Food Loss Food Waste Portfolio Evaluation

Executive Summary

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Executive Summary

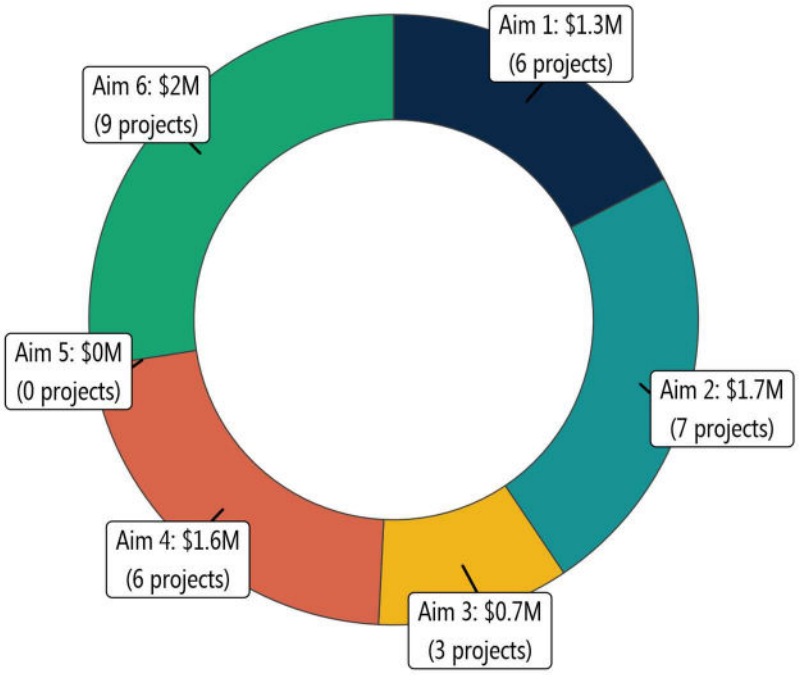
Successful innovations focused on food loss and waste—including technology, models, and monitoring tools—have the potential to yield significant social, environmental, and economic benefits. Addressing the nearly one-third of all food that is lost and wasted in the United States each year could improve food security for vulnerable populations while saving farmers, businesses, and consumers billions of dollars (ReFED 2025). Furthermore, minimizing food loss and waste could significantly reduce greenhouse gas emissions, conserve critical water resources, and ease pressures on agricultural land use, including deforestation. The Foundation for Food & Agriculture Research (FFAR) plays a leading role in addressing food loss and waste through its Food Loss and Food Waste (FLFW) Portfolio. With an investment of approximately $15 million across 11 funded projects from 2017–2025, the portfolio aims to address critical points along the food system and value chain—from harvest to household—to reduce waste, improve food security for vulnerable populations, and mitigate environmental impacts on both a regional and global scale.

The work of the portfolio investments was guided by six major aims:

1. Identify behavior drivers that contribute to food loss and waste across the value chain.
2. Improve food loss and waste measuring, monitoring, and reporting for more informed decision making.
3. Create decision-making tools and models to reduce food loss and waste.
4. Develop, modify, or improve post-harvest, processing, storage, and transportation technologies and strategies to reduce food loss and waste.
5. Improve food security for vulnerable populations by making foods more available and accessible.
6. Support opportunities to enhance the skills and capacity of the next generation of food loss and waste scientific workers.

All projects worked to advance at least one of these portfolio aims, and most supported multiple aims (Figure ES 1). Because most projects involved students or early-career scientists, nearly all—nine out of 11 projects—supported Aim 6. Aim 2 was the second most common in the portfolio, with seven projects working to improve food loss and waste measuring, monitoring, and reporting tools. No projects addressed Aim 5, as none of the innovations or tools supported by the portfolio were specifically targeted at reducing food insecurity for vulnerable populations.

Figure ES 1. Distribution of FFAR Funding Across Portfolio Aims and Projects



Notes: Calculations assume that projects addressing multiple aims divide their funding equally across the aims on which they work; data did not allow for disaggregation so the distribution of funding should be treated as illustrative but not precise.

FFAR contracted Mathematica to assess the innovations being developed across the 11 projects and understand these projects' progress toward FFAR's portfolio aims. Mathematica used a thematic mixed-methods evaluation approach to collect and analyze data from a variety of sources to draw out key lessons and findings that inform implementation and future portfolio investments, and assess the extent to which projects contributed to the overall aims for the FLFW portfolio. Mathematica also incorporated FFAR's scale of Stages of Research, Development, and Deployment (SRDDs) to assess portfolio progress on the development of tools and technologies from the proposal stage to the end of the funding period. The evaluation also includes an analysis of gaps in the FLFW field, opportunities for future investment, and an assessment of the sustainability of the research funded by the portfolio.

Synthesis of Findings

Knowledge Generation Around Behavioral Drivers of Food Loss and Food Waste

FFAR's investments significantly advanced understanding of the behavioral drivers of FLFW. Six of the 11 projects focused on this aim, paying particular attention to consumer behavior, supply chain dynamics, and marketing practices. Our evaluation found that the funded projects generated a significant amount of new knowledge around behavioral drivers—as well as other FLFW-related topics—and evidence that these findings have reached a range of end users, including academic, private sector, and public sector actors. Grantees highlighted their work leading to additional scientific research, demonstrating how the advances in knowledge generation from FFAR-funded projects may lead to additional knowledge generation

related to FLFW. Both grantees and match partners also highlighted the ways in which new knowledge generation opened doors to working with industry partners by demonstrating the potential benefits of technological innovations to those private sector partners.

> "That project was insightful because it helped start the conversation for opportunities to understand the causes of food waste…Having the data helped open up those conversations. There was more food loss left in the field than anticipated and once those were measured, it helped communicate on the farm and across the supply chain."
>
> *[Match Partner]*

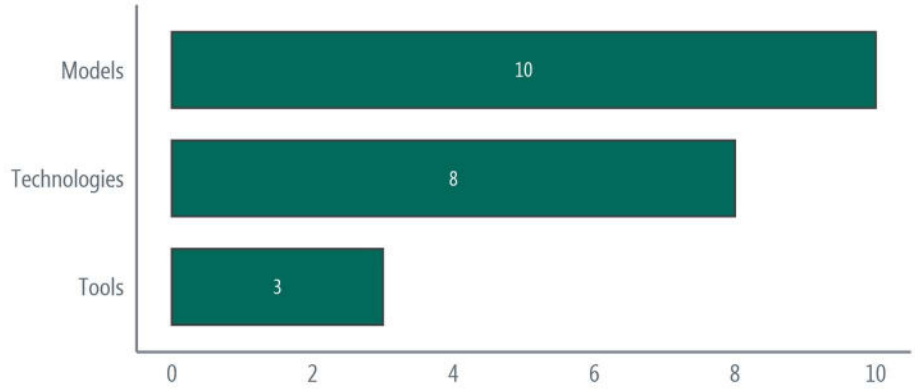
Grantees have published extensively on behavioral drivers of FLFW, including original research and syntheses of research. Grantees produced more than 200 peer-reviewed publications and other dissemination products, including webinars, symposia, and industry briefings; these products were related to their FLFW work on behavioral drivers but not all were supported directly by FFAR grant funding. Stakeholders noted that this research helped start the conversation about food loss at the farm level and informed strategies across the supply chain. Despite the breadth of dissemination, some experts questioned whether additional research on behavioral drivers was needed, suggesting that a shift toward outreach, scaling, and implementation-focused work may have a greater impact, given the existing literature on behavioral drivers that has already identified many potential solutions in need of implementation.

> "This has put us on the map with the corporate offices, retailers, etc. There is now exposure and they are trying to fold [findings from our research] into contracts or procurement practices. This is now also something farmers are interested in mitigating or getting help on, especially finding ways to sell their surplus."
>
> *[Grantee]*

Development of FLFW Innovations (Tools and Technologies)

All 11 projects developed new models, technologies, or tools aimed at reducing FLFW, with a total of 21 new innovations across the projects (Figure ES 2). These innovations ranged from slower-melting antimicrobial ice and AI-powered compost bins to decision support models and food byproduct processing technologies, covering nearly the full value chain from farm to fork and a wide range of food products. Most innovations were in the early stages of development at the start of the grant period; researchers used FFAR funding to build on an idea or preliminary prototype that had been tested in a laboratory setting and conduct more extensive testing. With the focus on early-stage research, most projects advanced only as far as the laboratory, field, or commercial trial stage by the end of their funding period. In some cases grantees were able to take the results from the FFAR-funded research to secure additional funding to conduct additional research or outreach. In this way, FFAR serves as a catalyzing force for the development and dissemination of innovations in the FLFW space. Although the funding was instrumental in advancing these individual innovations, some experts questioned the potential impact of funding very specific technological solutions to small segments of the value chain—targeting, for example, a single type of food byproduct—on ultimately reducing FLFW more broadly.

Figure ES 2. Projects Developed New Innovations



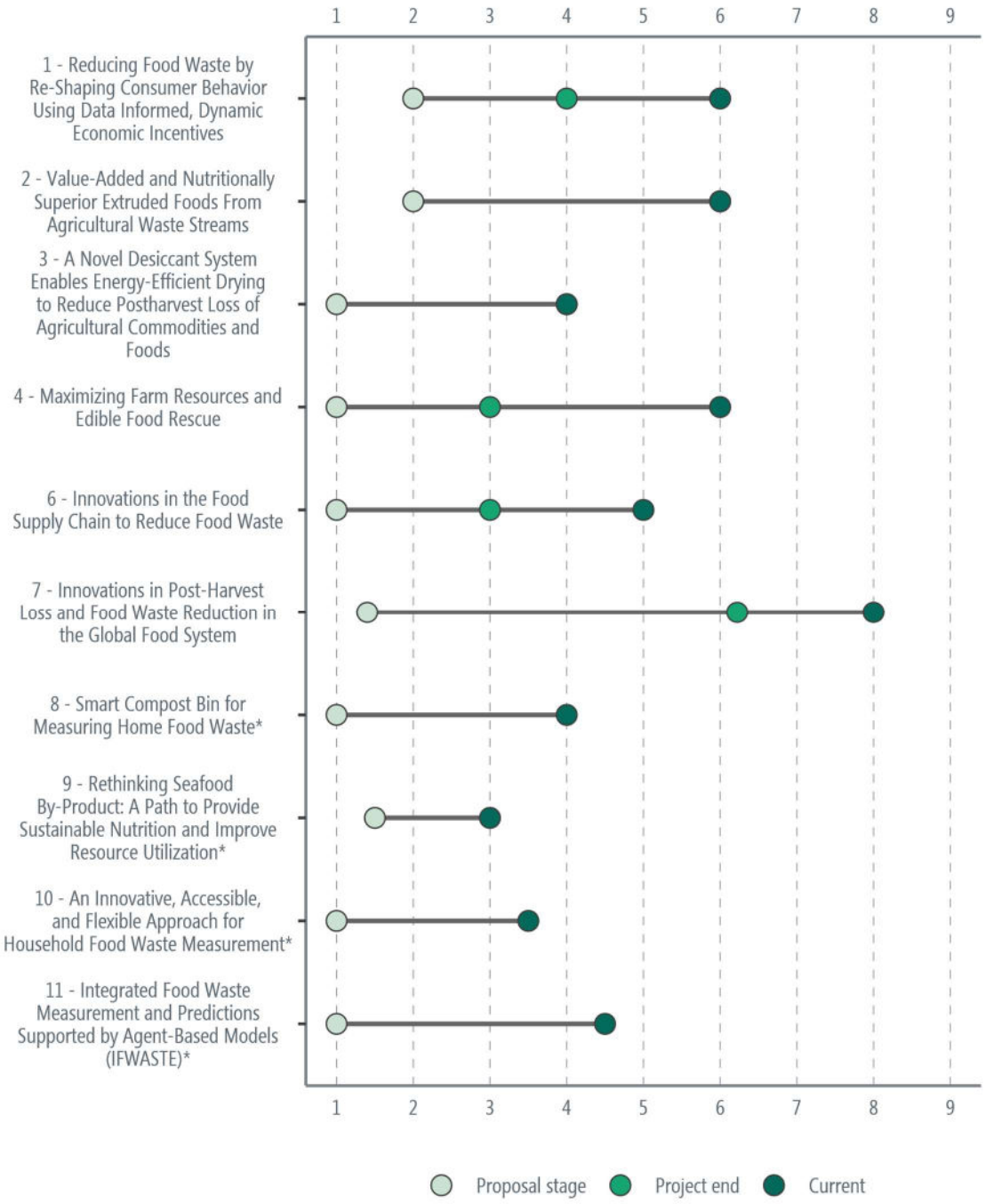
Adoption of Innovations

Public or private sector adoption of innovations remained limited during the funding period. Achieving adoption of the innovations developed was not within the scope of work for many of the grantees; most were university researchers whose attention was on developing the proposed FLFW tool, technology, or model. Some grantees reported interest from industry partners, particularly in food storage and processing technologies. As an example of private sector engagement, one grantee developed a model that has helped processors develop a more comprehensive understanding of and response to food spoilage—whereas processors previously blamed farmers for spoiled product, they now were starting to develop new testing protocols based on what they learned from the models. Most projects are still in too early a stage to have led to commercialization yet, and in some cases barriers such as cost, complexity, and lack of manufacturing infrastructure hindered commercial adoption and scale-up.

Public sector adoption was similarly limited, with some instances of engagement with public actors but no reported policy changes or government uptake of innovations. In some cases, the work has progressed toward engagement with public and private sector actors, supported by other funding sources or researchers' pro bono time, suggesting that FFAR's investments may be a catalyst that can lead to impacts even if they are beyond the grant period. Some projects that are progressing are still in too early a stage to have led to adoption at the time of the evaluation, and many grantees and stakeholders lacked funding to cover outreach and implementation of the types of innovations developed by this portfolio.

To summarize FFAR grantees' progress idea to deployment, we relied on FFAR's Stages of Research, Development, and Deployment (SRDD) framework. All projects began at SRDD Level 1 or 2, with a potential solution to an FLFW challenge or a proof of concept of a solution to a FLFW challenge; these reports emphasize the early-stage nature of most of the investments (Figure ES 2). Half of grantees reported that their SRDD at project completion was Level 3, indicating that the work was still undergoing controlled laboratory research, while some progressed further toward outreach and commercial piloting. In some cases, innovations have progressed since project completion. However, project teams' ability to take innovations to higher SRDD levels depends on additional funding and/or PIs' willingness to work on advancing the technologies without outside funding—which was reported in some cases—so progress toward adoption after the close of the funding period was inconsistent across the projects.

Figure ES 2. Change in Project SRDDS Between the Project Proposal and End Stages



Notes: SRDD scores were determined via interviews with project stakeholders and validated when possible. Project 5 in the FLFW portfolio was omitted from this analysis due to lack of data because this grantee was unavailable due to federal restrictions.
Project 7 was a consortium of multiple technology innovations, so the SRDD score in this figure represents a composite score of the SRDDs for each innovation. The current SSRD score reflects a weighted average of current scores when available and the project end scores from consortium members who did not provide current scores.
Projects 8, 9, 10, and 11 (denoted with "*") are ongoing so there is no SSRD score available for project end.

Food Loss, Food Waste, and Food Security

Because of the focus of the portfolio on early-stage research and the relatively short time between project close-out and the evaluation, it is too early to observe any reductions in food loss or food waste, although most grantees discussed ways in which their work could—if adopted—lead to those outcomes. Although improving food security was one of the portfolio's stated aims, none of the projects directly targeted food-insecure populations or measured impacts on food access. Some grantees discussed the potential for their innovations to contribute to food security in the future—such as through food rescue or price reduction strategies—but these outcomes were not within the scope of their funded work. As a result, the evaluation found no direct evidence that the portfolio improved food security during the grant period.

Scientific Workforce and Expertise on Food Loss and Food Waste

FFAR's investments made a strong contribution to building the next generation of FLFW researchers. Across the portfolio, 371 early-career scientists and students received training, with most projects involving undergraduate and graduate students in research activities. Most trainees were undergraduate students, and the largest contingent of students trained under FFAR-funded projects was one of the innovation teams within the consortium project, which provided training and growth opportunities to more than 250 undergraduate students. Projects also trained some master's students, PhD candidates, and post-doctoral fellows.

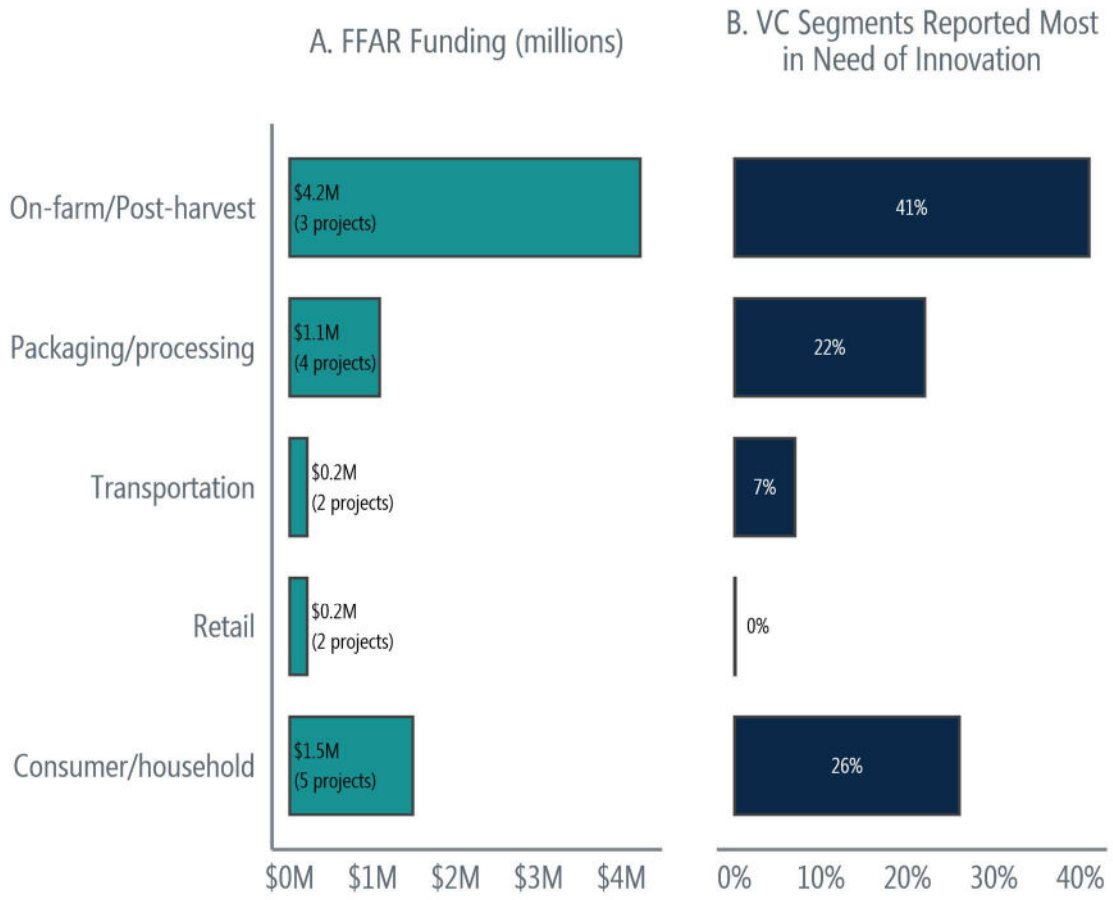
The high rate of research productivity on some projects provided ample opportunities for students to get their names listed on published research and improve their future career prospects. Students are listed as co-authors on many of the reports that resulted from FFAR-funded projects (see, e.g., Herron et al. 2022; Kataria et al. 2020). These opportunities provided students with exposure to interdisciplinary research and, in some cases, led to career advancement in the food and agriculture sector. For example, a student central to one grant-funded project went on to acquire an MBA so they could continue working in the food sciences on the industry side, and a number of students involved in research continued similar research into doctoral and post-doctoral programs.

Analysis of Gaps in FFAR's FLFW Portfolio

The evaluation identified several areas where FFAR's investments could be better aligned with sector needs. Consumer-level food waste, which accounts for the largest share of FLFW in the United States, was underrepresented in the portfolio. Moreover, although consumer preferences are a leading driver of household food waste, few projects directly addressed this issue. Stakeholders—including grantees and FLFW experts—highlighted a range of priorities that varied, depending on the ultimate goal of the work; for example, they ranked post-harvest food loss as the most crucial to address food security and consumer food waste as the most important regarding environmental impacts. Additionally, some highlighted the need for more investment in communication, education, and training, and a greater focus on implementation and adoption. Finally, while the narrow focus of many of the grantees' work on specific technological innovations or small segments of the value chain addresses FFAR's aims of developing new tools and innovations and building scientific knowledge in the FLFW space, research aimed at understanding how to implement known solutions at scale may be needed to meet the aims of reducing FLFW and improving food security for vulnerable populations.

FFAR's investments are spread across the value chain, with investments in the on-farm and post-harvest value chain segments accounting for the largest share of FFAR's portfolio—approximately $4.2 million (Figure ES 3). At the same time, food loss at this point in the value chain represents less than one-fourth of all FLFW in the United States, second to consumer-level food waste, which accounts for more than one-third (EPA 2021; ReFED 2023). Global and U.S.-focused studies have similarly reported consumer food waste as the most important sector in the value chain in quantity (Gustavsson et al. 2011; Gunders 2012). Consumer-level investments represent the second-highest share of the FFAR portfolio, at $1.5 million. Increasing impact on FLFW broadly could require aligning FFAR's investment portfolio with the area of greatest need and increasing resources dedicated to consumer-level food loss.

Figure ES 3. FFAR's Investments Across the Value Chain vs. Value Chain Segments Most in Need of Innovations to Reduce Food Loss and Food Waste



Source: Grantee reports (Panel A), FLFW expert survey (Panel B).

Notes: N = 11 projects for Panel A; N = 27 survey respondents for Panel B.

Panel A calculations assume that projects divide their funding equally across the value chain segments in which they work. Only two projects addressed multiple value chain segments. We calculated FFAR investment in each value chain segment by dividing each project's budget by the number of value chain segments in which it worked and then calculating the sum of fractional budgets by value chain segment.

Given the portfolio's focus on research into developing new technologies and innovations, we also compared FFAR's investments with the value chain segments that stakeholder survey respondents believe are the highest priorities for technological innovations (as opposed to action more broadly, which could

include interventions like education programs that are out of FFAR's current scope). to mitigate FLFW. The highest portion of survey respondents (41%) selected on-farm and post-harvest as the most important value chain segment for innovating to reduce food loss, reflecting alignment between FFAR's priorities and expert opinion. The next largest shares of FFAR's FLFW portfolio investment were invested in work at the consumer/household level and in packaging and processing ($1.1M). These value chain segments were rated as the highest priority for innovation to reduce food loss by 26% and 22% of respondents, respectively. Transportation and retail account for a very small portion of FFAR's investments into FLFW, and fewer respondents selected these sectors as the most in need of technological innovation.

Conclusions and Recommendations

FFAR's FLFW portfolio has laid a strong foundation for innovation and capacity building for the future of the scientific workforce, and many projects have shown signs of success. To build on this momentum, the evaluation recommends that FFAR adopt a more strategic approach to partnership, scale, and portfolio design. This approach could include forming partnerships with funders that specialize in later-stage activities, such as pilot testing, commercialization, and policy engagement. These partnerships could help ensure that promising innovations do not stall after the initial research phase. Most match partners did not play that role and many did not stay involved with the projects team beyond their initial funding. Projects in the portfolio that have made greater progress toward adoption or commercialization have strong collaborations with industry partners (not necessarily the partners providing matched funding), demonstrating the importance of this kind of collaboration for moving these projects out of the lab.

The evaluation also recommends that FFAR develop a more comprehensive theory of change (TOC) that integrates the SRDD framework with broader food system outcomes. Such a TOC would help clarify how innovations are expected to lead to impact, identify key transition points, and guide strategic decisions about where to invest. Additionally, FFAR should consider more frequent assessments of its funding priorities against expert-identified needs, particularly in areas like consumer behavior and food preferences that account for a large share of FLFW, and in ultimate outcomes like food security that are not addressed in the current portfolio. With these refinements to its existing grant-making strategy, FFAR could be well positioned to amplify its influence and help drive systemic change in how food loss and waste are addressed across the food system.

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