Navigating a citizen science food waste project: Challenges and lessons learned

Cody Gusto,[a] * Catherine G. Campbell,[b] Kay Kelsey,[c] and Ziynet Boz [d]
University of Florida

Abstract

While citizen science has increasingly gained recognition as a valuable approach for engaging the public in scientific research, the method has seen limited application in food waste contexts. Our reflective essay examines the application of citizen science to address household food waste as part of a broader, interdisciplinary research initiative, focusing on the challenges we experienced and the lessons we gleaned from applying the citizen science process to our research. Our study gathered two rounds of empirical household data on food and food-related packaging discard behaviors to refine a predictive agent-based model designed by our project partners to simulate household food waste patterns and implications. Over a two-week period in April 2024, citizen scientists in two Florida cities documented the types, quantities, and reasons for discarding food, as well as associated packaging waste. While the project demonstrated the utility of citizen science for gathering food waste data, it also highlighted several logistical and methodological challenges, including complex-

[a] * *Corresponding author:* Cody Gusto, PhD, Research Coordinator, Department of Agricultural Education and Communication, University of Florida; 1116 NE 15th Place; Gainesville, Florida 32601 USA; cgusto@ufl.edu; https://orcid.org/0000-0003-0008-0533

[b] Catherine G. Campbell, PhD, MPH, CPH, Assistant Professor and Extension Specialist, Community Food Systems, Department of Family, Youth, and Community Sciences, Institute of Food and Agricultural Sciences, University of Florida; 3002-A McCarty D, 1604 McCarty Drive; Gainesville, Florida 32611 USA; cgcampbell@ufl.edu; https://orcid.org/0000-0003-1574-3221

[c] Kay Kelsey, PhD, Professor, Evaluation Specialist, and Project Manager, Crop Transformation Center, Institute of Food and Agricultural Sciences, University of Florida; 2231 Fifield Hall; Gainesville, Florida 32611 USA; kathleen.kelsey@ufl.edu; https://orcid.org/0000-0001-9683-6993

[d] Ziynet Boz, PhD, Assistant Professor, Sustainable Food Systems Engineering, Department of Agricultural and Biological Engineering, Institute of Food and Agricultural Sciences, University of Florida; 105 Frazier Rogers Hall, P.O. Box 110570; Gainesville, Florida 32611-0570 USA; ziynetboz@ufl.edu; https://orcid.org/0000-0001-6764-2022

ities in materials distribution, participant training, and maintaining data quality. Based on our experience, we offer recommendations for future citizen science projects in the food waste domain, emphasizing the importance of well-designed materials, robust partnerships, and strategies to mitigate participant fatigue. This essay underscores citizen science's potential to illuminate consumer food waste research while offering guidance to researchers and practitioners interested in the method on how to mitigate challenges and achieve intended outcomes and impacts.

Keywords
citizen science, food waste, critical reflection, household waste, agent-based model, case study

Introduction
Over the past few decades, citizen science (CS) has been touted as an innovative approach to generate empirical data at scales and within contexts previously considered unattainable, or impractical, by traditional research methods alone (Bonney et al., 2016; Pateman et al., 2020). As the practice of deputizing nonprofessional scientists to contribute to various stages of research—from data collection to, in some cases, study design—CS can enable more inclusive examinations of complex social and environmental issues (Bonney et al., 2016; Campbell et al., 2024; Kasperowski & Kullenberg, 2019). Despite roots in 19th-century amateur naturalist and astronomy society groups, modern CS emerged over the past three to four decades due to rapidly improved and expanded technologies that facilitated the digital crowdsourcing of data to support biodiversity monitoring and other pro-environmental efforts (Bonney et al., 2009; Jordan et al., 2015).

CS proponents contend that the expansion of public engagement in science has produced several benefits for researchers and stakeholders alike, including increased transparency in scientific processes, improved efficacy of data collection at large scales, and a deeper appreciation and understanding of science among the broader, nonprofessional citizenry (Kasperowski & Kullenberg, 2019). Advocates and practitioners also suggest that CS's flexibility as a discipline—with numerous design and implementation options—means that it can be applied across diverse contexts to help address critical challenges and areas of inquiry (Ballard et al., 2017; Bonney et al., 2016; Pateman et al., 2020). For example, CS projects around the world are implemented to monitor bird species distribution and migration patterns, assess radiation levels in the aftermath of the Fukushima disaster, promote urban food production, and monitor urban noise pollution. The wide applicability of CS is irrefutable (Bonney et al., 2016; Campbell et al., 2024; Katapally, 2020; Mueller et al., 2018). Despite increased application in food systems contexts broadly, however, CS is still underutilized and underexamined as a means to address the critical global sustainability issue of food waste and loss (Pateman et al., 2020).

In light of global political consensus (as formalized in the United Nations Sustainable Development Goal [SDG] 12.3) on the urgent need to address food waste to reduce food insecurity and halve per capita global food waste (United Nations, n.d.), the issue has become a focal point in research (Attiq et al., 2021; Hoover & Moreno, 2017; Pateman et al., 2020; Roe et al., 2020). To date, however, very few studies have explicitly leveraged a defined CS approach to guide inquiries or interventions to address food waste, either at the household (consumer) level or within the production or distribution stages. Pateman et al.'s (2020) literature review of the use of CS in food waste contexts serves as a prominent example of linking the approach (CS) to the application context (food waste). The authors emphasize that while CS has shown promise in generating essential data on food waste by monitoring localized household waste patterns or surveying households to better understand the behaviors and psychosocial motivations that drive waste production, its broader potential remains underutilized (Pateman et al., 2020). The few recent studies conducted outside North America have leveraged CS to examine food waste through household waste by logging and performing compositional waste analyses. They have similarly underscored the value of CS as an engaging and cost-effective way to capture difficult-to-collect data, but also have identified key methodological and logistical challenges, such as adequately

training participants and ensuring data quality (Breitenmoser et al., 2024; Pierini et al., 2021; Requena-Sanchez et al., 2022).

As these authors and Pateman et al. (2020) note, the relative novelty of CS applied to food waste contexts presents opportunities for researchers to establish an evidence base for comparable interventions and to document both successes and challenges to inform future initiatives. In this reflective essay, we examine our own experience designing and implementing a CS project focused on household food waste, exploring how the approach enabled certain insights while raising challenges to navigate and investigate further. By detailing how our project unfolded and situating it within the emergent food waste–focused CS literature, we aim to offer insights that support the ongoing development of CS as an important approach for advancing the understanding of household food waste. Below, we outline our study context and procedures before reflecting on critical considerations, challenges, and recommendations from the experience.

Procedure Overview: Approach and Methods

Study Context
We conducted our CS study as part of a broader project titled "Integrated Food Waste Measurement and Predictions Supported by Agent-Based Models" (IFWASTE), funded by the U.S.-based Foundation for Food & Agriculture Research FFAR. The project aimed to expand the understanding of household food waste behaviors and improve the fidelity of predictive agent-based modeling (ABM) of consumer food waste patterns and outcomes. Practical implications of ABM include the municipal use of models to predict food waste needs for city collection efforts. One of the key aims of the project was to improve the predictive capacity of modeling efforts by leveraging material, community-driven food waste data collected through the CS phase of the study. The CS effort actively engaged participants from the greater Gainesville and Sarasota areas in Florida to record and quantify household food waste over a two-week period. As further detailed below, we trained

citizen scientists to record the types, quantities, and reasons for discarded food and food-related packaging in order to generate data intended to reflect genuine waste patterns useful for refining the ABM.

By simulating households and individuals as decision-making agents influenced by habits, norms, and a series of household-specific factors, the ABM was designed to integrate elements of our CS-based data to generate the most realistic simulations possible in order to better predict food waste influences and outcomes under various conditions. The exchange between our CS effort and the ABM team enabled a more accurate prediction of consumer food waste and the efficacy of potential interventions, providing stakeholders and policymakers with a robust, open-access tool to inform food waste reduction initiatives in their communities. Through this integrated approach, our IFWASTE project was able to produce an accessible and scalable ABM that provides decisionmakers with actionable, data-driven strategies to reduce food waste and achieve broader sustainability goals, a practice that has precedent in other policy contexts (Skeldon et al., 2018).

Recruitment
In March 2024, we recruited participants through a multichannel strategy targeting residents in the greater Gainesville and Sarasota areas in Florida, which were chosen for existing partnerships with key stakeholders and access to prospective participants. Recruitment efforts included the distribution of digital outreach materials, such as targeted emails, digital flyers, social media posts, and an official city government e-press release aimed at encouraging households to participate as citizen scientists in a two-week household food waste monitoring study. We developed and distributed these materials in partnership with a Sarasota County Extension educator who specializes in waste reduction education. The recruitment materials outlined the purpose and design of the study, with the primary emphasis on the prospective participants' expected roles as citizen scientists to be responsible for logging their household's food and food-related packaging waste over two weeks in April 2024. We provided compensation details,

indicating that participants were eligible to receive US$150 for completing the two-week waste logging process and a post-monitoring survey (administered via Qualtrics). Interested individuals were asked to complete a brief online registration and screening form (also distributed via Qualtrics), which captured key contact information, allowing study staff to confirm interest and formal enrollment in the study. These recruitment efforts yielded 192 total enrollees: 101 from Gainesville and 91 from Sarasota.

Instrumentation

A core component of this CS effort involved the design, preparation, and distribution of participant materials, which required thoughtful alignment with research objectives and participant needs. The subsections below describe the study's primary data collection instruments, the logistics of materials preparation and delivery, and the educational outreach provided to ensure consistent participant engagement and data quality.

Materials Design

The primary instruments used in the study were printed, 40-page kitchen log packets given to each citizen scientist, and an online Qualtrics survey distributed at the end of the food waste logging period. The kitchen log packet was the foundation for participants to record their waste monitoring data during the study. Participants used the 14-day kitchen data log in the packet to record daily food waste data, including the type of food discarded at specific mealtimes, the estimated amount of food discarded (in both servings and cups as directed), the primary reasons for discarding food items, and whether any food-related packaging was also discarded. The four core sections of the daily log are presented below. These sections are also viewable as a sample page of the daily log in Appendix A.

- **Section 1: Discarded Food Type and Estimated Amount:** Over the course of each day of the logging period, participants were asked to estimate the number of servings of food discarded across the following provided categories: meat-based proteins, plant-based proteins, egg proteins, dairy, grains, fruits, vegetables/herbs, and fats/oils. "Mixed inedible parts," which we defined as any food items that are not typically consumed (such as eggshells, broccoli stalks, strawberry tops, or coffee grounds) were to be measured in cups. Participants estimated serving sizes based on an originally developed visual guide provided in the packet. The visual guide provided serving size conversion guidelines for each food category (e.g., 1 serving of meat-based protein = 3 ounces of cooked seafood, meat, or poultry), with an image displaying that the item was roughly equivalent to the palm of a human hand.

- **Section 2: Total Weight:** At the end of each day, participants used a digital luggage scale to record the weight of the 2-gallon kitchen compost pail containing their food discards.

- **Section 3: Reasons for Discard:** After weighing the total food waste, participants were asked to note reasons that food was discarded from a list of 13 predetermined reasons relating to spoilage, improper food storage, personal preferences, plans to eat out, the edibility status of the foods, and more (including "Other," where they could write in a reason). Participants were instructed to note for each reason that food was discarded whether it was discarded for that reason *more than once* that day.

- **Section 4: Packaging Waste:** Participants followed a similar procedure to record the types of food-related packaging discarded each day (e.g., plastic containers, glass bottles). Twenty food-related packaging categories were provided for participants to select from, and participants were again instructed to note whether any packaging type that was discarded on a day was discarded more than once on that day.

The core data collection portion of the kitchen log packet was preceded by a quick-start guide (Appendix B) designed to introduce participants to the concept of CS, remind them of their role and responsibilities in the study, and outline the materi-

als they should expect to have at their disposal to complete the study. Following the quick-start guide, an instructional guide (Appendix C) detailed the protocols participants would need to follow to complete each of the four daily log sections. This section of the packet therefore included specific, clear instructions, as well as written and visual examples to ensure consistent reporting across the citizen science participants.

At the end of the two-week food waste monitoring and logging period, we gave the participants a link to a robust 101-question online Qualtrics survey where participants transferred their physical recorded log packet data into an online form, as well as answered a suite of demographic and reflective questions. The "kitchen log transfer" section of the survey, which took up the bulk of the question load, mirrored the structure and sequence of the four core kitchen log sections in the physical packet, allowing participants to input data across the logging period with relative ease by referencing previously recorded information in their packets. A small block of reflective questions followed the logging questions for both week one and week two. These questions prompted participants to consider whether the amount of food and food-related packaging discarded over that week's logging period was *much less*, *somewhat less*, *about the same*, *somewhat more*, or *much more* than an average week.

Materials Preparation and Delivery
The sourcing, preparation, logistical coordination, and delivery of study materials to each citizen scientist's home was complex and required sufficient planning and extensive internal (i.e., between study team members) and participant-facing communication. Each of the 191 enrolled citizen scientists needed a kitchen log packet, a small digital luggage scale, and a two-gallon compost bin to complete the study. Through their involvement in the City of Gainesville's food waste pilot program, a segment of the Gainesville citizen cohort already had the required two-gallon compost bins and therefore only received a study envelope containing the printed log pack and digital luggage scale. All other participants received compost bins in addition to their materials envelope. In Gainesville, our study team physically assembled originally developed materials (e.g., printed kitchen log packets) and externally procured materials (e.g., digital luggage scales) into kits marked for each citizen scientist participant via the unique assigned participant identification (ID) code. After extensive neighborhood and route mapping, these kits were hand-delivered to all 101 Gainesville participants. Three separate team members each had their own delivery route, and each made deliveries over several hours on the Friday before the start of the waste logging period. In Sarasota, our Extension educator partner distributed study materials over the course of multiple advertised pickup and distribution windows. During this, enrolled participants (*n* = 91) arrived at a predetermined site to pick up their materials.

Education and Training
Given the relative complexity of our citizen scientists' roles, we discovered the need to dedicate significant time to providing formal trainings and supplemental educational and logistical support. Overall, our study team produced and disseminated two prerecorded video trainings focused on data collection and recording procedures. The first session focused on completing the kitchen log packet, guiding participants through the steps of recording food waste, estimating serving sizes, and classifying discarded items. The second session provided instructions for transferring their data into the subsequent Qualtrics survey, ensuring that participants understood how to accurately input their collected information at the end of the logging period, as well as to expect the additional behavioral and demographic questions. We also organized and hosted two supporting virtual question-and-answer (Q&A) sessions, one for each primary data collection phase, and we generated a concise frequently asked questions (FAQ) document that aggregated and responded to common participant questions posed across the virtual Q&As in conjunction with directly emailed questions to the study team. Finally, we provided extensive technical and logistical support via direct email exchanges with participants. Rigorous monitoring demonstrated that we provided 115 unique (i.e., nonduplicative) instances of direct problem-solving support to participants over the study period.

Data Collection and Analysis

Out of 191 initially interested enrollees, 159 citizen scientists ultimately completed the study by logging their household food waste daily over two weeks, recording the type, amount, and reasons for food and packaging discards in real-time in the kitchen log packet and transferring their data back to the study team via a Qualtrics survey, which facilitated streamlined aggregation and analysis by our study team. The survey captured the self-reported food waste monitoring data from the daily logs, demographic and household characteristic data to contextualize primary data, and closed- and open-ended reflections on participants' food waste behaviors and their overall experience as citizen scientists. We sent structured, periodic reminders to participants throughout both data collection phases to ensure timely and complete data entry.

Prior to analysis, the dataset was managed using SPSS and required extensive data cleaning and quality screening to ensure the accuracy and reliability of data entries, given the nature of how data was recorded (i.e., transferred from a physical packet into a digital survey) and the size of the dataset. Data cleaning and management involved identifying inconsistencies, missing values, or outliers, cross-referencing responses, imputing missing data where appropriate, and removing outliers based on predetermined thresholds. For example, we flagged instances where participants may have reported unusually high food discard weights for further examination and deliberation. Once the dataset was cleaned, we performed descriptive statistics to summarize key waste logging and household characteristic variables. Our analysis also explored participants' reflections on their experiences with food and packaging waste logging. The qualitative results contextualized our primary data, allowing us to compare self-reported waste amounts with participants' perceived waste generation relative to their typical behaviors.

Reflection and Recommendations

There were several critical decisions made across the conceptualization, implementation, data collection, and analysis stages of the project. We deliberated significantly on the design and rollout of core project materials with deep consideration of our research questions and objectives, anticipated logistical constraints, and more. Our experience implementing a CS approach to better understand household food waste behaviors illuminated several challenges that should be carefully considered by future researchers or food waste stakeholders. The following recommendations provide practical solutions aligned with the challenges we encountered and broadly reflect insights from other studies that have applied CS to food waste contexts, such as those by Pateman et al. (2020) and Requena-Sanchez et al. (2022).

Design Materials with Research Objectives and Participants' Needs in Mind

For CS projects to yield useful and reliable data, it is crucial to design materials that meet the project's research objectives while simultaneously being accessible to participants. One of our critical decision points was determining whether participants would log their kitchen waste data in real time using a virtual tool, such as a live spreadsheet accessed via a URL or QR code, or via a physical packet, and later transfer the data into an online survey. We ultimately opted for an initial manual entry in printed packets to ensure accessibility and limit technical barriers for participants who may not have consistent access to digital devices or internet connectivity, or who were uncomfortable or unfamiliar with using digital tools to log data in real time. While we were confident that this was the best choice to make given the demographic makeup of our sample and the technical assistance challenges we anticipated, the decision produced other challenges in terms of the quality of recorded data. By requiring that participants input their logging records into a survey after generating food waste, we may have traded one challenge for another. In other words, while our choice likely helped mitigate technical access issues, it may have increased the risk of data entry errors due to the delay in entering information.

We recommend that CS facilitators overseeing household food waste monitoring protocols address this issue by providing optional real-time digital logging for participants who prefer this method. This pathway may mitigate data accuracy challenges in comparable CS projects (Pateman et

al., 2020). Researchers may also consider employing AI-driven food waste measurement software that can generate compositional analyses from participant-submitted photos, although they should be aware of potential training burdens and technical support issues.

Another consideration was whether we (as researchers) should digitally input the data that our participants manually recorded in their logging packets. Given concerns about our own time and resource capacities, and concerns about the accuracy of data in the event we may struggle to accurately interpret or corroborate participants' written data, we opted to guide our citizen scientists to re-record this data in the survey themselves. For researchers choosing to mirror the approach we used in our study, it is important that any manually recorded data that is transferred after the fact into an online survey be rigorously vetted by the primary research team (with support from external expert colleagues, if possible). Vetting should be done using evidence-based data quality management techniques to ensure that final entries are verifiable, reasonable, and complete (Bowser et al., 2020; Thuermer et al., 2023). Our experience with inaccurate values and missing data demonstrated that these steps may be necessary.

The development of the waste logging packet itself involved extensive consideration of design elements such as page length, visual flow, practicality, and compatibility for both digital and physical printing. Given the distinct lack of examples for the type of multisection kitchen log protocol and the supplemental instructional guidance that we strove to create, we developed the packet materials interactively, with multiple rounds of drafting, review, and refinement. As obvious as it may seem, ensuring that the materials captured the essential data we needed them to capture was a fundamental consideration, made more challenging by the scope of the protocols and the iterative and collaborative nature of their development. While our core CS team meticulously ensured that the logging packet's layout and questions were aligned with the study's primary objectives, achieving this required a careful balance between simplicity and comprehensiveness, a balance somewhat complicated by the collaborative nature of our interdisciplinary team.

Working as a team composed of members from various disciplines also brought challenges, particularly as some collaborators had limited experience with CS or social science research, resulting in "mission creep," the expansion of a project's scope beyond its original goals. As such, establishing frequent communication channels and fidelity to the primary research objectives through continual deliberation may be particularly valuable in collaborative work settings where varying priorities in a broad interdisciplinary or transdisciplinary team may be present.

Overall, we believe the ability to successfully carry out our CS process was largely due to the tailored design of our logging packet. While we prioritized the packet's functionality in soliciting the specific data required for the study (e.g., serving size estimates, total daily discard weights, reasons for discards, and types of food-related packaging discarded), our design was also guided by our goal that navigation through the packet should be as seamless and intuitive as possible for citizen scientists. We piloted the packet's accessibility by requesting that select colleagues thoroughly review various iterations of the packet and provide notes on its navigability and visual appeal. Given that our participant sample included individuals with a high level of education and relative familiarity with research protocols, we felt a degree of trust that the final product we arrived at was appropriately balanced between comprehensiveness and accessibility, as this was a volunteer activity for participants. Future researchers should assess their participant cohort and adapt materials to match their skills, preferences, and accessibility needs, given the community's demographics. For example, a study with a more diverse sample might benefit from the instructional logging packet being offered in other languages, such as Spanish, from generally simplified logging processes, or from even more visual aids than those we provided.

Secure Adequate Support for Materials Assembly and Distribution

The acquisition, preparation, and delivery of project materials were both resource- and time-intensive. With a supportive budget and the opportunity to requisition materials through our university's

procurement marketplace and contracted suppliers, the primary consideration for ordering materials was confirming adequate lead times to ensure that materials were delivered on time. Depending on the design and requirements of the project, ordering may involve submitting purchase requisitions and obtaining quotes from multiple vendors, potentially introducing more challenges to guarantee that all materials arrive within the desired timeframe. Once materials arrived, a new set of considerations and challenges emerged. We found the preparation, assembly, and distribution of participant kits and kit components to be heavily time-intensive tasks. Depending on the project's scale, core team members may consider recruiting volunteers or interns to assist with all stages of this process. Determining the quantity and type of materials needed for the kits, which included digital luggage scales, kitchen log packets, and compost bins, required careful planning. Following this, the storage, assembly, and organization of these items into kits for distribution was an involved process, particularly as each kit was personalized with unique participant identification numbers. This step highlighted the importance of comprehensive logistical planning and the need for a dedicated space and system for material assembly in future projects.

The delivery of these kits also required extensive planning, including neighborhood clustering, route mapping, and contingency planning for missed deliveries or for participants who retroactively indicated they needed project materials they initially reported were not needed, such as two-gallon kitchen compost pails. Despite thorough planning, issues such as nonresponse and inconsistent participant feedback emerged, particularly in those cases where participants realized they were missing materials or required replacements. Providing quick resolutions to these issues while either currently en route for deliveries or having just completed scheduled deliveries, with the realization that additional trips would have to be made, was challenging and highlighted the need for a flexible, responsive approach to participant support. In studies with large participant cohorts, like those discussed by Requena-Sanchez et al. (2022), logistical support can enhance efficiency and ensure the

accuracy of the materials distributed. Furthermore, researchers should consider alternative distribution methods. For example, organizing a central materials pick-up event could streamline logistics, reduce the need for home delivery coordination, and minimize participant nonresponses related to delivery issues. If participants are geographically dispersed, mailing kits may be a viable option, provided that materials are lightweight and not bulky.

Implement Flexible Training and Technical Support Structures

Training and technical and logistical support were also significant components of the project and required a customizable approach to address various learning styles. We provided a variety of resources, including recorded training videos, live Q&A sessions, and comprehensive FAQ documents, to ensure that participants understood how to complete the logging process effectively. However, we encountered numerous situations where participants posed questions specific to their home environments that we could not have anticipated during planning. Responding to these inquiries required a degree of adaptability and problem-solving that extended beyond our initial training materials, underscoring the importance of developing adaptable, responsive support protocols that can handle unforeseen and evolving participant needs. For future projects, we recommend considering on-demand virtual help sessions or establishing a dedicated support channel where participants can submit specific questions, perhaps using an AI chatbot. Studies such as those by Pateman et al. (2020) also corroborate the importance of regular check-ins with participants, which we strove to provide for responsive support. These proactive actions can also mitigate participant fatigue by addressing any confusion that might arise during data collection and encouraging continued participation, leading to improved data quality, saving significant backend effort.

Consider the Impact of Participant Fatigue

Daily data logging can be demanding, particularly when data entry may be required multiple times in a single day, as our protocol stipulates. Participant fatigue was evident in our project through several

email exchanges provided by citizen scientists after completing the survey and in open-ended feedback provided within the survey itself. Future researchers may therefore explore alternative data collection methods that reduce participant burden. One approach could involve using less frequent, more concise data collection intervals or employing photo-based logging, where participants document food waste visually rather than through detailed written records. Requena-Sanchez et al. (2022) adopted such virtual tools in their waste characterization study, which allowed for more flexible reporting and could be replicated to alleviate participant fatigue in similar CS contexts.

Develop a Structured Plan for Data Management and Analysis

Managing data generated by CS projects requires meticulous organization and a highly structured process. Managing the personal metadata of participants, such as contact details and physical addresses while maintaining data security was essential for the project's integrity. We assigned each participant a unique ID that allowed us to anonymize their data during analysis. Establishing a secure method for storing this information and ensuring participant confidentiality were integral to our data-management protocol. The large volume of primary data collected in our project required extensive data cleaning and processing, underscoring the need for a robust data management strategy. Researchers are advised to allocate time and resources to establish clear data storage, cleaning, and analysis protocols before data collection begins. Utilizing cloud-based systems for data storage and access can streamline the workflow, especially in interdisciplinary teams. Studies like those by Pateman et al. (2020) illustrate the importance of early planning in managing data complexity, which can improve data accuracy and help teams meet deliverable timelines. Labor resources should be budgeted to account for these administrative tasks.

Foster Partnerships and Commitments with Local Organizations, but Be Aware!

In CS projects, collaborating with community groups, local governments, or nonprofit organizations, particularly those that have a vested interest in food system sustainability, can be invaluable in supporting participant recruitment, enhancing project credibility, and creating avenues for tangible intervention actions after the study ends (Pateman et al., 2020). While formalized partnerships with local organizations can increase the reach and impact of CS projects, researchers and practitioners should anticipate and prepare for the possibility of certain challenges or pitfalls. For our project, we had a letter of commitment from a local community composting company to support part of the research project on a fee-for-service basis. While the business's owner/operator expressed a commitment to the project at the time of grant submission, we were unable to continue our partnership due to the company's limited time and resource capacity. Therefore, when soliciting interest and formalizing engagement from a prospective partner to support a CS project, it is important to be explicit in laying out what the project will entail and what the partners' roles and responsibilities will be within a specific timeframe.

Conclusion

Overall, our CS project (see Campbell et al. [2025] for results from our Gainesville cohort) facilitated the collection of household-level food waste data that we consider critical to the refinement of a predictive ABM, demonstrating that CS is a viable—albeit complex—strategy for collecting household-level data for food waste projects. While we experienced a range of challenges (some anticipated and some not), we nevertheless believe future researchers and project facilitators can reduce logistical and administrative burdens for their own CS efforts by considering the following recommendations: design materials with research objectives and participants' needs in mind; secure adequate support for materials assembly and distribution; implement flexible training and technical support structures; consider the impact of participant fatigue; develop a structured plan for data management and analysis; and foster partnerships and commitments with local organizations while being cautious and aware.

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Appendix A. Sample Log Sheet

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Citizen Science Food Waste Kitchen Log	Week: XX	Day: XX

Section 1.

*Record the type of food discarded by serving size. *Do not discard meat in compost bin.*

Discarded Food Type	Breakfast	Lunch	Dinner	Snack	Other (e.g., pre-meal prep)
Meat-based protein*	0	.25	1	0	.5
Plant-based protein	.25	0	0	0	.25
Egg protein	.5	0	0	0	0
Dairy	.25	0	.25	0	.5
Fruits	.5	0	0	0	0
Vegetables/ Herbs	0	0	1	.25	.5
Grains	0	0	.75	0	0
Fats/Oils	0	0	0	.5	0
Inedible parts	0	.25	0	0	.5

Section 2.

Record the total weight (entering the value displayed on your digital luggage scale) of food discarded at the end of each day by weighing your compost bin after your final meal for the day.

Total Discard Weight for Day			
Pounds	4.6	Ounces	12

Section 3.

Indicate whether food was discarded today for each of the reasons listed below. Place a "✔" in the appropriate row if food was discarded today for that reason. If food was discarded more than once for that reason mark "✔✔."	
Reason for Discard	**Discarded Today?**
There were inedible parts	
Not cooked properly	
Food had blemishes or damage	✔
Past the date(s) on the product packaging	
Stored improperly	
It was "old" (i.e. past recommended storage time in fridge or pantry)	
It smelled or tasted "off"	
It was too little left to save	✔✔
There was too much, and I did not have space to keep it	
Ate out or had plans to eat out	
It was subject to a recall or public health advisory warning	
It was rumored to be part of a contamination outbreak	
Other (write-in response)	

Section 4.

Indicate whether each packaging/disposable item type listed below was discarded today. Place a "✔" in the appropriate row if a particular packaging/disposable item type was discarded. If food was discarded more than once for that reason mark "✔✔"			
Discarded Packaging Type	**Discarded Today?**	**Discarded Packaging Type**	**Discarded Today?**
[Plastic] Bottles		[Metal] Aluminum foil and trays	
[Plastic] Bags	✔✔	[Paper & Cardboard] Boxes	
[Plastic] Film and wraps		[Paper & Cardboard] Bags	✔✔
[Plastic] Containers		[Paper & Cardboard] Wraps	
[Plastic] Trays		[Paper & Cardboard] Composite materials	
[Plastic] Foam		[Disposable] Utensils	✔
[Glass] Bottles	✔	[Disposable] Cups	
[Glass] Jars		[Disposable] Plates and bowls	
[Metal] Aluminum cans		[Disposable] Straws	
[Metal] Tin cans		[Disposable] To-go containers	

Appendix B. Quick-Start Guide

Food Waste Citizen Science: Quick-Start Guide

Thank you for partnering with the University of Florida to become a Food Waste Citizen Scientist!

Welcome to the study! We appreciate your willingness to help us learn more about household food waste and factors that may contribute to food waste.

Here are some key things to know about your role as a citizen scientist in this study:

What is "citizen science?"
Citizen science is a form of participatory scientific research conducted with volunteers who participate in scientific procedures such as data collection to co-create knowledge with professional researchers. Citizen science allows volunteers to increase their knowledge, and citizen scientists help researchers collect data at a scale and in contexts where they otherwise would not be able.

What am I being asked to do?
As a citizen scientist in this study, you will monitor your food waste over a two-week period using the materials in your citizen science kit (see section below for materials checklist). You will complete a survey after the two-week food waste monitoring window closes. Completion of the data recording and providing your data via the Qualtrics survey will earn you $150 in compensation—via an Amazon e-gift card—for your time. Completion of a subsequent "post-project" follow-up survey in August can earn you an additional $45 in compensation.

Citizen Science Materials Kit Checklist
You will need the following materials to successfully complete your citizen scientist duties:

- o Kitchen Diary Instructional Guide & Log (this document)
- o 2-gallon compost bin
- o Digital luggage scale

Who to contact if you have questions or concerns?
For questions concerning this study, please contact [redacted].

We appreciate your willingness to join our team and help us improve our understanding of food waste!

Appendix C. Written Instructional Guide

Food Waste Citizen Science: Kitchen Diary Instructional Guide

This document should be used as a reference when adding entries to the Kitchen Diary Logs for Weeks 1 and 2

Overview

The kitchen diary log is the heart of the "citizen science" experience for this project. The log is what you will use to record your food waste for each day. We ask you to record the following for each day over the course of two weeks:

- **Amount of Food Discarded by Food Type** *(in estimated serving size)*
- **Total Weight of Discarded Food** *(per day in pounds value displayed on digital scale)*
- **Reason the Food was Discarded** *(check "✓" if food discarded for each reason listed)*
- **Types of Packaging/Disposable Items Discarded** *(check "✓" or if a given packaging/disposable item type listed was discarded)*

The data you are recording will be transferred to an online Qualtrics survey you will receive via email at the end of your two weeks of recording your data. Filling out your kitchen log each day will ensure that you have the data you need to contribute to this citizen science research project.

The log will be your reference to complete the 'Kitchen Diary Transfer' section of the citizen science survey, so please be sure to write as clearly as possible so you will be able to share your data with us.

Below, we provide definitions and instructions for each kitchen diary log category:

Section 1: Discarded Food Type Amount

A record of the estimated amount (in serving sizes in all but one case, where cups will be used) for types of food discarded per meal for the day. **You will estimate your serving size (or cups) to the nearest quarter (.25) of a serving (or cup).** Discarded food type categories include:

- *Meat-based protein (seafood, meat, or poultry)**
  Note: *DO NOT DISCARD MEAT IN COMPOST BIN – discard in trash, feed to pet, etc., instead*
- *Plant-based protein (beans, peas, or lentils)*
- *Egg protein (whole eggs or egg whites/yolks)*
- *Dairy (milk, yogurt, cheese)*
- *Fruits (whole, cut-up, dried)*
- *Vegetables/herbs (leafy greens, cut-up vegetables, chopped herbs)*
- *Grains (bread, tortilla wraps, cereal, pasta, rice)*
- *Fats/Oils (grease, olive oil)*
- *Mixed inedible parts (eggshells, stems, etc.; **recorded using 8-oz cups as a measure**)*

Section 2: Total Discard Weight for Day

Weigh your 2-gallon compost bin at the end of the day, when you will not discard any more. **Record the total weight in pounds, entering the value displayed on your digital luggage scale.** Because each citizen scientist will have the same bin, **you do not have to do a tare weight for it**.

Section 3: Reason for Discard

For each day, indicate the reasons that food was discarded by placing a checkmark (✔) in the row next to that reason. If you discard food more than once for that reason, make sure to note that. Reasons listed on your log are:

- *There were inedible parts*
- *Not cooked properly*
- *Had blemishes or damage*
- *Past the date(s) on the product packaging*
- *Stored improperly*
- *Was "old" (past recommended storage time in fridge or pantry)*

- *Smelled or tasted "off"*
- *Too little left to save*
- *Had too much and did not have space to keep it*
- *Ate out or had plans to eat out*
- *Subject to recall or public health advisory warning*
- *Rumored to be part of a contamination outbreak*
- *Other (write-in response)*

Section 4: Discarded Packaging/Disposable Items

For each day, indicate each type of packaging that was discarded by placing a "✔" in that row. If you discarded that type of packaging for more than once, note that. Packaging/Disposable item categories are:

Plastic Packaging
- *Bottles*
- *Bags*
- *Film and wraps*
- *Containers*
- *Trays*
- *Foam*

Glass Packaging
- *Bottles*
- *Jars*

Metal Packaging
- *Aluminum cans*
- *Tin cans*
- *Aluminum foil and trays*

Paper and Cardboard Packaging
- *Boxes*
- *Bags*
- *Wraps*
- *Composite materials*

Disposable Utensils & Serviceware
- *Disposable utensils*
- *Disposable cups*
- *Disposable plates and bowls*
- *Straws*
- *To-go containers*