n = 498) purchased their perishables from large retail stores, including Meijer, Walgreens, and Walmart. Only a small percentage shopped at organic grocery stores (n = 97, 13.1%) and non-chain local food stores or farmers markets (n = 20, 2.7%) for their perishables.

Responses to the question "Who is responsible for most of the food preparation in your house-

Table 1. Respondent Socioeconomic Demographics (%)

Variable	Survey (%)
Rural/urban residence	
Urban	72.0
Rural	28.0
Gender	
Women	64.3
Men	35.2
Other	0.5
Age	
19–24	10.5
25–34	24.5
35–44	22.5
45–54	13.5
55+	29.0
Annual Income (US$)	
Less than $20,000	22.8
$20,001–$40,000	27.5
$40,001–$60,000	18.5
$60,001–$80,000	12.8
$80,001–$100,000	8.2
More than $100,001	10.2
Ethnicity	
White/Caucasian	70.9
Black/African American	17.0
Hispanic	5.8
Asian	4.0
Other	2.3

hold?" indicated that approximately 72% (n = 533) of respondents handled most of the food preparation. Only 9.6% (n = 71) shared this responsibility with household members. Those who bought perishables (n = 562, 75.7%) also prepared them, with most of these individuals being women. The relationship between gender and food preparation was found to be negatively correlated (ϱ = -0.058), although the correlation was not statistically significant.

Sales and Prepackaged Food: Effects on Respondents' Waste and Purchasing Behaviors

Sales offers seem to influence respondents' food purchasing habits, with the majority reporting that they use them, while only a small portion stated they do not (Table 2). Furthermore, about half of the respondents (n = 451, 47.3%) indicated that sales offers led them to purchase more food than necessary, while 25.8% (n = 192) held the opposite view. This overbuying was linked to more food waste. Interestingly, those who utilized sales offers wasted less food overall, including baked items, fruits and vegetables, dairy products, meat, fish, and precooked or preprepared foods.

Prepackaging also influenced food-buying behavior. Almost half of the respondents (n = 323, 43.6%) said they bought more when foods were prepackaged, while about 25% (n = 185) disagreed. Those who bought more food because it was prepackaged also wasted more baked goods, fruits, vegetables, dairy products, meat, fish, and precooked or preprepared foods.

This study also examined preferences for purchasing unpacked fruits and vegetables, as well as discounts on individual items. Most respondents (n = 499, 67.3%) preferred buying unpacked fruits and vegetables to ensure they purchased the right quantity, with a few expressing disagreements. Likewise, the majority favored price discounts on individual food items over multibuy deals (n = 493, 66.4%), with only a small number disagreeing.

Knowledge of Food Date Labels

The majority of respondents said that they had a clear or moderate understanding of the difference between *best before* and *use by* dates (n = 622, 83.8%), while a smaller portion expressed confusion or a lack of understanding (n = 120, 16.2%) (Table 3). Respondents with higher education were slightly less likely to say they understood the difference between the date labels, but this weak relationship was not significant at the 0.01 alpha level (p = -0.005).

We also tested respondents' understanding of the primary purpose of the *best by*, *sell by*, and *use by* dates. Just over half correctly understood the *best by* date (n = 388, 52.3%) as indicating food quality. Many people mistook it for a food safety warning, and others interpreted it as signaling a discard date or when to remove food from store shelves. Similarly, most respondents (n = 385, 51.9%) correctly understood the *sell by* date as indicating when stores

Table 2. Respondent Food Purchasing Behaviors Related to Sales and Packaging, and their Correlation with Food Waste by Product Category

Statements about food purchasing	Strongly disagree (%)	Disagree (%)	Neither disagree nor agree (%)	Agree (%)	Strongly agree (%)
I take advantage of sales offers	3.2	3.9	15.1	38.4	39.4
Sale offers lead me to buy more than I need	7.5	18.3	26.8	30.3	17.0
I buy more quantity of prepackaged items than if I were to buy the same items individually	9.2	15.8	31.5	27.8	15.8
I would prefer to buy my fruit and vegetables individually (rather than prepackaged) so I can decide how much to buy	3.4	6.6	22.8	39.9	27.4
I would prefer if shops offered price discounts on single items instead of having to purchase more than one item together (e.g., buy one, get one free)	3.1	7.4	23.0	38.4	28.0

Spearman correlation coefficient values between how much food was thrown away the week before taking the survey and different forms of sales promotional

		Baked items	Dairy products	Fruits and vegetables	Meat and fish	Precooked/ preprepared food
I take advantage of sales offers	correlation coefficient	-0.177**	-0.176**	-0.168**	-0.228**	-0.186**
	Sig. (2-tailed)	<0.001	<0.001	<0.001	<0.001	<0.001
Bought more food than needed due to sale offers	correlation coefficient	0.274**	0.307**	0.219**	0.226**	0.195**
	Sig. (2-tailed)	<0.001	<0.001	<0.001	<0.001	<0.001
I bought more prepacked food items than I could have purchased individually	correlation coefficient	0.140**	0.212**	0.158**	0.146**	0.108**
	Sig. (2-tailed)	<0.001	<0.001	<0.001	<0.001	<0.003

** Correlation is significant (Sig) at $p < 0.01$ (2-tailed)

should remove food from their shelves, while others mistook it as indicating food quality or safety. Furthermore, only 15.5% ($n = 115$) correctly recognized the *use by* date as a marker of food quality. The rest misunderstood it as signaling that the food is becoming unsafe and should be discarded or removed from store shelves.

Understanding of *best by* showed almost no association with education level. For the *sell by* date, those with more education tended to understand slightly better, but the relationship was not statistically significant. Interestingly, individuals with more education were somewhat less likely to interpret the *use by* date correctly; however, this relationship was not statistically significant.

Food Date Labels: Usage, Attitudes, and Opinions

Most respondents ($n = 473$, 63.7%) stated that food label dates help them determine when food is no longer suitable for consumption, although 21.8% ($n = 162$) were unsure (Figure 1). Additionally, most respondents believed that checking if food is bad before throwing it away is important, even if it has passed its labeled date, while some were uncertain about this. The findings also revealed mixed attitudes toward discarding food past its labeled date, even when the food is still good. Most respondents were uncertain or unconvinced, whereas some believed it was important to throw away such food, though only a small portion felt strongly about it. Moreover,

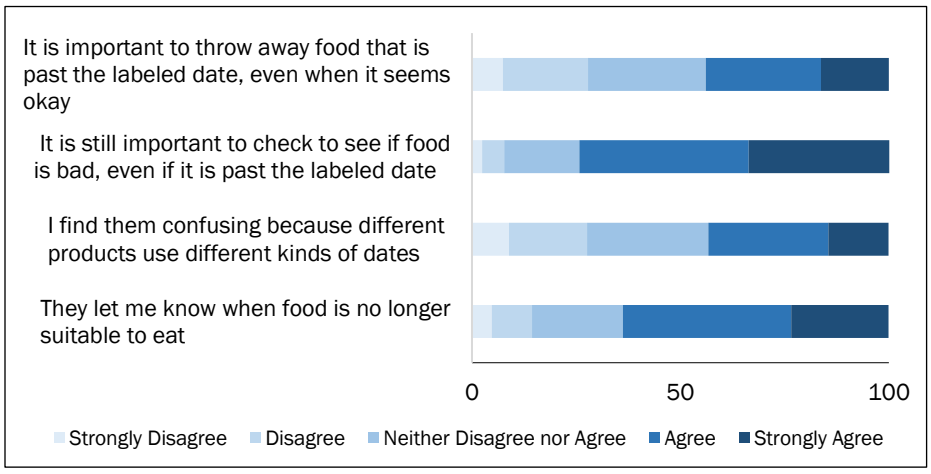
Table 3. Respondents' Knowledge of the Primary Purpose of Food Date Labels and Correlation with Their Education Status

Do you understand the difference between **best before** *dates and* **use by** *dates?*			%
Not at all			3.0
I am a little confused			13.2
More or less			40.0
Absolutely			43.8
What is the primary purpose of each of the following date labels?	**Best by (%)**	**Sell by (%)**	**Use by (%)**
To inform people when food becomes unsafe	32.2	12.8	55.0
To inform people when food quality is guaranteed	52.3	32.2	15.5
To inform stores when to take food off the shelves	10.2	51.9	19.9
To inform me when I should discard the food	5.3	3.1	9.6
Spearman's correlation between perceived understanding of some date labels and educational status			**Education**
Understand the difference between ***best before*** dates and *use by* dates	correlation coefficient		-0.005
	sig. (2-tailed)		0.896
Understand the primary purpose of *best by* date label	correlation coefficient		0.008
	sig. (2-tailed)		0.823
Understand the primary purpose of *sell by* date label	correlation coefficient		0.049
	sig. (2-tailed)		0.183
Understand the primary purpose of *use by* date label	correlation coefficient		-0.049
	sig. (2-tailed)		0.180

Correlation is significant at $p < 0.01$ (two-tailed)

43.2% of the respondents (n = 321) agreed that the use of different types of dates on products confuses them, while a smaller number disagreed, and some remained neutral.

Figure 1. Respondent Use and Opinions about Food Date Labels



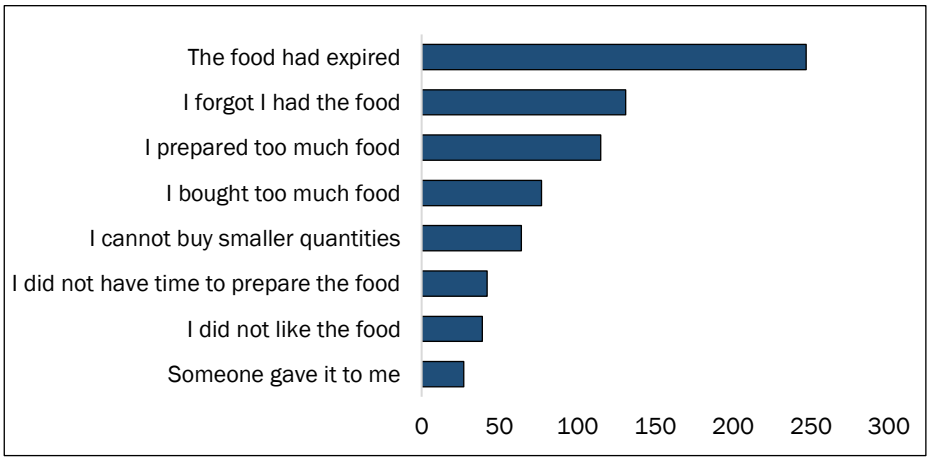
Throwing Away Foods, Foods Thrown Away

Respondents self-reported their household food waste for the previous week, with most indicating they threw away a small portion of their food, and a smaller number reporting that they wasted larger amounts of their food (30% to 40%). A few reported wasting nothing (Table 4). Furthermore, most respondents reported throwing away very little of the following: baked goods, dairy products, precooked or preprepared foods, meat and fish, and fruits and vegetables. However, baked goods were the least wasted, with 49.5% (n = 367) saying they threw away "hardly any." Fruits and vegetables had the highest number of respondents reporting larger amounts of waste. Across all categories, a smaller number of respondents indicated throwing away "a lot," and only a few reported not consuming certain food types at all.

Respondents were asked why they threw away food the last time before the survey. Most (n = 247, 33%) said the food had expired, 17.7% (n = 131) said they had forgotten about it, and 15.5% (n = 115) cited preparing too much food (Figure 2). We examined how food date labels influence the decisions to discard food. Most respondents would almost certainly discard

food if it looked expired (*n* = 546, 73.6%) or tasted bad (*n* = 598, 79.9%). Opinions were more divided about discarding food past *sell by* and *best before* dates, with many respondents unsure or neutral. However, respondents were generally more inclined to discard food past the *use by* date compared to the *best before* date. Equally, a greater number (*n* = 255, 25.1%) reported being less likely to discard foods past the *best before* date than those past the *use by* date (*n* = 139, 18.7%) (Figure 3).

Figure 2. Reasons for Throwing Away Food by Respondents



Respondents who reported higher food waste in the week before the survey were more likely to discard food past the *best before* and *sell by* dates (Table 5). In contrast, respondents were less likely to discard food solely based on whether it appeared expired or tasted bad. While there was a positive association between higher food waste and discarding food past the *use by* date, the relationship was not statistically significant.

Table 4. Self-Reported Food Waste by Respondents the Week Before the Survey

Percentage of food wasted by respondents

Percentage of food wasted	Number of respondents	Percentage of respondents
0	69	9.3
10	339	45.7
20	145	19.5
30	90	12.1
40	45	6.1
50	54	7.3
Total	742	100.0

Importance of Information on Food Labels

We asked respondents to rate the importance of specific information on food date labels to help reduce food waste. This included information on how to ensure food lasts, freezing, defrosting, consumption after opening, and packaging food for freshness. Most respondents considered this information important (Figure 4). The highest importance was placed on how soon to consume a product after opening (*n* = 528, 71.2%), followed by information on packaging for freshness (*n* = 507, 68.3%). Fewer respondents found guidance on freezing and defrosting (*n* = 31, 4.2%) or whether a product is suitable for home freezing (*n* = 28, 3.8%) to be important.

We asked respondents how they decide to store their food. Most relied on information from food labels or packaging (always: *n* = 324, 43.7%; sometimes: *n* = 258, 34.8%). Only 21.6% (*n* = 160) relied on their own knowledge.

Opinions on Food Waste Reduction Decision-Making

Many respondents reported that thinking about the possibility of saving money was a strong motivator

Amount of different food types thrown away by respondents

	Hardly any	Some	A fair amount	A lot	We do not eat this food	Mean	Standard deviation
Bakery items	367	139	109	90	37	2.24	1.88
Vegetables and fruits	289	194	132	114	13	2.22	1.41
Dairy products	336	142	137	108	19	2.20	1.56
Meat and fish	331	139	140	105	27	2.28	1.71
Precooked or preprepared foods	332	155	116	98	41	2.36	1.93

Figure 3. Survey Response to the Statement on the Likelihood of Throwing Away Food Because It Looks Expired or Is Past Specific Food Date Labels

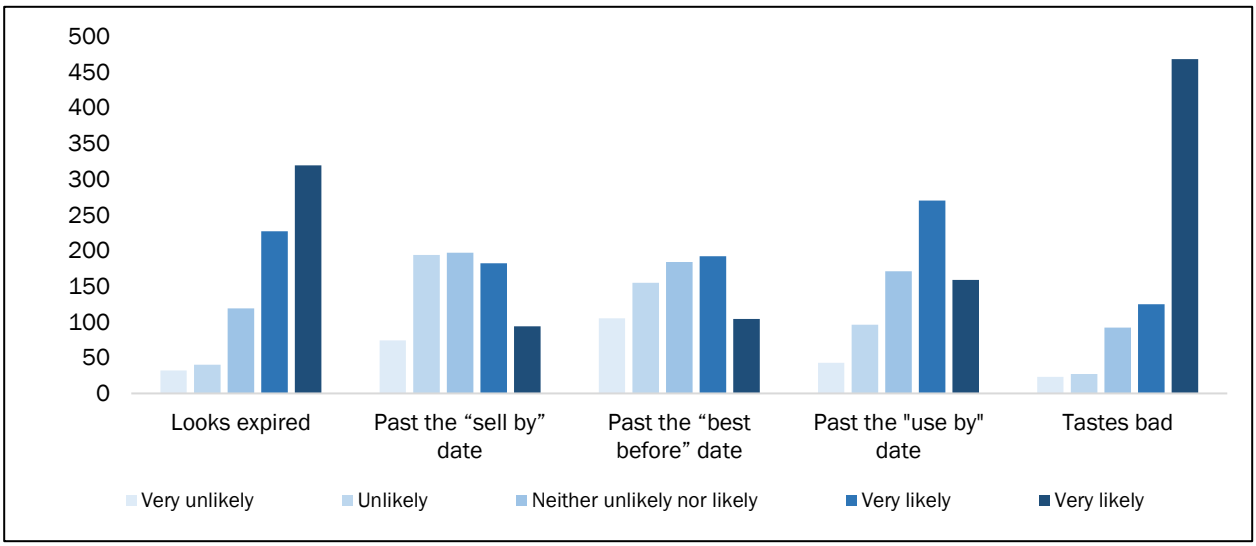


Table 5. Correlation Between Food Waste and Date Labels

		Spearman's **Rank Correlation Coefficient**				
		Past “best before” date	**Past “use by” date**	**Past “sell by” date**	**Tastes bad**	**Looks expired**
Estimated amount of food wasted	correlation coefficient	0.185**	0.064	0.163**	-0.264**	-0.106**
	sig. (2-tailed)	<0.001	0.084	<0.001	<0.001	0.004

** Correlation is significant (Sig) at $p < 0.01$ (2-tailed)

Figure 4. Survey Response to the Importance of Information on Food Storage, Packaging, Freezing, Defrosting, and Consumption Timing of Opened Products

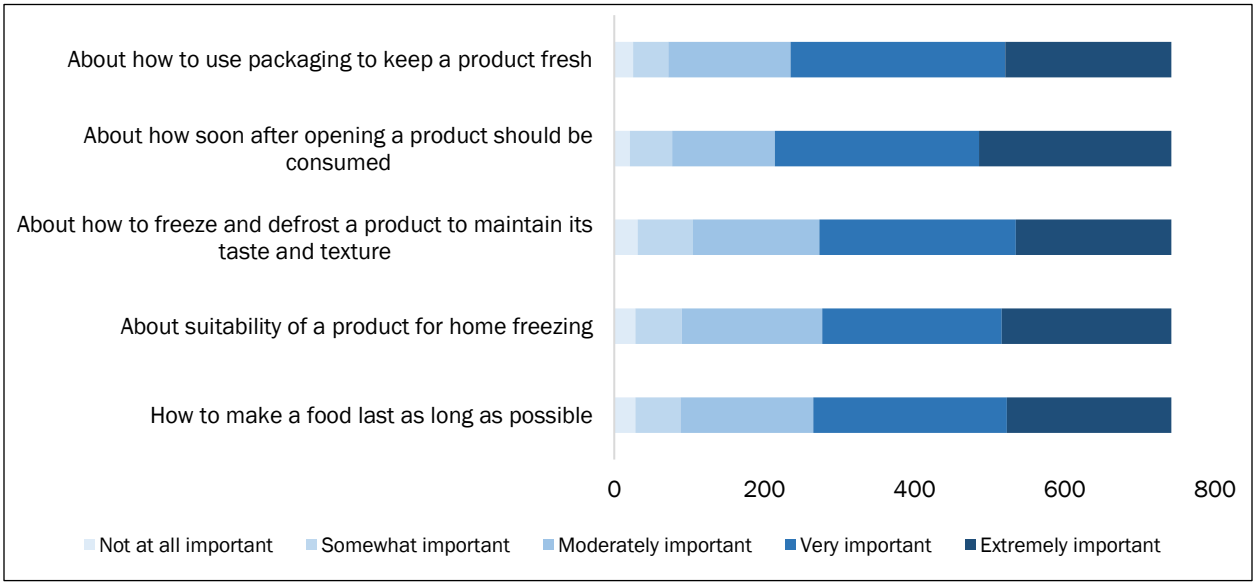


Table 6. Motivation to Reduce Food Waste (% of Response)

Motivation	Slightly Important	Moderately Important	Extremely Important
The possibility of saving money	14.7	25.1	60.1
The feeling of guilt about the time spent shopping, storing, or preparing food not eaten	24.1	31.1	44.8
Wanting to manage my home efficiently	16.8	29.2	60.0
Wanting to make a difference	18.7	27.8	53.5
Thinking about the greenhouse gases, energy, and water resources it took to get the food to my plate	25.1	53.2	46. 7

for reducing food waste, with 60.3% (n = 447) rating it as either extremely or very important (Table 6). Guilt about wasting the time spent purchasing, storing, or preparing food that was not consumed also played a significant role, although to a somewhat lesser extent. Most respondents indicated that managing their households effectively and believing their actions could have an impact were important motivations for reducing food waste. Similar attitudes were reflected in responses to the statement linking the reduction of wasted food to concerns about greenhouse gases, energy, and water resources used in the production and distribution of food from farm to plate—though the views here were more mixed, with fewer rating these concerns as extremely important (n = 145, 19.5%).

To reduce food waste, 52.3% (n = 488) of respondents wanted supermarkets to help consumers avoid overbuying, while 29.2% (n = 217) neither agreed nor disagreed. Approximately 19% either strongly disagreed (n = 49, 6.6%) or disagreed (n = 88, 11.9%).

Discussion

This study revealed that many U.S. consumers still do not understand the difference between *best before* and *use by* dates on food labels, as well as the primary purpose of *best by, use by,* and *sell by* dates (Neff et al., 2019; Wilson et al., 2018). The findings demonstrate how misinterpretation of these dates can lead to food waste and impact consumer purchasing behaviors. For example, 32.2% of respondents misinterpreted *best by* dates as specifying when food items are unsafe for consumption, which could lead to the unnecessary discarding of food. Mistaking *sell by* dates as a guarantee of food quality and safety, and misidentifying *use by* dates as indicating when food becomes unsafe, could lead to consumer food waste (Kavanaugh & Quinlan, 2020). The misrepresentations may also result in consumers avoiding or buying less food near its *best by*, *sell by*, or *use by* dates, leading retailers to discard unsold items (Yu & Jaenicke, 2021).

This confusion and misrepresentation suggest a need for more consumer education and clarification about food date labels from government agencies and nongovernmental organizations, such as the USDA, ReFED, Food Marketplace Inc., and large food retailers. The nature of the confusion suggests that the clarification could entail describing the date labels in terms of what they imply and what they do not. For example, the *best by* date can be accompanied by a statement indicating that it does not signify food safety or when the food should be discarded. The statement could also clarify that a food item that has passed its *best by* date does not necessarily mean it is unsafe to eat. It could also encourage consumers to use their sensory judgment to determine whether the food is still suitable for consumption. Similarly, the *sell by* date can be accompanied by a caveat that it does not indicate either food quality or food safety. Furthermore, the finding that over 50% of the respondents mistakenly believed the *use by* date indicated when food becomes unsafe illustrates the need for targeted consumer education. Additionally, the confusion among respondents regarding different food date labels highlights the need to streamline and standardize these labels to reduce food waste, as recommended by the FDA and USDA (EPA, 2019; U.S. Government Accounta-

bility Office [GAO], 2019). Considering existing consumer perceptions is crucial when standardizing these dates (Wilson et al., 2018).

Consistent with Kavanaugh and Quinlan (2020) and Newsome et al. (2014), our findings suggest that among *sell by*, *use by*, and *best by* dates, the *use by* date is the most likely to be misconceived and misrepresented by U.S. consumers. This may be due to the different definitions and varied applications associated with the *use by* date (Newsome et al., 2014). For example, the USDA states that the *use by* date is related to food safety only for infant formula: "A 'use-by' date is the last date recommended for using the product while at peak quality. It is not a safety date except when used on infant formula" (USDA, 2025, para. 12). The fact that over 50% of respondents mistook the *use by* date as indicating when food becomes unsafe may be connected to its use on infant formula. In the European Union, the *use by* date signifies food safety, meaning foods should not be eaten after this date (Hall-Phillips & Shah, 2017; Toma et al., 2017). Similarly, members of the United States Food Industry Association, the Food Marketing Institute, and the Grocery Manufacturers Association use the *use by* date as a marker of food safety (Roberts, 2022). The varying meanings and contexts of the *use by* date confuse consumers (Broad Leib et al., 2016). This highlights the need to streamline the meanings and applications of the *use by* and other food label dates, both nationally and globally. This could be achieved through an integrated, multi-stakeholder-engaged approach, as proposed by Patra et al. (2022a). The government could work with stakeholders like Food Marketplace Inc. to streamline and standardize the food date labels. Passing the Food Date Labeling Act of 2023 before the U.S. Congress is also imperative for regulating and unifying the dates (H.R.3159, 118th Congress, 2023).

Our findings suggest that including specific information on food labels could help reduce food spoilage, quality loss, and waste. This information should cover how to store and handle food to achieve a longer shelf life, whether a food item is suitable for home freezing, and the proper methods for freezing and defrosting to maintain optimal flavor, texture, and taste. As suggested by Newsome et al. (2014), combining *best by* dates with freeze-by statements on food labels could provide guidelines on whether and how to freeze food and the optimal time frame for consumption after removing it from the freezer. Combining *freeze by* instructions with *use by* dates could help guide consumers in preventing the wasting of food items frozen past their *use by* dates. The findings also highlight the need for consumer education on best practices for safely storing, home-freezing, refrigerating, and defrosting food to reduce spoilage and waste.

The motivation for reducing food waste that is linked to greenhouse gas emissions and the resources used in food production and supply chains aligns with Stangherlin and de Barcello (2018) but differs from Neff et al. (2015). The finding suggests that educating the U.S. public through awareness campaigns about the climate and environmental impact of food waste could reduce consumer food waste. Illustrating how reducing food waste improves climate and environmental health may be particularly effective for eco-conscious consumers (Pellegrini et al., 2019). The finding highlights the need to integrate policies and programs aimed at reducing greenhouse gas emissions, mitigating climate change, and promoting environmentally friendly behaviors with efforts to prevent and minimize consumer food waste. This integration could increase awareness of the link between environmental health and food waste prevention. Additionally, promoting money-saving and smart shopping strategies, such as purchasing only the necessary quantities and using a shopping list, can help reduce food waste among consumers (Young et al., 2017). These strategies should be incorporated into broader consumer food waste prevention education to prevent impulse and excess buying due to sales and discounts, which can lead to food waste (Porpino et al., 2015).

This study revealed that most respondents were highly responsive to food sales promotional offers. However, the implications of the findings for consumer food purchasing behaviors and food waste are nuanced. On the one hand, the findings showed that sales promotions encouraging consumers to make excessive purchases for discounts can lead to increased food waste. While this aligns

with Gravert and Mormann (2025), it contrasts with Tsalis et al. (2024), who reported that buying discounted food resulted in less waste. Interestingly, this study also found that taking advantage of sales offers does not necessarily lead to more food waste, a finding consistent with Tsalis et al. (2024). This may be because buying food items on sale does not always equate to overbuying.

Consistent with Stangherlin and de Barcellos (2018), this study shows that food retailers could play a crucial role in helping consumers reduce food waste. U.S. food retailers could do this by replacing promotional sales offers that lead to overbuying and increased food waste with price discounts on individual food items. They could also prioritize selling food items, especially fruits and vegetables, loose rather than prepackaged. This is because, as both this study and WRAP (2021) have revealed, purchasing prepackaged food items could lead to increased food waste. This is particularly important, given that most respondents prefer to buy their fruits and vegetables loose to ensure they purchase the correct quantity.

Conclusions

The study examined U.S. consumers' understanding and use of *best by, best before*, *use by,* and *sell by* food date labels, focusing on how these labels influence decisions about food consumption, discarding, and waste reduction. We also explored how sales offers and whether food items are sold loose or prepackaged affect food purchasing behaviors and food waste. The findings revealed that many U.S. consumers still do not comprehend the differences between *best before* and *use by* dates, nor the primary purposes of *best by, use by,* and *sell by* dates. Specifically, the *use by* date is the most likely to be misunderstood and misrepresented. Misunderstanding and confusion about the food date labels contribute to consumer food waste. This study also showed that promotional offers influence food purchasing behaviors, which could lead to overbuying, but not necessarily to increased food waste. In contrast, this study revealed that purchasing prepackaged food items can lead to increased food waste.

To reduce consumer food waste, this study concludes that sustained, targeted education is necessary to clarify the meanings of food date labels. It also highlights the need to streamline and standardize the many food date labels currently in use. The study emphasizes the importance of including information on food labels about proper storage and handling, suitability for home freezing, and guidelines for freezing and defrosting to maintain optimal quality. Additionally, promoting money-saving and smart shopping strategies, such as purchasing only the quantities needed, could help consumers reduce food waste. Retail stores could also contribute to reducing consumer food waste by replacing multibuy promotions with individual food item discounts and by selling food, especially fruits and vegetables, loose rather than prepackaged.

The findings of this study suggest the need for further exploration, including how best to incorporate additional information on food date labels that clarifies their meaning and what they do not mean. Further studies could also explore the most effective ways to educate consumers from diverse backgrounds about the meanings of food date labels. Additionally, studying how food date labels influence purchasing and consumption behaviors would help deepen the understanding of their role in consumer food waste.

References

Ahmed, S., Stewart, A., Smith, E., Warne, T., & Byker Shanks, C. (2021). Consumer perceptions, behaviors, and knowledge of food waste in a rural American state. *Frontiers in Sustainable Food Systems*, *5*, Article 734785. https://doi.org/10.3389/fsufs.2021.734785

Aktas, E., Sahin, H., Topaloglu, Z., Oledinma, A., Huda, A. K. S., Irani, Z., Sharif, A., Wout, T & Kamrava, M. (2018). A consumer behavioural approach to food waste. *Journal of Enterprise Information Management*, *31*(5), 658–673. https://doi.org/10.1108/JEIM-03-2018-0051

Broad Leib, E., Rice, C., Neff, R., Spiker, M., Schklair, A., & Greenberg, S. (2016). *Consumer perceptions of date labels: National survey* [Factsheet]. Harvard Food Law and Policy Clinic, National Consumer League, and Johns Hopkins Center for a Livable Future. https://www.nclnet.org/wp-content/uploads/pdf/date_labeling_report.pdf

Calvo-Porral, C., Medín, A. F., & Losada-López, C. (2016). Can marketing help in tackling food waste?: Proposals in developed countries. *Journal of Food Products Marketing*, *23*(1), 42–60. https://doi.org/10.1080/10454446.2017.1244792

Diaz-Ruiz, R., Costa-Font, M., & Gil, J. M. (2018). Moving ahead from food-related behaviours: An alternative approach to understand household food waste generation. *Journal of Cleaner Production*, 172, 1140–1151. https://doi.org/10.1016/j.jclepro.2017.10.148

Economist Intelligence Unit. (2018). *Fixing food 2018: Best practices towards the Sustainable Development Goals*. Barilla Center for Food and Nutrition. https://foodsustainability-cms.eiu.com/whitepaper-2018/

Environmental Protection Agency [EPA]. (2019, April). *Winning on reducing food waste - FY 2019-2020 federal interagency strategy*. (EPA 530-F-19-004). https://www.epa.gov/sites/default/files/2019-05/documents/reducingfoodwaste_strategy.pdf

Environmental Protection Agency. (2024, December 30). *Quantifying methane emissions from landfilled food waste*. The MITRE Corporation. https://www.epa.gov/land-research/quantifying-methane-emissions-landfilled-food-waste

Giordano, C., Alboni, F., Cicatiello, C., & Falasconi, L. (2019). Do discounted food products end up in the bin? An investigation into the link between deal-prone shopping behaviour and quantities of household food waste. *International Journal of Consumer Studies*, *43*(2), 199–209. https://doi.org/10.1111/ijcs.12499

Gong, Z., Su, L. Y. F., Zhang, J. S., Chen, T., & Wang, Y. C. (2022). Understanding the association between date labels and consumer-level food waste. *Food Quality and Preference*, 96, Article 104373. https://doi.org/10.1016/j.foodqual.2021.104373

Gravert, C., & Mormann, M. (2025). In-store food promotions increase sales as well as household food waste. *Scientific Report, 15*, Article 18035. https://doi.org/10.1038/s41598-025-01800-x

Hall-Phillips, A., & Shah, P. (2017). Unclarity confusion and expiration date labels in the United States: A consumer perspective. *Journal of Retailing and Consumer Services*, *35*, 118–126. https://doi.org/10.1016/j.jretconser.2016.12.007

H.R.3159 - 118th Congress (2023-2024). (2023, June 1). Food Date Labeling Act of 2023. https://www.congress.gov/bill/118th-congress/house-bill/3159

Katajajuuri, J. M., Silvennoinen, K., Hartikainen, H., Heikkilä, L., & Reinikainen, A. (2014). Food waste in the Finnish food chain. *Journal of Cleaner Production*, *73*, 322–329. https://doi.org/10.1016/j.jclepro.2013.12.057

Kavanaugh, M., & Quinlan, J. J. (2020). Consumer knowledge and behaviors regarding food date labels and food waste. *Food Control*, *115*, Article 107285. https://doi.org/10.1016/j.foodcont.2020.107285

Lyndhurst, B., & Waste and Resources Action Programme (WRAP). (2011, May). *Consumer insight: Date labels and storage guidance*. Project WRAP. https://www.wrap.ngo/sites/default/files/2020-12/Consumer-insight-date-labels-and-storage-guidance.pdf

MITRE-Gallup. (2023). *The state of food waste in America: 2023 report*. The MITRE Corporation. https://sites.mitre.org/household-food-waste/wp-content/uploads/sites/41/2023/11/The-State-of-Food-Waste-in-America-11-14-23.pdf

Neff, R. A., Spiker, M. L., & Truant, P. L. (2015). Wasted food: US consumers' reported awareness, attitudes, and behaviors. *PLoS ONE*, *10*(6), Article e0127881. https://doi.org/10.1371/journal.pone.0127881

Neff, R. A., Spiker, M., Rice, C., Schklair, A., Greenberg, S., & Broad Leib, E. (2019). Misunderstood food date labels and reported food discards: A survey of US consumer attitudes and behaviors. *Waste Management*, *86*, 123–132. https://doi.org/10.1016/j.wasman.2019.01.023

Newsome, R., Balestrini, C. G., Baum, M. D., Corby, J., Fisher, W., Goodburn, K., Labuza, T. P., Prince, G., Thesmar, H. S., & Yiannas, F. (2014). Applications and perceptions of date labeling of food. *Comprehensive Reviews in Food Science and Food Safety*, *13*(4), 745–769. https://doi.org/10.1111/1541-4337.12086

Patra, D., Feng, S., & Howard, J. W. (2022b). Confusion of food date label with food safety—Implications for food waste. *Current Opinion in Food Science*, *48*, Article 100917. https://doi.org/10.1016/j.cofs.2022.100917

Patra, D., Henley, S. C., Benefo, E. O., Pradhan, A. K., & Shirmohammadi, A. (2022a). Understanding and addressing food waste from confusion in date labeling using a stakeholders' survey. *Journal of Agriculture and Food Research*, 8, Article 100295. https://doi.org/10.1016/j.jafr.2022.100295

Patra, D., Leisnham, P. T., Tanui, C. K., & Pradhan, A. K. (2020). Evaluation of global research trends in the area of food waste due to date labeling using a scientometrics approach. *Food Control*, *115*, Article 107307. https://doi.org/10.1016/j.foodcont.2020.107307

Pellegrini, G., Sillani, S., Gregori, M., & Spada, A. (2019). Household food waste reduction: Italian consumers' analysis for improving food management. *British Food Journal*, *12*(6), 1382–1397. https://doi.org/10.1108/BFJ-07-2018-0425

Porpino, G., Parente, J., & Wansink, B. (2015). Food waste paradox: Antecedents of food disposal in low-income households. *International Journal of Consumer Studies*, *39*(6), 619–629. https://doi.org/10.1111/ijcs.12207

Povich, E. S. (2019, March 28). *Food waste is a major problem. Confusing date labels are making it worse.* Stateline. https://stateline.org/2019/03/28/food-waste-is-a-major-problem-confusing-date-labels-are-making-it-worse/

Povich, E. S. (2021, July 8). *Waste not? Some states are sending less food to landfills.* https://stateline.org/2021/07/08/waste-not-some-states-are-sending-less-food-to-landfills/

Quested, T. E., Marsh, E., Stunell, D., & Parry, A. D. (2013). Spaghetti soup: The complex world of food waste behaviours. *Resources, Conservation and Recycling*, *79*, 43–51. https://doi.org/10.1016/j.resconrec.2013.04.011

Quested, T. E., Parry, A. D., Easteal, S., & Swannell, R. (2011). Food and drink waste from households in the UK. *Nutrition Bulletin*, *36*(4), 460–467. https://doi.org/10.1111/j.1467-3010.2011.01924.x

ReFED. (2021, February). *Roadmap to 2030: Reducing U.S. food waste by 50% and the ReFED insights engine at-a-glance.* https://refed.org/downloads/refed_roadmap2030-FINAL.pdf

Roberts, J. (2022, July 21). *How can you avoid spoiled food if you don't know what the labels mean?* The Conversation. https://www.thedailybeast.com/confused-by-food-expiration-dates-theres-a-better-way

Shanker, D. (2023, April 20). *New data shows US food waste is getting worse*. Bloomberg. https://www.bloomberg.com/news/articles/2023-04-20/the-us-has-a-food-waste-problem-and-it-s-getting-worse

Stangherlin, I. D. C., & de Barcellos, M. D. (2018). Drivers and barriers to food waste reduction. *British Food Journal*, *120*(10), 2364–2380. https://doi.org/10.1108/BFJ-12-2017-0726

Toma, L., Costa Font, M., & Thompson, B. (2017). Impact of consumers' understanding of date labelling on food waste behaviour. *Operational Research*, *20*(2), 543–560. https://doi.org/10.1007/s12351-017-0352-3

Tsalis, G., Jensen, B. B., & Aschemann-Witzel, J. (2024). The relationship between retail price promotions and household-level food waste: Busting the myth with behavioural data?. *Waste Management*, *173*, 29–39. https://doi.org/10.1016/j.wasman.2023.10.032

Tsalis, G., Jensen, B. B., Wakeman, S. W., & Aschemann-Witzel, J. (2021). Promoting food for the trash bin? A review of the literature on retail price promotions and household-level food waste. *Sustainability*, *13*(7), Article 4018. https://doi.org/10.3390/su13074018

United Nations Environment Program (UNEP). (2021). *Food waste index report 2021*. UNEP, Nairobi. https://www.unep.org/resources/report/unep-food-waste-index-report-2021

U.S. Department of Agriculture [USDA]. (2025, April 23). *Food product dating*. https://www.fsis.usda.gov/food-safety/safe-food-handling-and-preparation/food-safety-basics/food-product-dating

U.S. Government Accountability Office. (2019, September). Date labels on packaged foods: USDA and FDA could take additional steps to reduce consumer confusion (GAO-19-407). https://www.gao.gov/assets/gao-19-407.pdf

Wilson, N. L., Miao, R., & Weis, C. (2018). Seeing is not believing: Perceptions of date labels over food and attributes. *Journal of Food Products Marketing*, *24*(5), 611–631. https://doi.org/10.1080/10454446.2018.1472700

Wilson, N. L., Rickard, B. J., Saputo, R., & Ho, S. T. (2016). Food waste: The role of date labels, package size, and product category. *Food Quality and Preference*, *55*, 35–44. https://doi.org/10.1016/j.foodqual.2016.08.004

World Economic Forum [WEC] & McKinsey & Company. 2020. *Incentivizing food systems transformation* (CH-1223). https://www3.weforum.org/docs/WEF_Incentivizing_Food_Systems_Transformation.pdf

World Food Program. (2024, June 25). *5 facts about food waste and hunger.* https://www.wfp.org/stories/5-facts-about-food-waste-and-hunger

WRAP. (2022, February 24). *Helping people to reduce fresh-produce waste: Modelling the impact of selling products loose or in packaging*. https://www.wrap.ngo/sites/default/files/2022-02/Modelling-the-impact-of-selling-products-loose-or-in-packaging.pdf

Young, C. W., Russell, S. V., Robinson, C. A., & Chintakayala, P. K. (2017). Sustainable retailing–influencing consumer behaviour on food waste. *Business Strategy and the Environment*, *27*(1), 1–15. https://doi.org/10.1002/bse.1966

Yu, Y., & Jaenicke, E. C. (2020). The effect of sell-by dates on purchase volume and food waste. *Food Policy*, 98, Article 101879. https://doi.org/10.1016/j.foodpol.2020.101879

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Fostering Socially and Ecologically Resilient Food and Farm Systems Through Research Networks

SPECIAL SECTION SPONSORED BY:

Implementing the systems-based breeding approach: Experiences and lessons learned from the European Union LIVESEED project

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Abstract

Organic breeders must meet many requirements when developing cultivars to satisfy demand for high yield, good quality, resource efficiency and climate robustness, cultural and ethical acceptability, and the provision of ecosystem services. Given the current and future climatic, agronomic, economic, and socio-cultural challenges, resilience can only be efficiently achieved through concerted actions. The concept of systems-based breeding integrates the strengths of different breeding

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orientations and provides a perspective where breeders can initiate developments toward ecologically and societally resilient crop production that address six sustainability targets, including (1) food security, safety and quality; (2) food and seed sovereignty; (3) social justice; (4) agrobiodiversity; (5) ecosystem services; and (6) climate robustness. In this paper we present five supportive pillars for implementing the concept of systems-based breeding, based on experiences obtained during the European Union (EU) project LIVESEED from 2017 to 2021, and including results from prior related projects and literature on innovation systems and systems change. The five supportive pillars we have identified are (1) increasing social awareness and reflection, (2) developing alternative financing approaches, (3) promoting the development of appropriate breeding methodologies and methods, (4) applying integrative interdisciplinary and transdisciplinary learning in education, and (5) fostering facilitation for connecting these processes. These five supportive pillars are all necessary for fostering sustainable transformative change in complex systems, such as organic plant breeding. Based on workshop outcomes, we find that the main impediments to a wider embrace of a more holistic perspective on organic breeding are the current strong focus on short-term profits and EU law and regulations. Increasing social awareness, alternative financing models, new breeding methods, and multi-actor approaches are necessary for broadening breeding approaches.

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plant breeding strategies, novel approaches, societal resilience, ecological resilience, sustainable seed systems, innovation systems, social awareness

Introduction

Plant breeding is not only a technical activity for improving plants, but also a social construction that can be addressed through a variety of breeding approaches (Table 1). Our thinking about this employed a holistic perspective on social construction that builds on Lammerts van Bueren et al. (2018), who analyzed several challenges to ecological and societal resilience given the current and future climatic, agronomic, economic, and social environment. They argued that social construction can only be properly addressed by concerted action and the inclusion of multiple perspectives on sustainable food systems (Figure 1). Polarization can easily arise between approaches to agriculture when systems like low-input and high-input approaches favor contrasting methods and goals (Struik & Kuyper, 2017). This is also true for hard and soft systems thinking: in hard systems thinking, the system exists independently from the observer and can be analyzed, understood, and developed if given a clear goal, while in soft systems thinking, a system is understood by the involved actors in different ways given their different perspectives (see Röling, 1992).

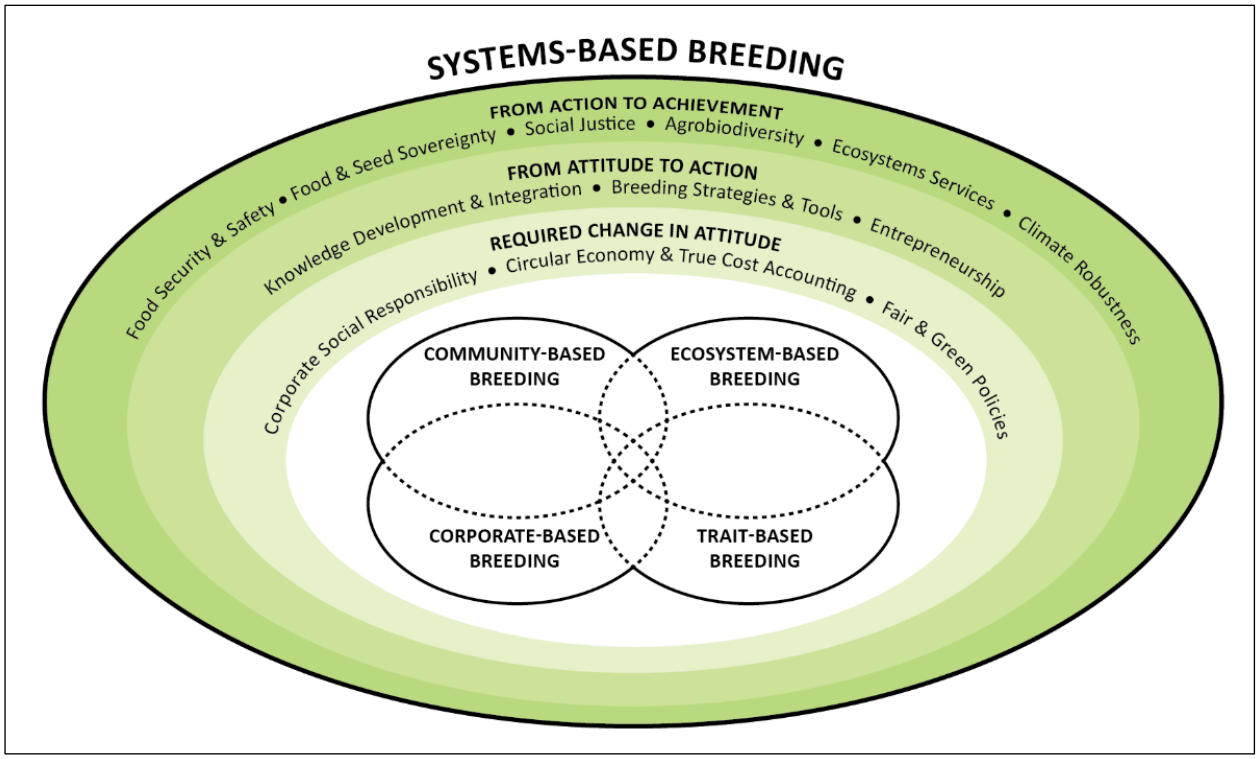
To avoid polarized discussions of plant breeding stances, a scheme developed by Bawden (2010) describing four paradigmatic orientations was used as analytical framework (Lammerts van Bueren et al., 2018). This scheme consists of two axes wherein the x-axis positions relativism versus objectivism and the y-axis plots holism versus reductionism (see Table 1 for a glossary of terms and concepts). The scheme makes the tensions that can be found in any society or group explicit, contrasting decision-making between the individual and society (the x-axis) and between the heart and the head (y-axis). The four paradigmatic breeding orientations identified using this schema include community-based, ecosystem-based, trait-based, and corporate-based. Each stance embraces a different mindset, style of thought, values, and economic models (Lammerts van Bueren et al., 2018).

Table 1. Glossary of Terms and Concepts

Category	Term or concept	Short explanation
Scientific perspectives	Objectivism	There is a permanent reality that can be known rationally.
	Relativism	Reality can never be completely known.
	Holism	There is an irreducible wholeness of nature and other living systems.
	Reductionism	Systems can be separated and subdivided into subsystems in a hierarchical manner.
Breeding approaches	Community-based breeding	A style of thought that combines holism and subjectivism. It aims to develop collaborative breeding networks and organizations involving a range of chain players at local or regional level, thereby respecting diverse cultural values and societal pluriformity.
	Ecosystem-based breeding	Starts from an ecological perspective and is a style of thought that combines holism and objectivism analyzing general patterns in ecology and aiming at developing varieties adapted to ecological conditions at regional level.
	Trait-based breeding	A style of thought that combines objectivism with reductionism, resulting in a mechanistic view of how plants grow, by subdividing complex traits into smaller, manageable (heritable) components and by better understanding how these components contribute to plant traits.
	Corporate-based breeding	A style of thought that combines subjectivism and reductionism. It assumes that the truth and knowledge on what is best are relative and are up to the individual or corporate organization.

Adapted from Lammerts van Bueren et al., 2018.

Figure 1. The Systems-Based Breeding Approach, with the Aim of Integrating the Strengths of the Four Breeding Orientations, to Meet Socio-Economic, Environmental, Climatic, Agronomic, and Ethical Values



Source: Lammerts van Bueren et al., 2018.

Each orientation has significant impact and value, but no single orientation alone will achieve all six of the sustainability targets listed above that compose systems-based breeding (Lammerts van Bueren et al., 2018). Following that each orientation has a different style of thought, these six sustainability targets can be understood in different ways. This can be done by applying overarching systems thinking as a driver to integrate the strengths of the four different breeding orientations and to provide a perspective where breeders can begin developing ecologically and societally resilient crop production.

Each of the four paradigmatic orientations has advantages and disadvantages, and none of them alone can be the only solution to meet the identified goals. Ideally, we need a balance among these four paradigmatic orientations. Today, plant breeding is dominated by corporate and trait-based breeding approaches, represented among others by large international seed companies (Lammerts van Bueren et al., 2018). To develop truly systems-based breeding, we need to stimulate additional types of breeding, such as farmer-led breeding or locally oriented breeding through community-based and ecosystem-based orientations (Chable et al., 2020).

In the current institutional, socio-economic, and political context of plant breeding in the Global North, it may not be easy to get a good balance between the four breeding orientations in conventional agriculture. In mainstream plant breeding, developments prioritize scale enlargement, more protection through patents, and more high-tech breeding methods as well as increased use of genomic techniques. Given the many vested interests of various types of companies (not only in plant breeding but also in processing, plant protection, and agricultural trade), we can speak of so-called lock-ins (Vanloqueren & Baret, 2009). These can only be solved if all parties in a value chain are prepared to act at the same time.

Assuming that the parties in organic agriculture aim to use a more holistic approach, we expect a greater potential to achieve a good balance between the four orientations. The four principles of care, ecology, health, and fairness, as identified by the International Federation of Organic Agriculture Movements (IFOAM) (Box 1), show that the organic sector considers both agroecological and socio-cultural aspects important to achieve sustainable agricultural systems. In that respect, organic agriculture could provide a model for the way forward for agriculture in general. Unfortunately, the organic principles provide no simple recipe to follow. The way forward is to stimulate various pro-

Box 1. The Transdisciplinary Research Networks Involved in the EU-Funded Project LIVESEED (Boosting organic seed and plant breeding across Europe)

To foster an increase in organic seed and breeding, the LIVESEED project used a multi-actor approach. This means that in various research and breeding activities, other value-chain actors were involved, building on transdisciplinary experiences developed in other EU projects such as DIVERSIFOOD (Embedding crop diversity and networking for local high quality food systems) and SOLIBAM (Strategies for Organic and Low-input Integrated Breeding and Management) (Chable et al., 2020; Ortolani et al., 2017). Depending on the activity, farmers, traders, processors, researchers, policymakers, and citizens were involved. As such, LIVESEED can be considered a transdisciplinary and participatory research network that drew upon the research networks of the involved project partners.

By conducting research on organic seed and breeding, LIVESEED aimed to contribute to more sustainable food and farming systems that maximize social and environmental goods related to (a) health, (b) fairness, and (c) care, following the descriptions of IFOAM:

- Health: Enhancing the health of soils, plants, humans, and the planet is considered indivisible.
- Fairness: Building relationships that foster collaboration in breeding and access to seeds.
- Care: Maintaining and fostering crop diversity, so it is accessible to future generations.
- Ecology: Working within living ecological systems, meaning that production is to be based on ecological processes.

cesses of change with different stakeholders at various levels simultaneously (Bos et al., 2009). Before actual change can be achieved, necessary actions need to be identified first, for which change in attitude is often a prerequisite (Figure 1). By stimulating community-based and ecosystems-based orientations, we can foster a larger diversity in breeding approaches and change the currently dominant linear value-chain thinking into more circular and systems thinking. At the same time, change in policy-making is considered to be crucial for fostering a fertile ground for systems-based breeding. Policy-makers can be crucial in developing a balance in concurrently maintaining diversity in breeding approaches and ensuring common ground or a level playing field.

In this paper, we present five supportive pillars for operationalizing the concept of systems-based breeding with a focus on organic agriculture, based on our experiences and activities in the EU LIVESEED project (see Box 1). In various workshops where the systems-based breeding approach was discussed, it was made clear by the participants that in order to implement a systems approach to breeding, further operationalization of the concept was needed. In that context we have developed five supportive pillars.

Material and Methods

The concept of the systems-based breeding approach was discussed with organic breeding practitioners and with actors in the value chain in several project workshops and meetings held from 2018 to 2021 using the framework of LIVESEED (see Box 1). Participants in these workshops worked for, among others, breeding companies, informal breeding initiatives, seed companies, non-governmental organizations (NGOs), universities, and independent research institutes. All were involved in the topic of organic breeding. Five international workshops were open to a wider audience. The sustainability targets as described by Lammerts van Bueren et al. (2018) were used as entry point to guide the discussions of the various workshops. Some workshops sought to gain insights into the role other value chain actors can play in the implementation of holistic organic breeding. Other workshops allowed for reflection and distillation of crucial steps various actors could take to implement the concept of system-based breeding. This analysis was complemented with new insights based on other LIVESEED project outcomes as described by Chable et al. (2021), Mendes-Moreira et al. (2021), Nuijten et al. (2020), Rodríguez-Burruezo et al. (2020), and Rodríguez-Burruezo et al. (2021). Additional insights were obtained from other research projects in which the authors have been involved in, such as the EU DIVERSIFOOD project.

Results and Discussion

Synthesis of the workshop results with information from other LIVESEED activities, other research projects, and the literature led to several conclusions. Based on the workshop results, we identified three supportive pillars: (1) increase social awareness and reflection, (2) develop alternative financing approaches, and (3) develop appropriate breeding methods. Based on other projects and literature, we have identified two additional supportive pillars needed to foster the integration and interlinking of the processes part of the first three supportive pillars. The fourth pillar is to (4) apply integrative interdisciplinary and transdisciplinary learning in education, which is needed to better anchor the integration of social and natural science thinking in daily practice. For example, having alternative breeding methods can support processes of social awareness, and clarifying the social aspects of breeding techniques can support the development of new breeding methods. The fifth supportive pillar is to (5) foster facilitation, which is needed to foster the integration and interlinking of the various processes at societal level. Below the five supportive pillars are described.

Supportive Pillar Number 1: Increase Social Awareness and Reflection

A lesson learned from the workshops was that the group processes create awareness on the importance for openness for other values, diversity, and thought styles. At the workshop in Witzenhausen, Germany, on February 21, 2018, practitioners were asked to reflect on how they are currently managing their breeding and how they could adjust their breeding practices in the future, including the

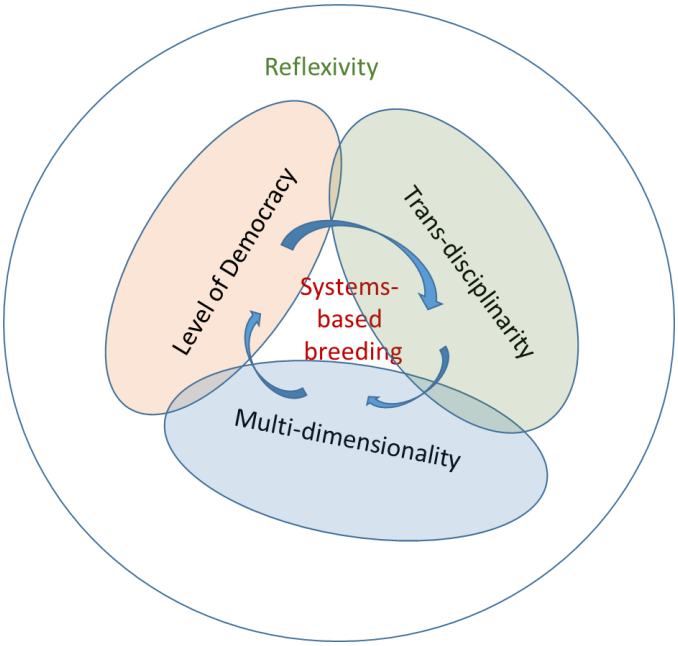
socio-cultural and ethical aspects (Nuijten, 2019). This workshop showed that a first step is a self-evaluation of their own breeding activities according to the 12 key elements using a spider diagram. A second step is group reflection, as the discussions will then deepen understanding and allow better internalization of the concepts.

To achieve changes in attitudes, continuous dialogue at various levels is necessary. The workshop in April 2019 with two Swiss biodynamic breeding companies, Sativa and GZPK, showed that the sustainability targets can be used for reflection and open dialogue. This reflection process can gain value when it is done repeatedly and regularly, as the process can be considered like peeling an onion to come to the essence of the organization in its ecological and societal context. With the first cycle of reflection, the obvious elements are discussed. During the next cycle of the reflection process, the less obvious issues emerge and can be challenged. If the targets are clear, they can be used as benchmarks and implemented in the strategy of the organization.

To foster processes of social awareness, a framework for multi-actor research developed in the DIVERSIFOOD project can be helpful (Rossi et al., 2019). The main elements of this framework are transdisciplinarity, democracy, and multidimensionality that are connected in an ongoing process of reflexivity (Figure 2). In the context of systems-based breeding, this means connecting and/or integrating different perspectives and knowledge fields of the four paradigmatic orientations in breeding (community-based, corporate-based, ecosystem-based, and trait-based) in an open and transparent way that allows a wide range of actors to be involved (breeders, farmers, scientists, and other actors in the food system). Guidelines that need to be considered to allow open communication include (1) proposing one's ideas to others instead of trying to convince them, (2) having an open attitude and respect toward others, (3) adopting ideas and practices that do not violate the principles and morals of the other actors involved, and (4) being open to a continuous process of reflection. Rossi et al. (2019) concluded that every multi-actor research project may have its own approach adapted to the specific context, depending on its goals, people involved, their perspectives, timeline, and resources. Likewise, implementation of the systems-based breeding approach will be different depending on the institutional, socio-cultural, and agro-ecological specificities of every context.

Figure 2. Overarching Framework

This shows that systems-based breeding has multiple dimensions, different actors involved, different knowledge fields, and that there is a constant process of re-iteration, resulting concurrently in a process of reflection.



Source: Adapted from Rossi et al. (2019).

Another outcome of the DIVERSIFOOD project was the identification of useful building blocks, such as common will, common vocabulary, trust, transparency, facilitation, resources, and well-adapted distribution of the work (Serpolay-Besson, 2018). These building blocks are all important for the successful implementation of the systems-based breeding approach. A common will is important, as confusion and disagreement inevitably will arise at any point in the process. Related to a common will is a "common sense of urgency," but a common will is proactive in following one's ideals, whereas a common sense of urgency is

reacting to urgent problems. A common vocabulary is important to allow efficient, clear, and transparent communication among a diversity of actors with diverse backgrounds. The common vocabulary may develop over time and will support trust, transparency, and facilitation, which are interrelated and can reinforce each other. Trust, transparency, and facilitation allow everybody involved in the process to clearly share their ideas, fears, and hopes. As a result, all actors involved clearly understand their own position regarding the orientations of the others, where the connections are, and what the (potential) tensions are. Translating this to the process of the systems-based approach is that instead of superimposing a new homogenous perspective, a common approach is developed that allows room for small differences in the perspectives of all individuals involved. Lastly, the availability of resources and a well-adapted distribution of the work are important to make the systems-based approach work in practice, beyond the level of discussion, which it usually starts with.

To induce change (e.g., a paradigm shift or a broadening or connecting of paradigms), all actors in the system need to be involved (Chable et al., 2020; Ito, 2018), and change must be made at various levels simultaneously (Bos et al., 2009), individual and system levels (and perhaps other levels). Although it seems counterintuitive, it has been demonstrated that people can shift their mindset in less than a second (Meadows, 1999), through arts as well as other means (Ito, 2018). However, a kind of "fertile ground" is still needed for mindset shifts, feeding the common sense of urgency: the involved actors need to have a more or less conscious feeling of running into limits. The current context with various crises at hand such as climate change, nitrogen pollution, and loss of biodiversity can speed up an individual's processes of change.

Meadows (1999) showed that not only actors need to change, but also the hardware of a system as well. Hence, a societal mind shift will usually only happen slowly. As multiple change is needed at multiple levels and to be achieved in diverse ways, a range of positive reflection tools is needed, as different people will be inspired by different approaches. Rossi et al. (2019) identified reflection at individual and group levels as especially important to foster awareness and mind shift (Figure 2).

Being able to transcend paradigms is the most effective way to induce sustainable change, since no one specific paradigm is considered the best; people can have multiple perspectives to solve a particular question or issue (Bawden, 2010; Bos et al., 2009; Meadows, 1999). The paradigmatic framework by Bawden (2010), on which the systems-based approach is based, can help explain the differences between the decision-making processes and social dynamics that are related to each of the paradigmatic orientations (Figure 3). As explained by Lammerts van Bueren et al. (2018), to date the two lower quadrants dominate in many western societies. However, each of the four quadrants has advantages and disadvantages in terms of decision-making and social dynamics, and hence, more balance in approaches is required.

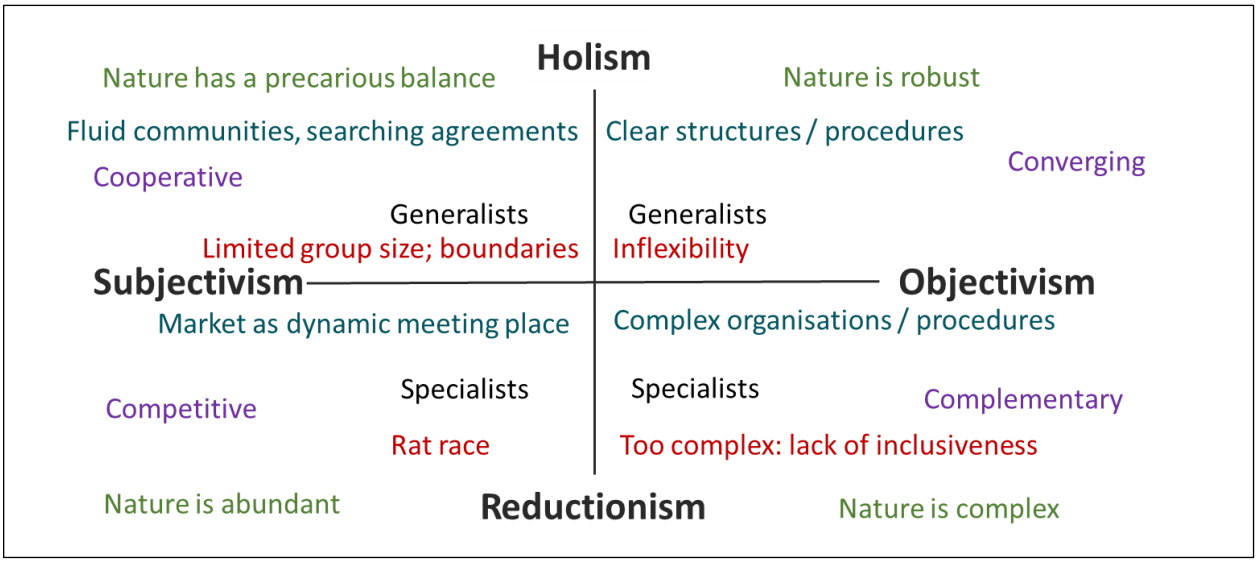
When it comes to breeding, change is not the sole responsibility of breeding practitioners. Government, value chain actors, and citizens also have a role to play. For citizens to take their responsibility, it is necessary to set up virtual and physical platforms—such as workshops, markets, and field visits—where citizens can meet and feel involved in this environment. As breeding has become distant from daily life and difficult to understand for many citizens, it is important to create more awareness and distribute information about today's breeding practices and let citizens experience the results and processes of breeding, such as through taste tests and field visits (e.g., Rodríguez-Burruezo et al., 2020, 2021).

Supportive Pillar Number 2: Develop Alternative Financing Approaches

In the dominant breeding approach in Europe, breeding efforts need to be financed through seed sales. For organic agriculture, however, a broad portfolio of crops and varieties is needed to create resilience in the cropping systems which cannot be recovered through seed sales. The current EU seed regulations require a high uniformity of varieties in order for them to be distinguishable from other varieties and to be stable in their appearance. Such varieties can be protected by breeders' rights, which ensure monopoly of sales and which in turn allow the financing of future breeding. Many small-

Figure 3. Keywords Describing the Social Decision-Making Processes Related to Each of the Four Paradigmatic Orientations

Key: **Black**: focus; **Green**: perspective on nature; **Purple**: tendency of human relationships; **Blue**: resulting positive aspects; **Red**: potential disadvantages



scale organic breeders prefer to work with more diversity within their varieties as it contributes to better adaptability and stability of the crop performance in the field. But complex registration processes based on EU regulations complicate the activities of small breeders working with landraces, traditional varieties, and populations. Adding to that, compared to the breeders' rights often applied for in Europe whereby breeders can still use each other's varieties for further breeding, the patenting of natural traits hampers the exchange of breeding material and the maintenance of a broad genetic base for food security.

At the workshop in Witzenhausen, Germany, the most-mentioned obstacles for new breeding approaches were "law and regulations," "short-term profit," and "long-term funding," while solutions were seen in "collaboration in breeding," "market reorganization," and "knowledge sharing" (Nuijten, 2019). Together these solutions describe a common idea for organizing breeding in a different way, with more collaboration in the value chain and broader forms of funding plant breeding. At a LIVESEED workshop connected to the DIVERSIFOOD final congress (December 12, 2018), participants emphasized that the financing of plant breeding needs to be changed. It is not possible to organize breeding in a different way if the financing remains unchanged. In the LIVESEED workshop at Biofach of February 21, 2019, participants emphasized that changes in relationships within the value chain and in education curricula are needed as well. At the second annual meeting of LIVESEED (May 15, 2019), workshop participants mentioned that it is important to realize and understand exactly how breeding, including its financing, has altered over the last 50 years.

Hence, a second essential element to implement the systems-based breeding approach is a larger diversity in funding approaches. Currently, the dominant approach to fund breeding (the mainstream model) is through seed sales by commercial enterprises. However, economic efficiency (based on a limited portfolio with a large spread) is not the same as ecological efficiency (based on a diverse portfolio adapted to different ecological and/or cultural conditions), and so it will not work for all breeding approaches, such as community-based and ecosystem-based breeding. As described by Nuijten et al. (2020), other financial models are needed to finance organic breeding when consider-

ing the IFOAM principles. The following existing alternative financing strategies were identified to sustain organic plant breeding: (1) public funding, (2) funding through private foundations, (3) open-source seed approaches, and (4) small-scale value-chain collaborations.

So far, the reach of these alternative financing strategies is limited, and other funding schemes are needed for the benefit for society. In response, Winter et al. (2021) propose another strategy: a so-called cross-sector pool funding strategy in which all value chain partners in the organic sector jointly invest in organic breeding and, hence, collectively secure the integrity of the future organic product supply. They have identified four success factors: a long-term commitment, a pool fund for organic cultivar development, awareness-raising on the importance of breeding, and an elevated level of transparency in the process. This approach also builds on a consensus in the organic sector that seed sales should cover the costs for seed production. However, the breeding activity can be considered part of managing the cultural heritage and the commons, and thus should receive financial support from the government and/or the value chain.

In any case, to foster processes of change, regular dialog with actors in the value chain and public authorities is needed. Another potential strategy is to involve citizens in funding as well, as they can be reached with appropriate labeling and other techniques.

Supportive Pillar Number 3: Develop Appropriate Breeding Methodologies and Methods

Whereas mainstream breeding methods have been developed in the context of corporate-based and trait-based breeding, the development of breeding methodologies and methods for community-based and ecosystem-based breeding has been limited until today. At the workshop in Witzenhausen, Germany, it was concluded that alternative breeding approaches imply more collaboration in breeding (e.g., with an active role of farmers and other value chain actors) and breeding for diversity (e.g., populations, intercropping, and agroforestry systems). Specific examples included the biodynamic vegetable breeding initiative Kultursaat in Germany, the biodynamic vegetable breeding company Sativa in Switzerland, the organic potato breeding project BIOIMPULS in the Netherlands, and collaboration of INRAE (Institut national de recherche pour l'agriculture, l'alimentation et l'environnement) with Reseau Semences Paysannes on cereals in France (Nuijten, 2019).

In the western world, potential breeding approaches, such as participatory and multi-actor approaches, have been explored over recent decades. These approaches have in common that they aim to consider the local agro-ecological and socio-cultural contexts as much as possible. Instead of minimizing Genotype x Environment (GxE) interaction, the logic is to maximize GxE interaction, profiting from local adaption (Ceccarelli, 1989). Lessons learned in EU projects like SOLIBAM, DIVERSIFOOD, and LIVESEED show how to integrate the different socio-economic contexts of the various European countries in the breeding practice, resulting in optimized Genotype x Environment x Society interactions with advantages such as improved yield stability and resilience (Nuijten et al., 2020). LIVESEED results underline that improving resilience in agricultural systems is not only based on improving specific plant traits, but also on dynamic relationships between plants (Mendes-Moreira et al., 2021); between plants and their environment, in particular the soil (Chable et al., 2021); and between plants and people (Rodríguez-Burruezo et al., 2021). Participatory and multi-actor approaches can integrate the benefits of these diverse types of relationships to improve yield stability, product quality, and resilience through

- On-farm cultivar testing, in which other actors in the food system are also directly involved,
- Optimizing cultivar mixtures to local contexts,
- Developing cultivar mixtures and populations with local actors,
- Designing crop mixtures adapted to local contexts (e.g., intercropping),
- Joint learning about resilience in complex systems (such as agroforestry systems), and

- Joint learning about plant-soil interactions through so-called Living Labs.

When it comes to developing breeding networks, a range of factors need to be considered. Rodríguez-Burruezo et al. (2020) observed that these factors can differ based on the existing building blocks for the breeding network to be developed. Based on the experiences with five representative crops (apple, cabbage, tomato, wheat, and white lupin) these factors were subdivided into two main categories organized according to socio-economic and organizationally related factors, and plant- and crop-related factors (Table 2).

LIVESEED Deliverable 3.6 (Mendes-Moreira et al., 2021) provided the following practical aspects and guidelines to consider for breeding for more diversity:

- Screening germplasm for its performance in complex systems
- Methods to search for the best combinations
- Ways to increase diversity level and performance
- Improvement of various strategies for weed competition
- Improvement of disease tolerance and resistance
- Comparisons of breeding strategies: strengths and weaknesses
- Methods for involvement of the value chain: multi-actor approaches

It may be apparent that the guidelines are different for annual and perennial crop mixtures, organic heterogeneous material, and agroforestry systems. In terms of breeding for improved resilience, nutrient-use efficiency, water-use efficiency, or drought tolerance, the use of a gene pool more diverse than current modern varieties is essential, as old landraces and ecotypes have evolved under less intensive and more stressful conditions (Nuijten et al., 2020). Methodological approaches should not only consider evaluation of the above-ground parts of the plant in response to stress conditions but pay more attention to the below-ground parts, as the root and soil interaction is essential. Chable et al. (2021) describe several ways in which plant roots and soil interact in detail. Good plant-soil interaction supports plant resilience by improving nutrient use and disease tolerance. Hence, when it comes to resistance breeding, organic breeding should consider this along with other

Table 2. Factors Important for Developing Breeding Networks

Factors with a social, economic, cultural, organizational, and/or regulatory nature	Plant- or crop-related factors
■ Trust-building among partners ■ Type of actors involved (level of congruency between skills and knowledge) ■ Group size and diversity in backgrounds ■ Exchange of material (limited, free, etc.) ■ Scale and/or economic importance of the crop ■ Funding resources ■ Timeline (congruency in time of activities) ■ Exchange of knowledge (facilitator can play a key role) ■ Involvement of other value chain actors (facilitator can stimulate this)	■ Goal and/or focus (variety improvement and/or specific traits) ■ Crop type (reproduction system, annual or biannual crop, rate of reproduction) ■ Crop-specific related knowledge: The current state of knowledge on breeding ■ Type of germplasm tested (population, breeding lines, varieties, etc.) ■ Breeding approach (focused on homogeneous varieties, populations, etc.) ■ Possibility of combining, integrating, and/or connecting different approaches ■ Availability of methods for testing (visual, lab analysis, etc.) ■ Evaluation: Set-up of design, level of participation, sharing of templates

From Rodríguez-Burruezo et al., 2020.

approaches to improve plant health and integrate into fair social and economic models (Nuijten et al., 2020). Weed tolerance, likewise, should be considered from a holistic perspective. These results of the LIVESEED project also underline the compliance of breeding methods with the organic principles and values as outlined by IFOAM.

Instead of trying to develop a single approach, the results of the EU project LIVESEED described by Chable et al. (2021), Mendes-Moreira et al. (2021), Nuijten et al. (2020), Rodríguez-Burruezo et al. (2020, 2021) all call for the development of guidelines for breeders, researchers, and farmers to develop tailor-made breeding approaches adapted to the specificities of the crop, agro-ecological context, climate conditions, and socio-economic and cultural contexts.

The higher the diversity in breeding approaches and the more initiatives, the more agrobiodiversity can be maintained and bred for, which is also important to make agriculture more climate-robust and resilient. In addition, diversity in breeding approaches and initiatives will foster the development and maintenance of diversity in knowledge, and it will help reinforce what seeds are: they are not only commodities but are also culture and part of common heritage.

Supportive Pillar Number 4: Apply Integrative Interdisciplinary and Transdisciplinary Learning in Education

Our experiences are that many practitioners realize the importance of integrating different perspectives, methods, and ways of working together only at a later stage in life. As systems-based approaches require skills and knowledge from various disciplines, training in interdisciplinary and transdisciplinary thinking will help young people to learn to look at problems and questions with a broad, holistic perspective. However, teaching at interdisciplinary and transdisciplinary levels is not common (Spelt et al., 2009).

It is also important that the underlying meaning and reasoning of the four basic principles of organic agriculture (ecology, fairness, care, and health; see Box 1) become part of educational curricula. For example, looking at the concept of health, an essential aspect is to enhance robustness to prevent illness. This is not only for people, but also for plants, soils, and ecosystems. Hence, the principle of health is interrelated with the principle of ecology (Nuijten et al. 2017). The implications for systems-based breeding are significant: it means we need to critically reflect when resistance breeding is at stake and when it requires improving general plant robustness and microbe-mediated disease tolerance, for example.

It also means that educational curricula should address the diverse types of visions of society as described by Bawden (2010). For example, it is important to stress that a balance is required between competition and cooperation (see Figure 3). Also, basic principles of social interaction should be addressed, such as having an open mind and being respectful of other ideas, proposing one's ideas to others instead of trying to force them on others, and practicing self-reflection and group reflection, as described by Rossi et al. (2019). It is important that young people are supported to find their actual role in life and live true to themselves. Building and maintaining a balance in common ground and diversity in ideas needs to become a widespread practice and needs to be in our daily consciousness. This implies that we need critical historical, epistemological, and ontological reflections on plant breeding science (Chable et al., 2020, 2021). The current dominant visions of plant breeding have been developed in parallel and contributed to the current dominance of an industrial vision of agriculture, and therefore of our food systems and our concept of health. Recent research on plant-soil interactions as described by Chable et al. (2021) shows that other approaches to breeding and agriculture have much potential to develop ecosystem resilience through organic breeding and organic agriculture.

Supportive Pillar Number 5: Foster Facilitation

The above makes clear that plant breeding is not only a technical activity but also a social activity (Chable et al., 2020, Lammerts van Bueren et al., 2018, Osman et al., 2016). The development of appropriate breeding approaches, methodologies, and methods suited to organic agriculture are not possible without co-construction among a broad range of actors, such as breeders, farmers, proces-

sors, traders, and other chain actors. Politicians also have a key role in shaping plant breeding, as demonstrated by Kloppenburg (2005).

Earlier, it was suggested that so-called knowledge brokers can play a key role in the transfer of knowledge (Klerkx & Leeuwis, 2009). It is important that breeders and other actors are aware of new insights on breeding, agronomy, economics, regulations, and other important aspects. Over the past decades, awareness has increased that the active involvement of all sorts of value chain actors in research and crop development is important, as all can contribute to the development of innovations (Klerkx et al., 2012). The role of good facilitation is especially important when different paradigmatic perspectives and their related ontologies and epistemologies come together. For example, knowledge can develop in a structured way, but it can also emerge through interaction (Bawden, 2010). Facilitation may need to be organized at various levels, depending on the goals and questions that exist. While in some situations, a particular entity (person or organization) has the role of facilitator, facilitation can be done by various actors (Serpolay-Besson, 2018). Rotating facilitation can be useful to maintain awareness of the importance of good facilitation among stakeholders. At an overarching level, government can play a key role in maintaining a good balance and dynamism in common ground and a diversity in approaches.

Conclusion

In this paper we argue that plant breeding is not only a technical activity but also a social activity. The concept of systems-based breeding aims to integrate the strengths of different breeding orientations. It provides a perspective where breeders can be initiators of developments toward a sustainable agri-food system based on an ecologically and societally resilient crop production. Five supportive pillars for implementing this concept include (1) increasing social awareness and reflection, (2) developing alternative financing approaches, (3) promoting the development of appropriate breeding methodologies and methods, (4) applying integrative interdisciplinary and transdisciplinary learning in education and (5) fostering facilitation for connecting these processes.

We argue that a multitude of breeding approaches that rests on these pillars is needed to contribute to agro-ecological and societal resilience. Multi-actor approaches are essential to involve farmers, processors, traders, and other value-chain actors in plant breeding. Among the discussed five supportive pillars, we think the financing models of breeding are the least developed and need more elaboration, since they are a precondition to diversify breeding approaches. Another future challenge important for diversification is the transition from the focus on short-term market profits toward long-term ecological and societal sustainability. This transformation also includes law and regulations in the EU regarding complex and inflexible variety registration processes to foster a diversity of activities of small breeders.

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References

Bawden, R. (2010). The community challenge: The learning response. In C. Blackmore (Ed.), *Social learning systems and communities of practice* (pp. 39–56). Springer. https://doi.org/10.1007/978-1-84996-133-2_3

Bos, A. P., Groot Koerkamp, P. W. G., Gosselink, J. M. J., Bokma, S., (2009). Reflexive interactive design and its application in a project on sustainable dairy farming systems. *Outlook on Agriculture*, *38*(2), 137–145. https://doi.org/10.5367/000000009788632386

Ceccarelli, S. (1989). Wide adaptation: How wide? *Euphytica*, *40*, 197–205. https://doi.org/10.1007/BF00024512

Chable, V., Lemichez, S., Hohmann, P., Mendes-Moreira, P., Cardoso, H., Klaedtke, S., Groot, S., Messmer, M., & Nuijten, E. (2021). *Report on the holobiont as promising selection target to improve resilience and product quality*. LIVESEED Deliverable 3.7. https://www.liveseed.eu/wp-content/uploads/2021/09/LIVESEED_D3.7-Report-on-importance-of-the-holobiont-1.pdf

Chable, V., Nuijten, E., Costanzo, A., Goldringer, I., Bocci, R., Oehen, B., Rey, F., Fasoula, D., Feher, J., Keskitalo, M., Koller, B., Omirou, M., Mendes-Moreira, P., van Frank, G., Naino Jika, A. K., Thomas, M., & Rossi, A. (2020). Embedding cultivated diversity in society for agro-ecological transition. *Sustainability,12*(3), Article 784. https://doi.org/10.3390/su12030784

Ito, J. (2018). *Practice of change: How I survived being interested in everything* [Doctoral dissertation, Keio University]. https://www.practiceofchange.org/

Klerkx, L. & Leeuwis C. (2009). Establishment and embedding of innovation brokers at different innovation system levels: Insights from the Dutch agricultural sector. *Technological Forecasting and Social Change*, *76*, 849–860. https://doi.org/10.1016/j.techfore.2008.10.001

Klerkx, L., van Mierlo, B., & Leeuwis, C. (2012). Evolution of systems approaches to agricultural innovation: Concepts, analysis and interventions. In I. Darnhofer, D. Gibbon, & B. Dedieu (Eds.), *Farming systems research into the 21st century: The new dynamic*. Springer. https://doi.org/10.1007/978-94-007-4503-2_20

Kloppenburg, J. R. (2005). *First the seed: The political economy of plant biotechnology* (2nd ed.). University of Wisconsin Press.

Lammerts van Bueren, E. T., Struik, P. C., van Eekeren, N., & Nuijten, E. (2018). Towards resilience through systems-based plant breeding. A review. *Agronomy for Sustainable Development*, *38*(5), 42. https://doi.org/10.1007/s13593-018-0522-6

Meadows, D. H. (1999). *Leverage points: Places to intervene in a system*. Sustainability Institute. https://donellameadows.org/wp-content/userfiles/Leverage_Points.pdf

Mendes-Moreira, P., Bruszik, A., Nuijten, E., Costanzo, A., Messmer, M., Legzdina, L., & Lazzaro, M. (2021). Enhancing resilience at systems level through breeding for diverse cropping systems. LIVESEED Deliverable 3.6. https://www.liveseed.eu/wp-content/uploads/2021/08/LIVESEED_D3.6_Enhancing-resilience-at-systems-level-1-min-compressed-compressed.pdf

Nuijten, E. (2019). LIVESEED workshop on new concepts and strategies for organic plant breeding. LIVESEED Deliverable 3.10. https://www.liveseed.eu/wp-content/uploads/2019/10/LIVESEED_D-3.10-Report-on-the-results-of-Workshop-1-for-input-from-formal-and-informal-breeders-involved-in-breeding-for-organic-farming-systems.pdf

Nuijten, E., Lazzaro, M., Costanzo, A., Chable, V., Annicchiarico, P., Rodríguez-Burruezo, A., Klaedtke, S., Ceccarelli, S., Kölling, A., & Messmer, M. (2020). Innovative organic breeding concepts: Challenges and examples. LIVESEED Deliverable 3.5. https://www.liveseed.eu/wp-content/uploads/2022/01/Review-LIVESEED_Task-3-1-110122.pdf

Nuijten, E., Messmer, M. M., & Lammerts van Bueren, E. T. (2017). Concepts and strategies of organic plant breeding in light of novel breeding techniques. *Sustainability*, *9*(1), Article 18. https://doi.org/10.3390/su9010018

Ortolani, L., Bocci, R., Bàrberi, P., Howlett, S., & Chable, V. (2017). Changes in knowledge management strategies can support emerging innovative actors in organic agriculture: The case of participatory plant breeding in Europe. *Organic Farming*, 3(1), 20-33. https://doi.org/10.12924/of2017.03010020

Osman, A. M., Almekinders, C. J. M., Struik, P. C., & Lammerts van Bueren, E. T. (2016). Adapting spring wheat breeding to the needs of the organic sector. *NJAS - Wageningen Journal of Life Sciences*, *76*, 55–63. https://doi.org/10.1016/j.njas.2015.11.004

Rodríguez-Burruezo, A., Annicchiarico, P., Uehlinger, N., Koutis, K., Bollinger, N., Baćanović-Šišić, J., Backes, G., Borgen, A., Pettiti, M., Sestili, S., Campanelli, G., Nuijten, E., Lazzaro, M., & Messmer, M. (2021). Progress report on breeding activities of white lupin, cell fusion free brassica vegetables, apple, common bunt resistance in winter wheat and participatory tomato breeding LIVESEED Deliverable 3.8. https://www.liveseed.eu/wp-content/uploads/2022/01/D3.8-LIVESEED_FINAL_Revised-ARB-TL-EN-january-2022.pdf

Rodríguez-Burruezo, A., Koutis, K., Annicchiarico, P., Nuijten, E., & Messmer, M. M. (2020). Report on breeding gaps and key factors for strengthening small breeding initiatives: Experiences on five crops. EU-project LIVESEED Deliverable 3.4. https://www.liveseed.eu/wp-content/uploads/2020/09/LIVESEED_D3.4.-strengthening-small-scale-breeding-initiatives_final_revised.pdf

Röling, N. (1992). The emergence of knowledge systems thinking: A changing perception of relationships among innovation, knowledge process and configuration. *Knowledge and Policy*, *5*, 42–64. https://doi.org/10.1007/BF02692791

Rossi, A., Serpolay-Besson, E., Nuijten, E., & Chable, V. (2019). Proven concept for a holistic, multi-actor approach suited for participatory research. Deliverable 1.3 DIVERSIFOOD. http://www.diversifood.eu/wp-content/uploads/2019/03/DIVERSIFOOD-D1.3_Proven-concept-for-a-holistic-multi-actor-approach.pdf

Serpolay-Besson, E. (2018). Connecting methods: Toolkit of common methods and meta-analysis for field trials, seed networks and food-chain analysis. DIVERSIFOOD Deliverable 1.2. https://diversifood.eu/wp-content/uploads/2019/03/DIVERSIFOOD-D1.2_Connecting-methods-toolkit-of-common-methods-and-meta-analysis-1.pdf

Spelt, E. J. H., Biemans, H. J. A., Tobi, H., Luning, P. A., & Mulder, M. (2009). Teaching and learning in interdisciplinary higher education: A systematic review. *Educational Psychology Review*, *21*, 365–378. https://doi.org/10.1007/s10648-009-9113-z

Struik, P. C., & Kuyper, T. W. (2017). Sustainable intensification in agriculture: The richer shade of green. A review. *Agronomy for Sustainable Development*, *37*, Article 39. https://doi.org/10.1007/s13593-017-0445-7

Vanloqueren, G., & Baret, P. V. (2009). How agricultural research systems shape a technological regime that develops genetic engineering but locks out agroecological innovations. *Research Policy*, *38*, 971–983. https://www.sciencedirect.com/science/article/abs/pi

Winter, E., Grovermann, C., Aurbacher, J., Orsini, S., Schäfer, F., Lazzaro, M., Solfanelli F., & Messmer M. M. (2021). Sow what you sell: Strategies for integrating organic breeding and seed production into value chain partnerships. *Agroecology and Sustainable Food Systems*, *45*(10), 1500–1527. https://doi.org/10.1080/21683565.2021.1931628

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From community to commodity: The costs of big ag in *Dodge County, Incorporated*

Book review by
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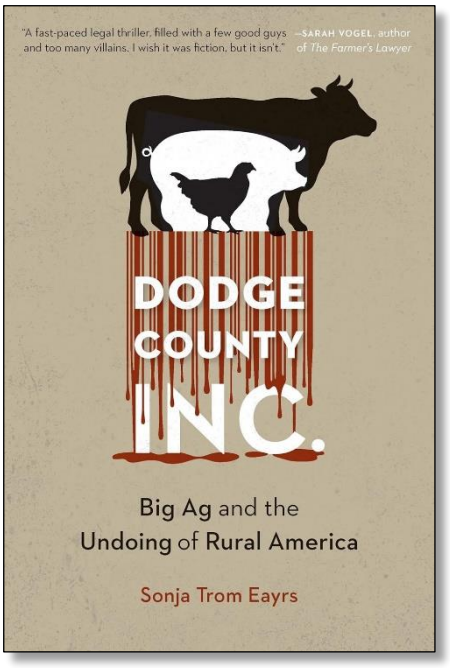

Review of *Dodge County, Incorporated: Big Ag and the Undoing of Rural America*, by Sonja Trom Eayrs. (2024). Published by Bison Books. Available as paperback and ebook (PDF or EPUB); 344 pages. Publisher's website: https://www.nebraskapress.unl.edu/bison-books/9781496234995/dodge-county-incorporated/

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In *Dodge County, Incorporated*, Sonja Trom Eayrs offers a compelling and deeply personal account of her rural Minnesota community's transformation under the weight of industrial agriculture. Her narrative arrives at a critical moment in national discourse, as concentrated animal feeding operations (CAFOs) and the corporatization of agriculture increasingly draw scrutiny. As both an attorney and environmental advocate, Eayrs documents the environmental degradation, public health crises, and erosion of democratic processes that have accompanied the rise of corporate agriculture in Dodge County. Her work is especially relevant to readers of this journal, as it weaves together themes of agricultural practice, food systems, and community development.

Eayrs's personal connection to the land and her community lends authenticity and urgency to her critique. She recounts her family's and neigh-

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bors' experiences as they confront the encroachment of large-scale hog operations, highlighting the environmental hazards, such as pollution and inadequate waste management, that stem from housing thousands of animals on limited acreage. These environmental issues are linked to serious health concerns, including cancer clusters. As she notes, the problems are complex and it defies simple solutions to "explore the complex, challenging realities of modern agriculture's impact on the environment" (p. 202).

The book also explores the socio-economic consequences of corporate agriculture, showing how local economies and community cohesion are undermined by vertically integrated systems that leave little room for independent producers. As Dukeshire (2013) observed, corporations increasingly dominate the food chain from processing to retail, while Lloyd, Treakle, and Hendrickson (2024) argue that this concentration of power threatens progress toward both sustainability and justice. Eayrs illustrates how corporate influence extends into local and national politics, weakening regulatory oversight and antitrust enforcement. Even those who attempt to engage in the democratic process often find themselves outmatched by corporate interests with deep financial resources.

Through vivid storytelling and rigorous analysis, Eayrs humanizes the broader structural issues facing rural America. She skillfully integrates environmental, health, economic, and political perspectives to present a holistic view of the challenges confronting rural communities. Her call for civic engagement and policy reform is both urgent and inspiring, urging readers to take action to protect and revitalize rural life.

While the book's focus on Dodge County provides depth and specificity, a broader comparative analysis could have further illuminated the national scope of these issues. Ikerd (2024), for instance, identifies similar patterns of industry concentration and systemic risk across the U.S., attributing these trends to technological change and policy shifts, particularly those made through the farm bill.

Eayrs's account aligns with broader critiques of industrial agriculture, which, while driven by economies of scale, often result in monopolistic or oligopolistic control. CAFOs, in particular, commodify production, marginalize small farms, and impose significant environmental and social costs. This transformation may increase efficiency, but it also heightens vulnerability, reduces farmer autonomy, and erodes community diversity. As Lloyd et al. (2024) note, rural communities disproportionately bear the burdens of pollution, health risks, and land use changes.

Both Eayrs and Ikerd (2024) envision a path forward through transformational policy. Ikerd argues that while we may not need to return to having five million farmers in the U.S., we do need more family-scale, management-intensive farms to ensure a sustainable future. Strengthening antitrust enforcement, enacting community-oriented farm policies, and building public support for sustainable agriculture are essential steps. These changes would benefit not only producers but also consumers, by expanding choices and promoting fairer pricing (Dukeshire, 2013). Collective action, political education, and the integration of climate and antitrust policies are key to building a resilient food system (Lloyd et al., 2024).

Ultimately, *Dodge County, Incorporated*, is a vital contribution to the literature on industrial agriculture's impact on rural communities. It underscores the need for sustainable farming practices, robust local governance, and community resilience. For scholars and practitioners in agriculture, food systems, and community development, Eayrs's work offers valuable insights into the consequences of corporate farming and the urgent need for systemic change.

This is a poignant and timely narrative that illuminates the often-overlooked repercussions of industrial agriculture. Eayrs's work is a must-read for those engaged in agricultural policy, rural development, and environmental advocacy. As one interviewee in the book states, "We need a paradigm shift. ... Food systems need to be more sustainable, inclusive, and resilient" (p. 234). A deliberate, policy-driven approach, one that prioritizes ecological stewardship, community well-being, and economic fairness over corporate efficiency, is not only necessary but long overdue. Dodge County stands as a powerful example of why such change is imperative.

(continued)

References

Dukeshire, S. (2013). Concentration, consolidation, and control: How big business dominates the food system [Book review of *Foodopoly*]. *Journal of Agriculture, Food Systems, and Community Development*, *4*(1), 171–173. https://doi.org/10.5304/jafscd.2013.041.010

Ikerd, J. (2024). The Economic Pamphleteer: Perspectives on the past and future of agriculture. *Journal of Agriculture, Food Systems, and Community Development*, *13*(2), 5–10. https://doi.org/10.5304/jafscd.2024.132.001

Lloyd, S. E., Treakle, J., & Hendrickson, M. K. (2024). Agroecology and corporate power in the U.S. [Commentary]. *Journal of Agriculture, Food Systems, and Community Development*, *13*(3), 107–111. https://doi.org/10.5304/jafscd.2024.133.009

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School food moves up the political agenda

Book review by
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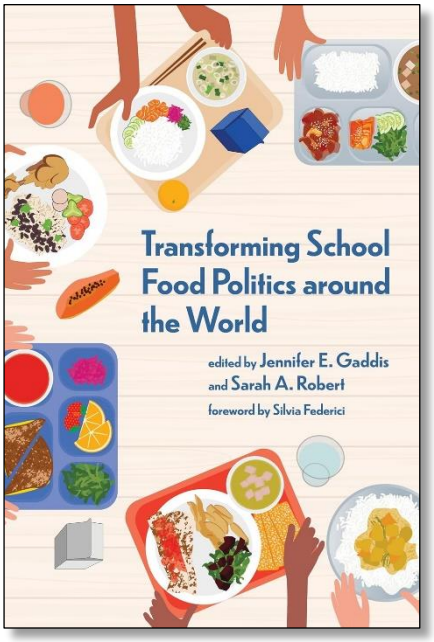

Review of *Transforming School Food Politics around the World*, edited by Jennifer E. Gaddis and Sarah A. Robert. (2024). Published by MIT Press. Available as paperback and Kindle, and open access; 364 pages. Free discussion and activity guide also available. Publisher's website: https://mitpress.mit.edu/9780262548113/transforming-school-food-politics-around-the-world/
Open access version: https://direct.mit.edu/books/oa-edited-volume/5789/Transforming-School-Food-Politics-around-the-World

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The school food reform agenda is moving from the margins to the mainstream of the political agenda in the countries of both the Global North and the Global South. Jennifer Gaddis and Sarah Robert, the joint editors, are well-equipped to curate the transnational contributions to this excellent book because their previous publications in this field are highly regarded. Being a global survey, the book covers an enormous amount of ground, both thematic and territorial, all of which is organized around four themes: national programs, youth and worker voices, just school food economies, and tools and campaigns for systems change.

The editors argue that school food programs around the world are being reimagined and rebuilt to mitigate the catastrophic effects of the COVID-19 pandemic. Building on one of their earlier arguments, they say that "debates about school lunch are fundamentally about care … and whether caring for public goods like children and the environment should be the private responsibility of individuals in the home or a public responsibility that is collectivized and shared" (p. xxviii). The book aims to tap the collective wisdom of a diverse group of scholars, policymakers, and practitioners to promote a more radical school food reform

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agenda throughout the world.

Since it is impossible to do justice to such a wide-ranging book in a short review, let me highlight three key agents of change that are featured in various chapters, namely, children, governments, and coalitions.

In a chapter on Canadian school food programs, Jennifer Black and her colleagues make a compelling case for treating *children* as genuine stakeholders because they have their own knowledge, they attach their own meanings to food, and they can exert their own agency by opting out. Rather than being fashioned *for* children, school food programs need to be "conceived, designed, and run with meaningful input from children" if they are to be acceptable and sustainable (p. 33). School food reformers would do well to act accordingly.

Many chapters in the book underline the systemic significance of *governments* in regulating and resourcing the school food service. Although Brazil and India have two of the largest government-sponsored school food systems in the world, both of which are featured in the book, it is one of the smallest countries that pioneered the greatest social innovation in school food reform. Finland was the first country in the world to provide a universal free school meal service when it introduced its tax-funded system in 1948. In a fascinating chapter on the Finnish experience, Kristiina Janhonen and colleagues argue that the new challenge is to promote food-related learning where students are treated "as an active, collaborative change agent" (p. 85). They argue that food-related learning requires a new compact between teachers and catering (food service) staff, two professions that are crucial to the goal of the pedagogical school meal.

Of all the agents of change in the school food domain, perhaps the most consequential is the school food *coalition* because, at its best, it enables a host of different interest groups to subsume their particular issues in the interest of a larger common purpose. Anne Moertel provides a compelling analysis of such a coalition in a chapter that recounts the history of the Center for Ecoliteracy's approach to school food systems change in California. Although early efforts to forge a grand coalition failed—not least because it sought to achieve too many goals—later efforts focused unequivocally on Senate Bill 364: the Free School Meals for All Act introduced by California State Senator Nancy Skinner.

To support this legislative initiative, the center led an advocacy campaign that decided to use the slogan "School Meals for All" as the official campaign name instead of the more ambiguous "Universal Meals." The campaign launched in February 2021 with 15 organizations supporting the policy, including influential national bodies such as the Food Research & Action Center (FRAC) and Center for Science in the Public Interest (CSPI). At its peak, the coalition embraced organizations spanning health, education, labor, agriculture, and food banks. Paradoxically, the cause of free school meals for all was aided and abetted by the COVID-19 pandemic because, thanks to a series of waivers from the U.S. Department of Agriculture (USDA) starting in March 2020, school meals were made available for free nationwide during the pandemic. The bill eventually passed with unanimous bipartisan support in the Senate Education Committee, and on July 9, 2021, California officially adopted School Meals for All. "History was made," Moertel says. "As the first state in the nation to provide free school meals to all public school students regardless of eligibility, California provided a model for the country to make healthy school meals a part of every child's educational day" (p. 265). Moertel rightly argues that the strategies used in the School Meals for All campaign can be leveraged by school food coalitions in local and national campaigns in and beyond the U.S.

Distilling the insights of the many contributors to this book, the editors conclude by saying,

> When we care about school meals, we must care for and about not only the children who eat them but also the cooks and cafeteria workers, teachers, agricultural workers, and others whose labor they depend on. And through our school food systems, we must care for the natural environment on which all life depends. This core belief is threaded through the many chapters of this book and their multifaceted engagements with the concept of sustainability, which is

> foundational for enacting a feminist politics of food and education that centers care. (p. 299)

At a time when the public food system in the U.S. is under siege, as the Trump regime lays waste to the little victories of the progressive movement, this book provides a powerful case as to why school food campaigns can be part of a democratic countermovement by making social justice, public health, and ecological integrity resonate across a wide political spectrum.

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Eating in a transnational food chain: Culture, identity, and the most pressing questions of a global food system

Book review by
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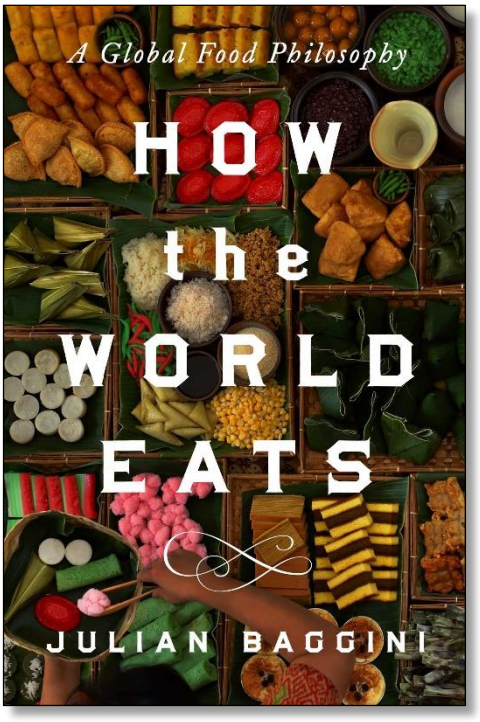
Washington State University Extension



Review of *How the World Eats: A Global Food Philosophy*, by Julian Baggini. (2025). Published by Pegasus Books (distributed by Simon and Schuster). Available as hardcover, Kindle, and audiobook (read by the author); 464 pages. Publisher's website: https://www.simonandschuster.com/books/How-the-World-Eats/Julian-Baggini/9781639368198

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In a world where we rely on an extremely intricate web of players to deliver food daily to our plates, Julian Baggini does not stray away from delving into the interlinking of politics, power, and choice that contribute to our transnational food systems complexities in *How the World Eats*. In a year when tariffs on goods and deportations of farmworkers are being put into action by the current Trump administration, reading this book will be crucial to understanding how people interact with each other when it comes to food and why it matters so much. *How the World Eats* is highly relevant and necessary to read in 2025. Baggini brings a philosophical background to exploring our global food system— one that is crucial to understanding how and why decisions are made and how we choose to feed ourselves as human beings.

* Noelle Elizabeth Beecroft is a senior program coordinator with Washington State University Extension and a graduate student in the College of Agricultural, Human, and Natural Resource Sciences at WSU. She has developed a knack for weaving together life sciences, gastronomy, agriculture, sociology, and ecology in her research and program coordination. Locally, her work is grounded in community engagement, nonprofit leadership, food security and logistics, nutrition and cooking education, strategic planning, and food systems improvements. Her graduate research is focused on land/sea connections in the Pacific Northwest (e.g., seaweed use in agriculture). Noelle can be contacted at Noelle.beecroft@wsu.edu.

While most of Baggini's work has been rooted in secularism and national identity, after reading this book, I can understand how this background, when combined with philosophy, is helpful when examining why specific communities and individuals make certain choices about food consumption or why certain facets of the food system face so much scrutiny. This book is perhaps an ode to the need to allow a variety of disciplines to enter the world of evaluating our food spaces. I was initially skeptical about how a philosopher could cram so much information about the global food system into around 360 pages and was taken aback by everything he decided to delve into. While perhaps not every single topic is successfully discussed, the majority of food system topics are, and are coupled with discussions that are not common in food system worlds. To the readers' surprise, he creatively ties together topics that one may not talk about together often, such as the 10 principles of agroecology and zoonotic plagues or the socio-emotional validity of food consumption in space. He begs us to deepen our thinking on how varied topics can be interlinked. Baggini's philosophical aspect is exactly the multifaceted approach that is needed to provide a sweeping and thoughtful analysis of our global food system.

Throughout this book, Baggini pulls on threads that start to unweave our complicated global food system narratives pertaining to the powers that control our food, how it is produced, and how it is consumed. In the introduction, he starts with tracing something as simple as a bowl of cornflakes, down to its influence on irrigation, CAFOs, and machinery. This foreshadows how the rest of the book will play out; what you thought were "simple" solutions to today's pressing global food system issues may not be as simple as you thought. He divides the book into four parts (Land, People, Other Animals, and Technology), while exploring current topics in food systems, waste management, the International Space Station, culture, veganism, ethics, modern-day slavery, soil management, food security, aquaculture, technology, COVID-19, and more. Baggini paints a picture in which every part is connected, even if a whole ocean away from each other. On the one hand, he forces the reader to feel less removed from other parts of the world, while on the other hand, he makes you question how all of us inhabiting this Earth can live in such vastly different realities. Baggini connects those dots in *How the World Eats* and personalizes why this transnational system is not as far removed from your everyday actions as you may have once believed. At the end of Section 2, he states, "Food is ultimately provided by the land and the sea, rivers and lakes, plants and animals. But the food system is shaped by people, politics, and business" (p. 179).

Baggini touches on hot-button issues such as meat consumption and labor in a way that made me question my own biases, why I have believed certain narratives, and the fact that these topics are not as black-and-white as the world has made them seem. He scrutinizes a variety of divisive topics with full force but does so with grace and without villainizing the other party. Having Baggini mediate a conversation between those with opposing beliefs would be worthwhile to see in real time. In the introduction, Baggini states, "advocates of food ideologies need to accept that their best cannot be the enemy of the common good, and that to heal the food world, they need to find common ground alongside people they disagree with profoundly" (p. xviii). This theme is beautifully carried throughout the book as he introduces solution-based frameworks. One of the most profound strengths of this book is the examination of the gray areas within complex and sometimes painful food system issues. Diving deep into the nuanced complexities of highly pressing issues through a multidimensional lens facilitates a more constructive and informed discourse rather than adopting a binary framework, particularly within the context of the global food system. Baggini calls for us as humans to stop trying to apply a one-size-fits-all approach and instead explore multiple possibilities for solving complex food system problems while challenging fixed ideas and systems in place. In Chapter 3, he states, "the question of how we feed ourselves is a normative one, meaning that it involves value judgements" (p. 41).

Each of the four sections of the book that were mentioned earlier ends with a chapter titled "Taking Stock," synthesizing Baggini's thoughts and conclusions from the culmination of the section's

chapters. While I will admit that some sections seemed slightly convoluted due to the abstract connections and large number of topics, the "Taking Stock" chapters provide the reader with a comprehensible overview and a better understanding of each topic's relationship to one another. In the conclusion, he charges the reader with adopting seven principles for reshaping our global food system: "Holism, Circularity, Puralism, Foodcentrism, Resourcefulness, Compassion, and Equality" (p. 361). These themes are deeply prevalent throughout the reading and encompass what the call to action of each chapter holds. Overall, I believe this book to be an insightful and unconventional look into our global food system that both food system professionals and the general public should read.

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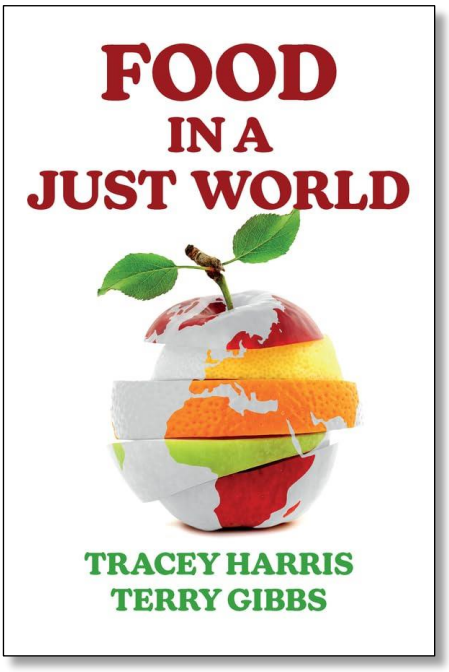
Cultivating compassion in the global food system: A review of *Food in a Just World*



Book review by
Megan Knight*
University of Vermont

Review of *Food in a Just World*, by Tracey Harris and Terry Gibbs. (2024). Published by Polity Press. Available as hardcover, paperback, and ebook; 256 pages. Publisher's website: https://www.politybooks.com/bookdetail?book_slug=food-in-a-just-world-compassionate-eating-in-a-time-of-climate-change--9781509554010

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Food in a Just World, by Tracey Harris and Terry Gibbs, offers a far-reaching analysis of injustice in the global food system. The book weaves together narratives of nonhuman animal exploitation and discussions of human rights, structural violence, climate change, and environmental degradation to show how the animal-industrial complex (A-IC) both reflects and reinforces deep systemic inequities. Drawing on semi-structured interviews with researchers, workers, policymakers, advocates, and activists from diverse backgrounds, the authors take a critical stance toward our institutions and relationships with nonhuman animals in the food system. Their approach exposes the invisible interconnections of oppression from the perspectives of citizen-consumers, workers, nonhuman animals, and the environment, while building a vision for a just transition rooted in radical democracy, transparency, accountability, and compassion.

Harris and Gibbs support their arguments with a diverse combination of qualitative research, critical theory, and interdisciplinary evidence. Central throughout the book are excerpts from their semi-structured interviews, and by weaving direct quotes throughout the book, the authors bring emotional and experiential depth to complex issues. Harris and Gibbs further support their claims by drawing from a wide body of interdisciplinary academic

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research. They cite studies from environmental science, sociology, public health, law, and political economy to ground their arguments on the impacts of industrial animal agriculture on climate change, the exploitation of human and animal labor, and food safety and security. The authors also draw on a range of theoretical frameworks to structure their critique, such as structural violence, speciesism, and the democracy of species. Drawing on thinkers like Vandana Shiva, the authors utilize the conceptual framework of *Earth Democracy* to demonstrate how the suffering of nonhuman animals is inseparable from universal injustices like climate change, poverty, human rights violations, and food insecurity, and how the diverse issues of workers, consumer-citizens, and nonhuman animals share a common origin. Their systems-based approach connects disparate injustices back to their central critique of neoliberal capitalism and the commodification of human, animal, and plant life.

Harris and Gibbs critically examine how corporate consolidation and the "logic of capital" drive the exploitation of human and animal labor. Central to the logic of capital is the commodification of people and land, which they argue is inseparable from the commodification of nonhuman animals. They examine how profit optimization has resulted in increasingly concentrated operations that heighten both animal physical and psychological suffering, pollute and damage surrounding environments, and increase the spillover of zoonotic disease. Harris and Gibbs use firsthand accounts and cite research to show how workers, especially migrant and undocumented laborers, are subjected to unsafe conditions for minimum pay and face the mental and physical toll of participating in routinized violence. They use the concept of speciesism, which is defined as the elevation of the human species to a more privileged status compared to other animals, to explain how our socio-economic system normalizes, regulates, and enforces the exploitation of nonhuman animals. The authors connect our acceptance of speciesism to the continued pervasiveness of hierarchical concepts like racism, nationalism, and sexism, arguing that we must adopt a values system where all life-forms are treated as equally valuable if we are ever going to tackle all of these injustices.

Utilizing this intersectional approach, Harris and Gibbs focus on the animal industrial complex's impacts on climate change, workers, and animal health as central examples of the interconnectedness of injustice. They identify climate change as a form of structural violence, which they define as the political, economic, and cultural systems that inflict harm on people, animals, and the environment. They point to evidence demonstrating that climate change is increasing food insecurity, driving forced displacement, and exacerbating resource conflict, disproportionately impacting those least responsible for carbon emissions. Harris and Gibbs cite robust research demonstrating the animal agriculture sectors' disproportionate contribution to greenhouse gas emissions, deforestation, and environmental pollution around the world. This supports their argument that industrial animal agriculture directly contributes to the structural violence of climate change and that reducing its emissions is key to mitigating the climate crisis and rectifying the injustice of climate change. The authors use climate grief and our response to global crises as emotional entry points into imagining systems built on compassion, a recurring theme throughout the book.

A key strength of *Food in a Just World* is how it makes the often invisible and normalized harms embedded in the A-IC both visible and vivid. They argue that exposing the conditions faced by animals and workers in the A-IC is one essential part of ending this violence, and advocate for systemic transformation through transparency, education, and communication. Despite the book's breadth, the authors manage to maintain clarity and coherence without oversimplifying the concepts they aim to communicate. While at times the book moves quickly between topics and frequently introduces concepts and ideas which may be new to the reader, the authors skillfully articulate complex ideas like speciesism and the commodification of nature while providing robust evidence that distills a vast array of research to support their arguments.

Food in a Just World is ultimately an appeal to understanding, realization, and action for both individuals and institutions. The authors argue that the key to solving our interconnected crises is through our social and ecological relationships,

connection, community, and compassion for all beings. Relationships of mutual respect are central to the authors' vision of a just food system and a just world. They identify the need for paradigm shifts in our social and economic values, community-building to increase resilience and interdependence, and a combination of incremental reforms and radical transformation. Their vision of a just food system is rooted in the precautionary principle, radical democracy, and localized decision-making. By centering the interconnectedness of all living beings and refusing to rank forms of suffering, Harris and Gibbs offer a profound and necessary message: a just food system is inseparable from a just world.

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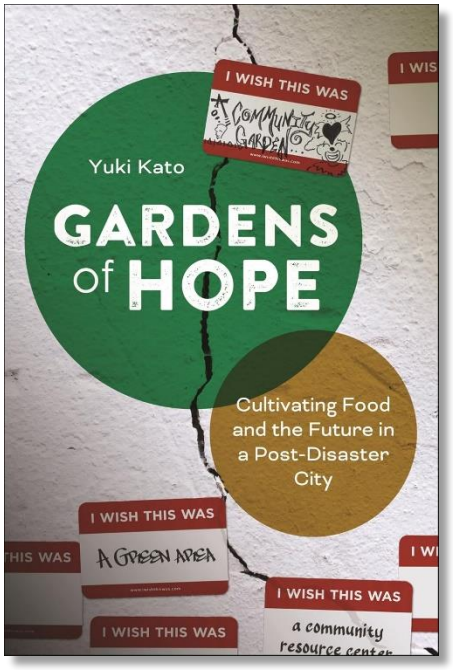
Do something: Lessons on pragmatic urbanism and cultivating hope from post-disaster New Orleans



Book review by
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Review of *Gardens of Hope: Cultivating Food and the Future in a Post-Disaster City* by Yuki Kato. (2025). Published by NYU Press. Available as hardcover, paperback, and ebook; 320 pages. Publisher's website: https://nyupress.org/9781479827404/gardens-of-hope/

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Gardens of Hope provides both an inspiring and cautionary tale of hope and burnout among urban cultivators in New Orleans, Louisiana, in the time since Hurricane Katrina devastated the city (and region) in August 2005. Kato's project spans from 2005 to 2023 and encompasses in-depth interviews with the growers who came and went during the eras of post-disaster recovery, transition, and redevelopment. Readers learn about the motivations, challenges, possibilities, successes, and downfalls of those who were growing in a crisis. The tension between hope and despair has undoubtedly gripped the public mind in today's current political, economic, and environmental climate. At a very timely moment, Kato gives readers a window into the experiences of growers who tried to enact the world they wanted but that did not yet exist.

Kato's work articulates two central concepts: urban cultivation and prefigurative urbanism. Using the term "urban cultivation," Kato focuses

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specifically on urban growing projects in New Orleans that "practice engagement with other community members by intentionally sharing food, space, labor, or ideas" (p. 3) and "defy or expand the normative expectations of an urban lifestyle and a capitalistic valorization of land, labor, and food" (p. 4). As the book explains well, urban cultivation projects cannot do everything. They cannot address all issues with property management, land use policy, community safety, individual health, or racial inequality. But they can tangibly implement small changes in the spaces where they operate. As Kato demonstrates throughout the text, they can cultivate hope. From this, she develops the concept of "prefigurative urbanism" as "everyday practices that demonstrate alternative ways of life that do not yet exist in the city. … [It is] civic action that aims to bring about immediate, tangible changes through direct actions that deviate from social and legal norms" (p. 11). Readers learn from urban cultivators featured in the book such as Jeanette, Pamela, Cory, and Macon about their desire to *do something*: to bring about some kind of pragmatic change in post-disaster New Orleans.

Throughout the book, the author provides useful typologies, while recognizing the nuances and blurred lines among these categorizations. Kato categorizes the aspirations of urban cultivators into five types: urban cultivation expansion, community rebuilding, alternative food systems, social entrepreneurialism, and alternative careers. These categories—although blurry—allow for distinctions to be made between the different motivations, visions, outcomes, beneficiaries, and prefigurations of different growers and their projects. As a community garden coordinator, I found myself reflecting on the project that I participate in and our place within this typology, which I expect other reader-growers will do as well. She also situates prefigurative urbanism within a typology of nine forms of social action: no action, prefigurative urbanism, do-it-yourself (DIY) urbanism, prefigurative politics, social movements, nongovernmental and nonprofit organizations, market, civic engagement, and government. Readers engaged in urban cultivation and/or social action can recognize their work in these categories and perhaps challenge themselves to be more intentional in their efforts.

Kato's analysis is attentive to the intersections of race, gender, and class, noting how aspects of identity and privilege shaped participants' experiences and interactions without reifying these as immutable categories. She situates her work and the work of these urban cultivators within the long and varied histories of growing in New Orleans, the state of Louisiana, and the United States. The analysis is place-based and dives deep into the policies and negotiations around local organizations such as the New Orleans Redevelopment Authority (NORA), VEGGI Farmers Cooperative, and Habitat for Humanity's Habitat Urban Garden (HUG) initiative. And the cautionary tales from this place are many. As Kato notes, "it was much more common to hear stories of failed attempts to launch cultivation projects than successful ones" (p. 90). Urban cultivators struggled repeatedly with land use issues, including barriers to accessing vacant lots, bureaucratic nightmares with getting appropriate permits, and precarious land use agreements. They also faced challenges with sustaining the necessary labor and with the difficult economics of urban food production. Some urban cultivators realized that they were not fulfilling the goals that they set out to achieve, while others chose to move on to another stage of their careers, and others burned out completely. Growers continued to address these challenges individually, coming from the pragmatic place of prefigurative urbanism, rather than work collectively to mobilize systemic changes. Yet the lessons of *Gardens of Hope* are by no means isolated to post-disaster New Orleans. As I write this, a long-standing community garden in my home province has been given 29 days to vacate its land (Sorokan, 2025), echoing the issues with land use experienced by many of Kato's participants and reminding us that urban cultivation has by no means become the status quo.

One critique of the work is acknowledged by Kato in the text. Her work does not include interviews with members of the community outside of the growers themselves. The reader has only the perspectives of Kato and the urban cultivators. I agree with the author that including interviews with other residents may "have provided more nuanced,

potentially conflicting, accounts of the impact that these gardens and farms were having in the community" (p. 257). Although Kato makes clear that growers' descriptions are their own subjective experiences, not objective truths, additional voices would have shed more light on the ways these urban cultivation projects unfolded and were experienced by communities throughout New Orleans. But from the growers, Kato is able to offer crucial suggestions for other urban cultivators: to first understand the history and social relationships of the place your project is situated in; to learn and work alongside others, rather than remain individualized; to be reflexive of your own social position and the wants of the community; and to be conscious of your own capacity and of the time and energy required to exceed the boundaries of existing norms.

Gardens of Hope provides meaningful contributions for practitioners of urban cultivation, academics, activists, and policymakers. While their challenges were numerous, the urban cultivators in post-disaster New Orleans were able to redefine urban land productivity, reimagine agricultural work, experiment with new markets, and engage the public. Growers bent and broke social and legal norms to make a case for how things could be. There is much work to be done, and I recommend *Gardens of Hope* to anyone who is looking to learn from the experiences of New Orleans' urban cultivators and from Yuki Kato's keen analysis, and who seeks to *do something*.

Reference

Sorokan, K. (2025, August 6). City evicts community garden from land that's been vacant for decades. *CTV News*. https://www.ctvnews.ca/saskatoon/article/city-evicts-community-garden-from-land-thats-been-vacant-for-decades/