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Challenges and barriers in food supply chains: A scoping review of needs assessments in the southern border counties of Texas and New Mexico

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Abstract

Food supply chains in the southern border counties of Texas and New Mexico face persistent disruptions driven by environmental, infrastructural, socioeconomic, and policy-related stressors. Understanding these challenges is crucial for informing coordinated efforts to enhance regional food systems. We conducted a scoping review to identify and synthesize evidence on challenges and barriers affecting food supply chains in the region. Peer-reviewed articles and grey literature published between 2014 and 2024 were searched and appraised using the AACODS framework. Nine sources met the inclusion criteria and were analyzed to characterize cross-sectoral challenges

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spanning production, aggregation, distribution, and retail systems. Findings reveal a set of interconnected barriers shaping regional food supply chains. Environmental stressors, including drought, aquifer depletion, extreme heat, and conflicts over water governance, limit agricultural productivity and increase reliance on external suppliers. Infrastructure gaps, particularly shortages of aggregation hubs, cold storage facilities, and transportation networks, further constrain efficient movement of goods. Cross-border dependencies, such as inspection delays, regulatory shifts, and policy uncertainties at U.S.–Mexico ports of entry, exacerbate systemwide vulnerabilities. Finally, retail-access inequities in rural colonias, where many communities rely on small outlets with limited refrigeration and constrained inventory capacity, interact with structural affordability barriers, limiting the availability and variety of fresh, perishable foods. Across sectors, food supply chains in the Texas–New Mexico border region are shaped by cascading challenges that span environmental stressors, infrastructure deficits, and cross-border policy volatility. Upstream disruptions in water governance, labor stability, and aggregation capacity amplify transportation costs and downstream retail constraints. These findings identify actionable priorities for regional decision-makers, including strategic investment in cold-chain and aggregation infrastructure, coordinated binational port and inspection processes to reduce spoilage risk, and workforce-stabilization policies that support small- and midscale producers.

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Introduction

Food supply chains play a central role in supporting food security, economic stability, and community well-being by connecting production, processing, distribution, and retail systems (Linnenluecke & Griffiths, 2010; Ponis & Koronis, 2012). However, global food systems are increasingly exposed to disruptions from climate change, market shocks, policy shifts, and environmental pressures, creating significant risks for regions that are already socio-economically and geographically vulnerable (Bhamra et al., 2011; Katsaliaki et al., 2022). The southern border counties of Texas and New Mexico present one such region where environmental and socio-economic challenges converge to influence food production, aggregation, and distribution. In this review, colonias refers to residential communities along the U.S.–Mexico border that often lack basic infrastructure such as potable water, sewer systems, paved roads, drainage, and safe housing (Texas Office of the Attorney General, n.d.).

Proximity to the U.S.–Mexico border introduces additional complexities, as local food systems depend heavily on cross-border trade flows, migrant labor, and binational supply chains (Lozano, 2022). Shifts in immigration policies, transportation regulations, and trade agreements have direct con-

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Data Availability
Supporting data is available from the corresponding authors upon reasonable request.

sequences on availability and affordability of food in the region (Cruz-Sánchez et al., 2024). The region also faces intensifying climate-related stressors, including prolonged drought, declining flows of the Rio Grande, aquifer depletion, and extreme heat, which constrain irrigated agriculture, increase production volatility, and elevate costs across regional supply chains (Intergovernmental Panel on Climate Change, 2015; Viva Doña Ana Initiative, 2015; Waldman, 2021). These environmental pressures are compounded by competing demands for water and limited irrigation resources, issues further complicated by the region's legal and policy frameworks governing water rights (Lashmet, 2018; Serrano, 2020).

Because food supply chains operate as complex adaptive systems (CASs), disruptions at one point, such as droughts, labor shortages, or transportation bottlenecks, often cascade through interconnected sectors, amplifying risks across production, processing, and retail levels (Ivanov et al., 2014; Surana et al., 2005). For small and medium-sized enterprises (SMEs), which comprise a significant portion of the regional food economy, these challenges are particularly acute, as they often lack the necessary infrastructure, technical capacity, and financial resources to manage disruptions effectively (Bak et al., 2023; Hammond et al., 2013). To address these systemic issues, investments in infrastructure, workforce development, and technological innovation have been widely recognized as priorities for strengthening supply chain stability (Kamalahmadi & Parast, 2016; Zsidisin et al., 2005). Expanding cold storage, aggregation capacity, and transportation infrastructure can enhance distribution efficiency, while adopting digital tools and real-time monitoring systems can improve coordination and response to shocks (Linnenluecke & Griffiths, 2010; Pajić et al., 2024).

Although this review was undertaken during the planning phase of the Rio Grande Colonias Regional Food Business Center (RGC-RFBC), its findings underscore structural constraints that extend beyond infrastructure development alone. Specifically, environmental water limitations, cross-border regulatory volatility, and labor instability may constrain the effectiveness of aggregation-focused investments unless addressed in tandem. Thus, the review serves not only as a planning input but also as a critical lens through which regional investment strategies can be reassessed and refined. Using a systematic search of major databases and regional needs assessments published between 2014 and 2024, we aimed to consolidate existing evidence on food supply chain challenges in this region. Our research question was: *What are the main challenges and barriers faced by various sectors of the food supply chain across the southern border counties of Texas and New Mexico?*

By synthesizing fragmented peer-reviewed and grey literature, this review advances understanding of food supply chain challenges in border regions by identifying cross-sector structural vulnerabilities and illustrating how environmental, infrastructural, and policy constraints cascade across interconnected sectors. This integrative analysis reframes food supply chain resilience as a governance and coordination challenge rather than solely as an infrastructure deficit, thereby informing regional planning strategies that account for upstream–downstream linkages. Conceptually, this study contributes to food systems literature by applying and contextualizing the complex adaptive system (CAS) framework to U.S.–Mexico border food supply chains—a setting largely absent from existing CAS-informed supply chain scholarship. The review suggests that in binational border food systems, cascading disruptions are governed not only by internal network properties but also by exogenous regulatory volatility (trade and immigration policy) and transboundary resource constraints (shared water governance), a configuration that existing CAS frameworks have not yet fully addressed. By surfacing these border-specific dynamics, the study offers insights that may inform supply chain resilience theory and offers a transferable analytical lens for other binational food corridor contexts globally.

Methods

The review proceeded through four stages: systematic searching, eligibility screening, credibility appraisal, and structured thematic analysis.

Search Strategy

This study employed a scoping review methodology to map the breadth and characteristics of avail-

able evidence on food supply chain challenges in the southern border counties of Texas and New Mexico. A scoping approach was selected because the literature base in this region is sparse and heterogeneous, and includes a substantial body of grey literature. Rather than evaluating intervention effectiveness, the objective was to identify structural barriers, cross-sector patterns, and evidence gaps across production, aggregation, distribution, and retail segments. A scoping framework was therefore more appropriate than a systematic review, which is typically designed for a narrowly defined intervention or outcome assessment.

A comprehensive search was conducted across PubMed, Scopus, Web of Science, Medline Ovid, AGRIS, and Google Scholar to identify peer-reviewed literature. Given the limited number of peer-reviewed studies specific to the southern border region, the search was expanded to include government reports, policy documents, and publications from non-governmental organizations. Targeted searches of state agency websites, institutional repositories, and regional organizations were also conducted.

The search strategy employed a combination of keywords and terms, including "food systems," "food industry," "food supply chains," "Texas," "New Mexico," "border counties," "southern border counties," "challenges," and "barriers." Boolean operators (AND, OR) were used to refine the search results appropriately. This approach ensured a comprehensive and systematic identification of relevant sources that addressed the research question. For example, a representative Boolean string applied in PubMed and Scopus took the form: ("food supply chain" OR "food system" OR "food industry") AND ("Texas" OR "New Mexico" OR "border counties" OR "southern border") AND ("challenges" OR "barriers"). Equivalent strings were adapted to the controlled vocabulary and field tags of each platform (e.g., MeSH terms in MEDLINE/Ovid, AGROVOC descriptors in AGRIS). Grey literature was identified through structured targeted searches of state and regional agency websites (e.g., Texas Department of Agriculture, New Mexico Department of Agriculture, USDA regional offices), the websites of regional food systems nonprofits and planning organizations, and institutional repositories. Supplementary grey literature was identified via a snowball approach in which the reference lists of all included sources were reviewed to surface additional documents not captured through database or website searches.

The search period was restricted to 2014–2024 to capture contemporary supply chain conditions. Search terms included combinations of "food systems," "food supply chains," "Texas," "New Mexico," "border counties," "challenges," and "barriers," using Boolean operators (AND/OR) to refine results. Sources were included if they: (1) focused on food supply chains or food systems in Texas or New Mexico; (2) addressed structural challenges or barriers affecting production, aggregation, distribution, or retail sectors; and (3) were published in English between 2014 and 2024. Sources were excluded if they did not address the target region, did not examine supply chain barriers, or were published prior to 2014.

Study Selection

The study selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure a rigorous and unbiased review (Page et al., 2021). The selection process was conducted in three stages. Initially, two independent reviewers screened the titles and abstracts of all identified sources to determine their relevance based on the inclusion criteria. Any discrepancies in study selection were resolved through discussion, and a third reviewer was consulted when necessary to reach a consensus. Following the initial screening, a full-text review of potentially relevant sources was conducted. Two independent reviewers assessed these sources to confirm eligibility and ensure that they met the inclusion criteria. Any disagreements were discussed and resolved, with a third reviewer available to adjudicate when consensus could not be reached.

In the final stage, a comprehensive inclusion check was conducted to ensure that all selected sources aligned with the review's scope. This involved a thorough review of both reviewers' data extraction forms and the full-text articles, with additional input from a third reviewer when

needed. This multi-step approach strengthened the reliability of the study selection process, ensuring that only the most relevant sources were included in the review (Appendix, Figure A1).

Data Management, Reviewing, and Appraisal

The selected sources were systematically organized and categorized for analysis and synthesis. Each source was cataloged according to predefined criteria to facilitate structured data extraction across production, aggregation, distribution, and retail domains. To enhance reliability, two independent reviewers conducted data extraction. Discrepancies were resolved through consensus discussion; when agreement could not be reached, a third reviewer adjudicated.

To assess the credibility of grey literature sources, an adapted AACODS framework (Authority, Accuracy, Coverage, Objectivity, Date, and Significance) was applied (Tyndall, 2010). Each grey literature source was independently appraised across all six domains. Rather than applying a numeric scoring system, reviewers assessed whether sources met minimum credibility expectations in authority (recognized institutional or organizational authorship), transparency of data or methodology, relevance to the regional food supply chain context, and absence of overt commercial bias. Sources lacking identifiable authorship, methodological transparency, or clear relevance, as well as sources showing overt commercial bias, were excluded. Disagreements in appraisal were resolved through discussion and, when necessary, third-reviewer adjudication. No source meeting relevance criteria was excluded solely due to minor methodological limitations; however, quality concerns were documented and considered during synthesis.

Information Extracted

For each included source, reviewers extracted the source title, publishing or commissioning organization, authors, publication year, geographic scope, food system focus, study objectives, and key findings relevant to supply chain barriers. Extracted information was used to identify recurring vulnerabilities (e.g., water scarcity, climate and labor instability, aggregation and cold-storage gaps, transportation bottlenecks, retail-access inequities, and cross-border regulatory delays affecting food production) in the southern border counties of Texas and New Mexico, as well as in aggregation, distribution, retail access, and cross-border coordination. Following data extraction, two reviewers conducted an inductive thematic synthesis using a structured coding protocol rather than formal qualitative analysis software. Barrier categories were allowed to emerge from the extracted findings rather than being applied from a predetermined framework. Reviewers independently coded each source by identifying recurring barriers and assigning provisional codes with operational definitions and supporting examples. Codes were then compared across sources to identify patterns of convergence, divergence, and overlap.

Through iterative consensus discussion, related codes were clustered into higher-order themes representing systemic challenges, infrastructure and cross-border constraints, and sector-specific interactions across the regional food supply chain. Themes were finalized when no additional higher-order barrier categories emerged from the included sources and when each theme could be supported by evidence from more than one source type, where available. Throughout this process, coding decisions and evolving theme definitions were documented in a shared working file to support consistency and provide an informal audit trail. The final thematic structure, including theme labels, definitions, and supporting evidence, was reviewed by the author team before being incorporated into the Results and Discussion section.

Results and Discussion

This scoping review synthesized findings from nine peer-reviewed and grey literature sources published between 2014 and 2024. As shown in the Appendix, Table A1, the majority of the grey literature sources met high standards for authority, objectivity, and regional relevance, although most relied on qualitative or stakeholder-driven methods. This pattern reflects regional evidence grounded in applied planning and community engagement rather than quantitative evaluation studies. Infrastructure and aggregation gaps were identified in at least five of the nine sources (Barber & Stone,

2023; Ferrini, 2021; Frost & New, 2023; Nelson & Kraenzel, 2017; Rasmussen, 2019), suggesting structural entrenchment. By contrast, cross-border regulatory volatility was emphasized in only two sources (Barber & Stone, 2023; Ferrini, 2021), suggesting this constraint may be commodity- or pathway-specific rather than universal. These patterns of convergence and divergence are discussed in the sections that follow.

Comparative analysis of the nine sources (Appendix Table A2) reveals notable convergence across domains. Infrastructure and aggregation gaps were identified in at least five reports (Barber & Stone, 2023; Ferrini, 2021; Frost & New, 2023; Nelson & Kraenzel, 2017; Rasmussen, 2019), consistently highlighting limited cold storage, processing capacity, and transportation coordination as barriers to market access. Environmental and water governance constraints have been emphasized in Rader et al. (2016), Raj and Raja (2018), and Orozco Santos (2022), suggesting that irrigation inequities, declining flows of the Rio Grande, and drought-related yield instability function as persistent structural constraints on production. Retail access inequities, particularly in colonias, have been documented by Barber and Stone (2023), Ferrini (2021), and Orozco Santos (2022), linking infrastructure deficits and transportation gaps to limited product diversity at the community level.

Divergence across sources was most apparent in the treatment of cross-border dynamics. While Barber and Stone (2023) and Ferrini (2021) explicitly identified inspection delays and regulatory volatility at ports of entry as supply chain stressors, other reports focused primarily on intra-state infrastructure and governance challenges. This variation suggests that cross-border dependencies may disproportionately affect specific commodities or logistics pathways rather than uniformly shaping all sectors.

During iterative coding, individual barriers identified within each source were first categorized by supply chain segment (production, aggregation, distribution, retail) and by type of constraint (environmental, infrastructural, governance, labor-related). Cross-source comparison of these coded categories revealed recurring structural clusters, which were then consolidated into three higher-order themes. Synthesizing these convergent and divergent patterns, three overarching themes emerged: (1) systemic environmental and governance constraints; (2) infrastructure and cross-border capacity limitations; and (3) sector-specific barriers that interact across production, aggregation, distribution, and retail. Notably, environmental water constraints and infrastructure gaps for aggregation appear consistently across multiple reports, suggesting structural entrenchment, whereas trade volatility and localized irrigation conflicts exhibit greater contextual variability.

Systemic Challenges Across Regional Food Supply Chains

Environmental pressures consistently emerged as some of the most significant barriers to food system stability. In the work of Rader et al. (2016), producers reported operational downsizing, reduced cultivated acreage, and shifting planting cycles in response to chronic drought, aquifer depletion, and declining Rio Grande flows. Similarly, Orozco Santos (2022) documents soil degradation, declining yields, and increased pest pressure, particularly for high-value crops such as chili peppers, pecans, and onions. These findings indicate that small and medium-sized producers, particularly those without access to adaptive technologies or capital, face disproportionate risks under intensifying climate stress.

Water governance conflicts further exacerbate these environmental barriers. Raj and Raja (2018) highlight irrigation inequities and urban land-use competition in Doña Ana County, where smaller producers reported restricted access to critical water resources. These findings align with a report by New Mexico First (2020) that emphasizes that fragmented policy frameworks and insufficient cross-sector coordination limit regional capacity to respond effectively to water scarcity and other systemic stressors.

Labor instability compounds these production-level vulnerabilities. According to Barber and Stone (2023), the region remains heavily dependent on migrant and seasonal agricultural workers, exposing production systems to disruptions from immigration enforcement, inconsistent visa policies, and

limited workforce protections. Seasonal workforce shortages, particularly when involving crops that require intensive manual labor, exacerbate productivity declines associated with environmental stressors. Together, these findings demonstrate how environmental, governance, and labor pressures interact to reduce regional agricultural productivity, increase operational costs, and drive reliance on external suppliers, setting the stage for downstream disruptions across aggregation, distribution, and retail sectors.

The nine sources consistently characterize the economic consequences of structural barriers in qualitative and directional terms, though few provide precise monetary estimates of their impacts. Nelson and Kraenzel (2017) noted that the absence of local aggregation and processing infrastructure compels producers to seek distant facilities, with associated transportation costs identified as a key barrier to market participation for smaller operations. Rasmussen (2019) reported that the lack of regional hub access limits producers' ability to meet institutional buyer volume thresholds, reducing their competitiveness in school, hospital, and other procurement markets. Barber and Stone (2023) documented that transportation gaps and distributor fragmentation result in higher consumer prices and reduced product diversity in colonia communities, particularly for perishable goods. Ferrini (2021) characterized cross-border inspection delays as contributors to spoilage losses and elevated logistics costs, though precise estimates were not reported.

Collectively, the reviewed literature describes a pattern in which structural barriers increase costs and reduce revenues across multiple supply chain actors (producers, distributors, and consumers), but the evidence base does not yet support precise cross-sector monetary quantification. Future research should prioritize empirical cost estimation to strengthen the economic case for targeted infrastructure and governance investments. Drawing on available evidence, several proxy indicators help characterize the scale of economic burden. Transportation distance to the nearest aggregation or cold storage facility functions as a proxy for disproportionate freight cost burden: Rasmussen (2019) documents that frontier producers in New Mexico often lack access to local hubs, implying extended haul distances that inflate per-unit logistics costs and reduce competitiveness for small-scale operations. The frequency and duration of cross-border inspection holds, identified by Ferrini (2021) as a recurring stressor, serves as a proxy for spoilage-related revenue loss, particularly for perishables such as chili peppers, pecans, and leafy greens with narrow post-harvest windows. Exclusion from institutional procurement markets due to unmet volume thresholds, documented by Rasmussen (2019) and Nelson and Kraenzel (2017), represents a proxy for foregone revenue: institutional buyers (schools, hospitals, and similar entities) offer stable, premium-priced procurement channels that remain inaccessible to producers lacking aggregation support. Collectively, these proxies suggest that economic losses are distributed across all supply chain tiers and are disproportionately borne by the smallest actors, reinforcing the case for targeted infrastructure and governance investment.

Infrastructure Gaps and Cross-Border Barriers

Infrastructure deficits were widely identified as persistent, structural challenges across the food supply chain, particularly in terms of aggregation capacity, cold storage, and processing facilities. Rasmussen (2019) and Nelson and Kraenzel (2017) found that the absence of regional hubs forces producers to transport products long distances for storage and consolidation, inflating operational costs and limiting participation in institutional procurement programs like schools and hospitals. Without localized facilities, smaller producers lack equitable access to competitive markets and face a heightened risk of spoilage. Frost and New (2023) add further evidence of structural aggregation gaps, noting that rural and underserved communities across New Mexico and western Texas face widespread shortages of cold storage capacity, processing facilities, and shared-use infrastructure. Although the Resilient Food Systems Infrastructure Program discussed by Frost and New highlights plans to invest in infrastructure development, the baseline findings underscore the depth of unmet aggregation and processing needs that directly affect the viability of smaller producers.

Distribution systems face similar constraints.

Barber and Stone (2023) and Ferrini (2021) document the problems of insufficient transportation fleets, poorly maintained rural roads, and fragmented logistics systems, which reduce reliability and increase the costs of product movement. These transportation gaps disproportionately affect colonias and other rural areas, where distance from supply hubs exacerbates delays and worsens retail inequities. Ferrini (2021) further highlights inefficiencies arising from limited coordination among distributors, leading to underutilization of existing transportation capacity.

Cross-border dependencies introduce another layer of complexity unique to the Texas–New Mexico region. Barber and Stone (2023) and Ferrini (2021) report that extended inspection delays, shifting port regulations, and inconsistent trade policies significantly slow the movement of products at U.S.–Mexico crossings. These delays often lead to spoilage of perishable goods and elevate consumer costs, while policy uncertainty discourages investment in regional logistics capacity. Because the region's food systems rely heavily on binational flows of inputs and products, disruptions at the border amplify the effects of upstream environmental constraints and local infrastructure deficits.

Perishable, high-value commodities, such as fresh chili peppers, pecans, onions, and leafy greens, are disproportionately vulnerable to cross-border inspection delays because of their narrow spoilage windows. Small and medium-scale producers who lack refrigerated transport capacity or financial reserves to absorb holding costs face the greatest risk exposure. Distributors operating time-sensitive logistics routes and small retailers in colonias who depend on regular restocking of perishables are similarly affected. These actors typically lack the contractual leverage and infrastructure redundancy of larger supply chain operators, making them structurally less able to absorb the cost and spoilage risks associated with regulatory volatility at ports of entry. At the system level, these cross-border dynamics generate a compounding fragility that extends well beyond individual shipment delays. When inspection disruptions coincide with upstream production shortfalls or seasonal labor constraints, the resulting compounded supply interruptions propagate downstream through aggregation bottlenecks and distribution gaps, ultimately inflating wholesale and retail prices in colonias and reducing the variety and availability of fresh foods reaching the most vulnerable communities. Repeated exposure to this volatility may also produce longer-term structural effects: smaller distributors operating thin margins may exit time-sensitive perishable routes altogether, reducing the overall number of actors willing to service border-adjacent markets. This market withdrawal dynamic concentrates distribution capacity in larger, better-capitalized operators and reinforces structural inequities in retail access. Taken together, these system-level consequences position cross-border regulatory governance not as a peripheral logistical concern but as a structural determinant of regional food system resilience, one that interacts with and amplifies the effects of environmental, infrastructure, and labor constraints across all supply chain sectors.

Sector-Specific Barriers and Interactions

Findings across the sources highlight how challenges in production, aggregation, distribution, and retail systems are deeply interconnected, producing cascading effects throughout the regional food supply chain. Production barriers are consistently documented in Rader et al. (2016), Orozco Santos (2022), and Raj and Raja (2018), which collectively report that prolonged drought, declining Rio Grande flows, soil degradation, rising input costs, and unstable labor supply constrain yields and increase production volatility—particularly for irrigated specialty crops such as chili peppers and pecans.

A representative cascade emerges when these upstream stressors are traced across sectors. Reduced yields and irrigation instability limit consistent product volumes, making it difficult for smaller producers to meet aggregation thresholds required by regional hubs (Frost & New, 2023; Rasmussen, 2019). In turn, limited aggregation capacity and reliance on distant cold storage facilities increase transportation distances and fuel costs (Ferrini, 2021; Nelson & Kraenzel, 2017). These distribution inefficiencies contribute to higher wholesale prices and reduced product diversity

reaching rural colonias, where small retailers already operate with constrained refrigeration capacity (Barber & Stone, 2023; Orozco Santos, 2022). The result is not simply a production shortfall but a downstream amplification of cost and access inequities. This pattern illustrates how environmental and governance constraints at the production level propagate through infrastructure and logistics bottlenecks, ultimately shaping retail affordability and food access outcomes.

Aggregation bottlenecks, described by Frost and New (2023), Nelson and Kraenzel (2017), and Rasmussen (2019) stem from limited cold storage, processing facilities, and consolidation hubs. Without accessible infrastructure, producers incur higher transportation expenses and face barriers to entering competitive institutional and retail markets. Distribution constraints identified by Ferrini (2021) and Barber and Stone (2023) include limited trucking fleets, degraded road networks, rising fuel costs, and coordination inefficiencies. These gaps directly contribute to higher consumer prices and limit product diversity, particularly in remote communities.

Retail inequities are highlighted by Ferrini (2021) and Orozco Santos (2022), which document that many rural colonias rely on small convenience stores that lack refrigeration capacity, thereby restricting access to fresh, perishable foods. Ferrini (2021) further notes that structural affordability constraints limit households' ability to consistently purchase higher-cost, perishable products, even when there is clear interest in accessing nutritious foods. Because fresh produce and refrigerated items often carry higher price points and greater spoilage risk, retailers in low-income areas may limit inventory expansion due to thin profit margins and uncertain turnover. This dynamic reflects cost and infrastructure barriers, rather than a lack of consumer preference for healthier foods.

Across these sectors, findings reveal that barriers are mutually reinforcing. For example, production declines linked to drought and irrigation conflicts (Rader et al., 2016; Raj & Raja, 2018) increase reliance on distant aggregation facilities (Frost & New, 2023; Rasmussen, 2019), raising transportation costs and resulting in higher retail prices and reduced product diversity (Barber & Stone, 2023; Ferrini, 2021). These cascading impacts demonstrate that addressing barriers within a single sector is insufficient; the evidence suggests the need for integrated strategies that span production, aggregation, distribution, and retail systems.

Strengths and Limitations

A major strength of this review is its integration of grey literature, which enabled including localized perspectives from community needs assessments, producer-focused surveys, and regional policy analyses. Applying the AACODS framework ensured the inclusion of good-to-high-quality grey literature and enhanced the relevance of findings for underserved regions in Texas and New Mexico.

However, several limitations should be noted. First, reliance on grey literature and regional reports may have introduced selection bias, as sources that were publicly available, easily retrievable, or produced by more visible organizations may have been more likely to be included than unpublished, internal, or less accessible local documents. As a result, some perspectives, particularly from smaller producers, informal food system actors, or under-resourced community organizations, may be underrepresented. Second, variability in methodological rigor and considerable heterogeneity in source type (including differences in study design, geographic coverage, data collection methods, and reporting standards) limited opportunities for direct comparative quantitative analysis and may have affected the comparability of findings. Third, the geographic scope, southern Texas and the border counties of New Mexico, constrains generalizability to other regions. Finally, many of the included sources were descriptive rather than evaluative, leaving critical gaps in the evidence on the effectiveness of specific interventions to mitigate barriers. Future research should prioritize empirical evaluations of infrastructure investments, cross-border coordination strategies, and climate-adaptive agricultural practices in order to inform targeted policy and regional planning.

This review highlights opportunities to address structural challenges in the food supply chain through coordinated regional planning and investment. The analysis was initially undertaken during planning for the RGC-RFBC, a USDA-funded ini-

tiative. Although the program is no longer active, the structural vulnerabilities identified in this review (particularly those related to water governance constraints, gaps in aggregation infrastructure, volatility in cross-border inspections, and labor instability) remain salient for regional stakeholders. The findings suggest that infrastructure expansion alone is unlikely to resolve supply chain fragility without concurrent attention to environmental governance, workforce stabilization, and binational coordination mechanisms. Addressing these interdependent constraints will require sustained cross-sector collaboration among producers, distributors, policymakers, and community organizations, irrespective of specific federal programmatic vehicles.

Conclusion

Across the nine included sources, we identified a network of systemic barriers that span production, aggregation, distribution, and retail systems, shaping food availability, affordability, and access in the region. At the production level, persistent drought, aquifer depletion, extreme heat, and conflicts over water governance reduce yields, increase input costs, and create a reliance on external suppliers. In aggregate, the lack of sufficient cold storage, processing capacity, and regional hubs forces many producers to rely on distant facilities, thereby increasing transportation expenses and limiting their participation in institutional markets. Within distribution networks, challenges include inadequate fleets, poorly maintained rural roads, and cross-border dependencies, which can lead to inspection delays and shifting regulatory requirements, thereby elevating spoilage risk and increasing consumer costs. Finally, retail access inequities are especially pronounced in rural colonias, where limited refrigeration capacity, constrained purchasing power, and a lack of nearby outlets result in reduced product diversity and limited availability of nutritious foods.

Findings across these sectors underscore that barriers do not operate in isolation. Instead, upstream production shortfalls cascade into aggregation bottlenecks, distribution inefficiencies, and restricted retail availability, amplifying inequities for underserved communities. Addressing these interconnected challenges will require coordinated regional strategies that integrate infrastructure investments, aligned water governance, workforce stabilization, and cross-border logistics coordination. While initiatives such as the RGC-RFBC were designed to facilitate stakeholder engagement and infrastructure planning, policy volatility and funding shifts underscore the need for more durable coordination mechanisms. These mechanisms may include state-level infrastructure consortia, producer-led aggregation cooperatives, regional cold-chain partnerships, formalized binational inspection coordination agreements, and locally anchored public–community investment models that reduce dependence on single federal funding streams.

Although the evidence base does not clearly identify a single superior model across all regional food systems, prior research and practice-oriented literature generally support multi-stakeholder governance structures with dedicated coordination capacity as the most promising mechanism for addressing fragmented supply chains. For policymakers, this suggests that the most actionable approach may be a regional food systems consortium or coordinating body that brings together producers, distributors, public agencies, community organizations, and cross-border regulatory partners. Such a mechanism could align infrastructure investments, aggregation capacity, cold-chain logistics, inspection coordination, and workforce strategies under a shared regional plan. Compared with isolated investments in individual facilities or programs, this type of coordinated governance model may be better positioned to sustain supply chain resilience amid shifting policy environments and changing federal funding priorities.

To translate these findings into actionable guidance, we propose several concrete policies and planning priorities. First, state and regional agencies should prioritize investment in shared cold-chain and aggregation infrastructure in underserved rural areas, with particular attention to colonia communities that currently rely on small-format outlets lacking refrigeration. Second, binational task forces involving U.S. and Mexican customs and agriculture agencies should explore streamlined, commodity-specific inspection protocols to

reduce the risk of perishable spoilage at ports of entry. Third, workforce-stabilization policies, including expanded agricultural visa programs and occupational protections for seasonal workers, should be pursued in tandem with infrastructure investments, as labor instability directly amplifies the downstream effects of environmental and logistics constraints. Fourth, water governance reform at the regional and interstate level should integrate agricultural access priorities, ensuring that small and mid-scale producers can sustain irrigated production under worsening climate conditions. These priorities are sequentially interdependent: infrastructure investments will yield limited returns without concurrent attention to governance, labor, and environmental constraints.

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Appendix Table A1. Appraisal of Included Grey Literature Sources Using the AACODS (Authority, Accuracy, Coverage, Objectivity, Date, and Significance) Framework

#	Source Title	Authority	Methodological Rigor/Accuracy	Coverage & Relevance	Objectivity	Date	Overall Appraisal
1	**Texas Food Access Study**	Strong (UT-RGV)	Moderate: Synthesizes community input, administrative data	High: Targets underserved areas with food access barriers	High: Developed by academic and public-sector collaborators; no commercial bias; aimed at informing city-level policy	2023	**High**
2	**Resilience in NM Agriculture**	Strong (New Mexico First & NMSU)	Moderate: Qualitative, stakeholder-driven	High: Focuses on resilience in New Mexico's agricultural systems	High: Produced through public engagement and supported by a university; intended to inform inclusive policy	2016	**High (despite age)**
3	**Food Security Task Force Report**	Strong (City of El Paso)	Moderate: Policy recommendations based on local agency input	High: Centers on food infrastructure and equity	High: Commissioned by a local government to support regional food policy and climate adaptation; objective in focus	2021	**High**
4	**Resilient Food Systems Infrastructure (RFSI) Program**	Moderate (NM Dept. of Agriculture)	Moderate: Stakeholder survey; responses used for policy development	Moderate: Targets USDA and state-level funding priorities	Moderate: Developed as part of a USDA initiative; aligned with public funding goals; possible internal prioritization, but no private-sector bias	2023	**Moderate to High**
5	**Health: Body, Mind, and Spirit Town Hall**	Strong (New Mexico First)	Moderate: Qualitative insights from town hall dialogues	Moderate: Includes health, wellness, and food access concerns	High: Driven by community voices through participatory process; no commercial agenda; seeks broad health and policy equity	2020	**Moderate**
6	**Value-Added Market Feasibility Study**	Strong (La Semilla Food Center)	High: Data-informed feasibility analysis with economic modeling	High: Clear relevance to food system economics and producer resilience	High: Conducted by a nonprofit with food justice mission; objective in evaluating viability without private gain	2017	**High**
7	**Snapshots of Resilience**	Strong (La Semilla Food Center)	Moderate: Narrative, community-based case study approach	Moderate: Offers qualitative data on resilience at household/farm level	High: Community storytelling without policy lobbying or commercial angle; centered on resilience and justice	2022	**Moderate to High**
8	**Agrarian Values and Urban Futures**	Moderate (Growing Food Connections)	Moderate: Policy analysis grounded in land-use planning	Moderate: Focuses on governance and agricultural futures	High: Aimed at informing local governments; developed by university and nonprofit partnership; no corporate affiliations	2018	**Moderate**
9	**Feasibility of a Regional Food Hub for Southwest NM**	Strong (NCFC)	High: Combines producer interviews and buyer surveys	High: Highly relevant to food supply infrastructure and procurement	High: Developed by a nonprofit serving rural communities; supports economic development without commercial promotion	2019	**High (especially for infrastructure insight)**

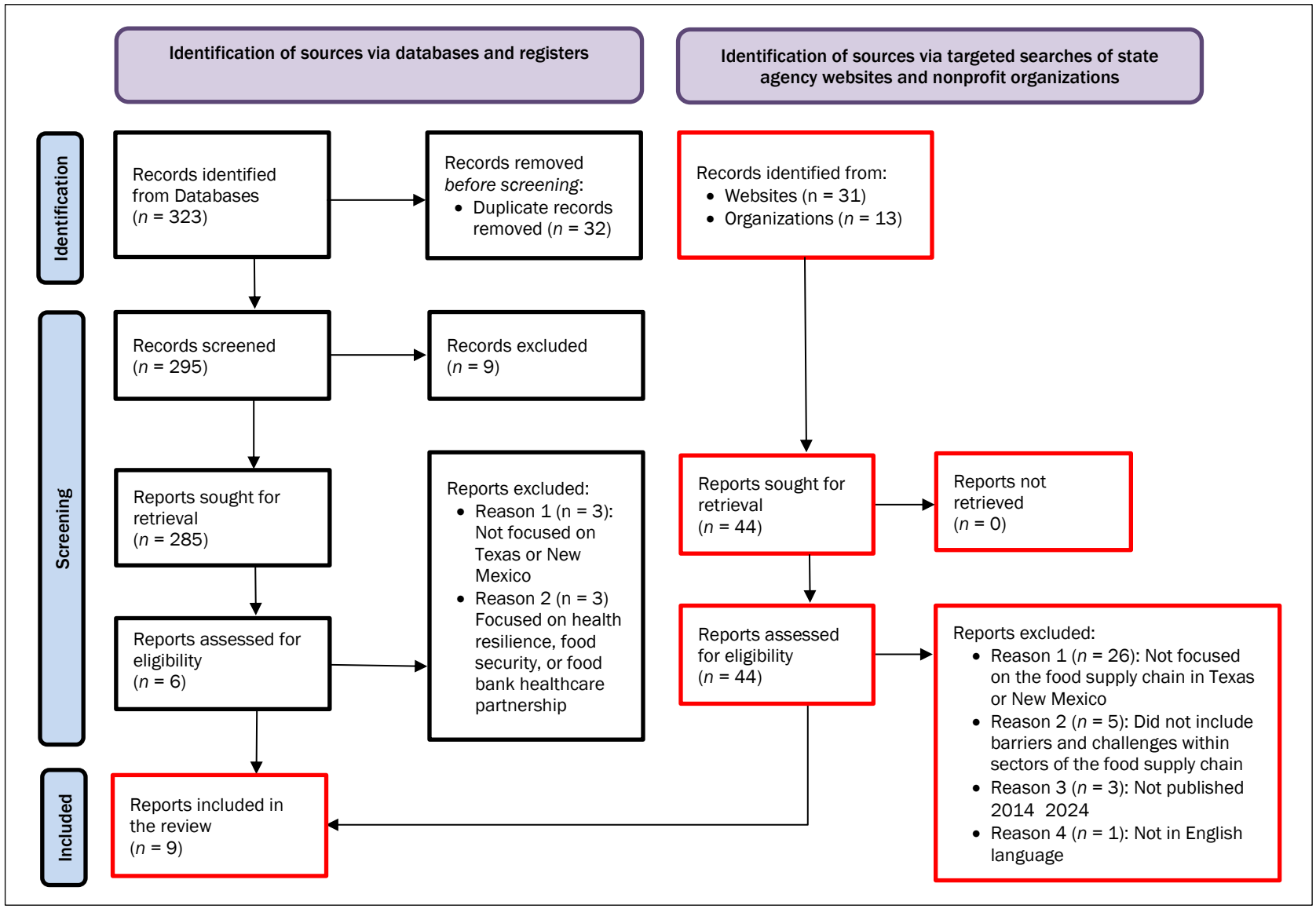
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Appendix Table A2. Description, Relevance, and Conclusions of Articles and Reports Included in the Review

#	Title	Source	Authors (Year)	Scope & Focus	Key Findings	Relevance to Food System	Conclusions
1	**Texas Food Access Study**	UT Rio Grande Valley	Barber & Stone, 2023	Examines barriers to food access and potential solutions	Identifies barriers to food access (e.g., grocery store distribution, economic factors) and strategies to address them	Informs targeted interventions for underserved communities	Enhanced coordinated efforts and collaboration among food supply chain sectors can maximize limited resources to better adapt to climate, supply, and distribution-related challenges
2	**Resilience in NM Agriculture**	New Mexico First & NMSU	Rader et al., 2016	Stakeholder-driven assessment of NM's agricultural resilience	Calls for a balance between export-oriented agriculture and local food networks; emphasizes multi-stakeholder collaboration	Identifies economic and environmental factors affecting agricultural resilience	Highlights the need for collaboration and strategic planning among diverse stakeholders to address challenges in New Mexico's agricultural industry, ultimately aiming for a resilient, cooperative, and economically viable food system
3	**Food Security Task Force Report Recommendations**	City of El Paso	Ferrini, 2021	Policy recommendations for food security	Proposes solutions for food access, funding allocation, and infrastructure improvements	Offers policy solutions for food security and local food infrastructure	To ensure food security and improve food access in El Paso County, efforts must focus on establishing a comprehensive food system, integrating food security into climate planning, and implementing food waste policies.
4	**Resilient Food Systems Infrastructure Program (RFSI)**	New Mexico Department of Agriculture	Frost & New, 2023	Stakeholder survey on food system resilience initiatives	Highlights priority needs for technical assistance, market access, and USDA funding opportunities	Identifies investment opportunities to strengthen food infrastructure	Insights from stakeholder survey results were used to guide the finalization of state funding priorities that were also included in the RFA.
5	**Health: Body, Mind, and Spirit Town Hall**	New Mexico First	New Mexico First, 2020	Statewide discussions on public health and policy needs	Informs state policy through community-driven insights, including food access considerations	Provides community-driven perspectives on food system challenges	Investment in policies and strategies that help local food systems flourish and strengthen resilient local agriculture is needed.
6	**Value-Added Market Feasibility Study for NM Products**	La Semilla Food Center	Nelson & Kraenzel, 2017	Examines potential for developing value-added agricultural products	Identifies top products for local processing and economic viability	Highlights market opportunities for local farmers and processors	Findings recommend developing a detailed business strategy that highlights methods which will strengthen the organization's competitive advantage.
7	**Snapshots of Resilience: Tending Land & Food Traditions**	La Semilla Food Center	Orozco Santos, 2022	Community narratives on food access and cultural food practices	Documents barriers and adaptive strategies in food production and household food security pre- and post-COVID-19	Provides qualitative insights into resilience strategies	Embracing resilience is essential to adapt and innovate for future generations.

8	**Agrarian Values and Urban Futures**	Exploring Stories of Opportunity	Raj & Raja, 2018	Policy and food system challenges	Provides policy insights for local government on agriculture and food security	Explores land-use policies and governance challenges affecting food systems	Improved public policy engagement is essential to support agricultural innovation, farmland protection, community food assessments, and stable funding for grassroots food system initiatives.
9	**Feasibility of a Regional Food Hub for Southwest NM**	National Center for Frontier Communities	Rasmussen, 2019	Assessment of farmer and buyer interest in a regional food hub	Evaluates local farmers' capacity and institutional buyer demand for a regional hub	Supports local procurement and supply chain infrastructure	A regional food hub would boost local farmers' earnings, expand market access, improve healthy food availability in low-access areas, and strengthen the regional economy.

Appendix Figure A1. PRISMA Flowchart with Reasons for Exclusion



Adapted from Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA 2020 Statement (Page et al., 2021).

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