VII MSU Food Assistance Packaging Solutions Workshop
Michigan State University School of Packaging

November 13-15, 2024

Food that is not safe is not food. Food that is not packaged effectively is neither safe nor nutritious.

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2024 Food Assistance Sustainable Evidence-based Packaging Agenda

The FASPA Report

Table of Contents

I. Introduction

Sustainable, fit-for-purpose food packaging is a critical component of food assistance and nutrition programming, ensuring the safe and timely delivery of life-saving nutritious foods. Inadequate packaging can render an entire food assistance program unsustainable. The 2024 USAID-funded **VII Food Assistance Packaging Workshop Series** and hosted by the Michigan State University School of Packaging, aimed to convene key food assistance stakeholders to assess the status of food aid commodity packaging, address challenges, explore new technological advances, propose solutions, and identify next steps for optimizing food aid packaging. This year's workshop, held in person in East Lansing, marked the seventh iteration of this annual technical event and was attended by sixty-nine (69) stakeholders in person and forty (40) online.

The workshop series allows for the identification and development of actionable steps to address challenges using readily available technologies, alongside opportunities for research and innovation. It typically brings together a diverse range of stakeholders, including commodity suppliers, technology vendors, academia, food assistance implementing partners, and research organizations. These discussions, centered on specific packaging themes and topics, as in the agenda in Annex II, often lead to the formation of working groups tasked with advancing an evidence-based, sustainable packaging agenda, as captured in this **FASPA Report**.

II. The Food Assistance Sustainable Evidence-based Packaging Agenda (The FASPA Report)

Reinforcing the interconnections among food packaging, food safety and quality, nutrition, and health was a primary focus of the 2024 workshop. Under the theme "Food that is not safe is not food, and food packaged inappropriately is not safe," the event highlighted the critical role of packaging in sustaining cost-effective food assistance programs. Experts from the U.S. Food and Drug Administration (FDA), the World Packaging Organization (WPO), and the World Food Program (WFP) underscored this importance. As in previous years, packaging sustainability was also a central theme, as reflected in the agenda provided in Annex II.

Over the past decade, the U.S. Government, its partners, the commodity industry, and a diverse range of other stakeholders have intensified efforts to innovate food aid packaging. These efforts have led to the identification, testing, and piloting of promising packaging technologies and solutions which were discussed at the workshop. Key initiatives reported in 2024 include intentionally infesting specialized packaging in laboratory contained settings, to test them against infestation and evaluate their resilience across the supply chain; developing packaging integrity testing methods; conducting commodity shelf-life studies; performing packaging life cycle assessments; and redesigning packaging functionalities to enhance food safety, nutritional quality, and distribution efficiency.

Increasingly, there is recognition of the advantages of building local capacity and localizing food packaging, shipment, and storage through partnerships with local actors. This approach offers significant benefits for both humanitarian and development initiatives. Packaging food closer to its point of distribution minimizes risks to food safety and quality, enables more efficient programming, and strengthens partnerships with local governments and organizations. It also fosters capacity-building and stimulates innovation through packaging technology spillover effects. To advance a sustainable food packaging agenda, USAID has over the years collaborated closely with suppliers and implementing partners. Together, there have established packaging working groups focused on priority areas and sustained active engagement throughout the year to address key challenges and advance the food aid packaging research and innovation agenda. These collective efforts have led to notable improvements in the quality, functionality, and performance of packaging across the supply chain.

The broader sustainability framework adopted by USAID and its partners emphasizes responsiveness to environmental and climate change concerns. It prioritizes reducing food infestation, waste, and losses while maintaining the cost-efficiency of food assistance programs. Beyond protecting the integrity of food, packaging delivers additional value chain benefits, such as convenience at the last mile—particularly at points of distribution—and supports more dignified food aid programs. These efforts collectively aim to save lives and improve living conditions in under-resourced regions where humanitarian food assistance is most critical.

2.1. The 2024 FASPA Report

An important goal of each packaging workshop, and in between, is to identify collaborating opportunities among groups of stakeholders, and build a common agenda, leading to the solution of the various packaging and supply chain challenges, sustainably. That's what *FASPA,* or simply **The FASPA Report** is: a *Food Assistance Sustainable Evidence-based Packaging Agenda*, outlining steps forwards to solving major packaging challenges, sustainably. This effort shall ultimately lead to achieving more sustainable humanitarian food assistance programs.

For full access to recording and to this and other resources, presentations at the workshop, please go to the following the: Food Aid Packaging Solutions workshop website.

III. Relevant workstreams discussed and included in this 2023 FASPA Report

3.1 The Broader Food Assistance Sustainable Packaging Solutions and Systems

A robust discussion was held around exploring options to reduce environmental impact throughout the food assistance supply chain with a focus on packaging. As a

viable pathway, it is being agreed to jointly work on food and packaging waste measuring and management, including approaches that integrate reverse logistics. This turns packaging waste back into a valuable product, achieving a business model that ensures environmentally sustainable procurement and food distribution within local and regional circular economies. Currently, there is very limited food and packaging waste collection services and infrastructure on waste recycling and safe disposal, which aggravates the environmental, public and climate impacts of waste.

One of the biggest challenges facing sustainable packaging implementation is to find a balance between environmentally sensitive packaging materials and the ability of packaging technologies to ensure adequate shelf life and appropriate protection of food integrity.

Persistent challenges include limited waste collection services, which might lead to improper disposal methods such as dumping and burning. The Global Logistics Cluster's environmental sustainability project, of which USAID and its partners are part, aims to address these challenges by increasing awareness and supporting best environmental practices. The circular economy approach prioritizes waste prevention and sustainable packaging, emphasizing the need for access to recycling and proper disposal methods. Challenges include the lack of access to energy recovery and treatment/disposal options. Discussions at the MSU VI food aid packaging workshop raised questions about the continuum of waste management programs and the need to establish a globally supported Food and Packaging Waste Management Cluster, leveraging the learning from specific case studies such as the Cox Bazar Refugee Settlement in Bangladesh and waste collection and management in Pakistan (WFP project).

Further discussions explored various potential solutions, including investing sustainable packaging material, in repurposing packaging materials, involving communities in waste management plans, incentivizing green suppliers, and implementing waste collection programs. Proposed solutions range from establishing collection programs at the community level to developing reusable packaging options and training programs for waste disposal. An agreed approach to addressing food and packaging waste related to humanitarian food assistance programs and beyond is the ***Circular Food Assistance*** model, which involves turning waste into useful products while providing skills development and income opportunities for refugees. Overall, it emphasizes the importance of collaboration across sectors and stakeholders to address environmental challenges in humanitarian supply chains. A need for humanitarian actors to support food suppliers in implementing sustainable practices was also highlighted. Finally, it was acknowledged that environmental sustainability should be made the responsibility of everyone along the supply chain.

More sustainable packaging and responsible packaging waste management continue to grow in importance by all stakeholders of food assistance. The main

focus in 2025 will be to pilot the many good ideas to gain insight from our colleagues running programs and the participants who will ultimately benefit. To further impact, the private sector will also be engaged at all of the steps along the supply chain.

Specifically, USAID and WFP plan to collaborate with each other and partners through 2025 on the following plans:

- Identify options to replace metallized flexible laminate used for specialized nutritious foods (SNF): WFP will continue the work initiated to tests alternative materials (e.g. mono-material, paper based solution) in collaboration with the private sector
- Study compostable film for LNS through shelf-life studies. Additional tests and trial will be planned as needed to validate the film.
- Conduct field tests with improved vegetable oil can functionality, including the repurposing of cans
- Pilot a reverse logistics project in the field, especially to manage the multi-layer sachets
- Further harden the supply chain, including critical packaging, to additional risks caused by climate change
- Identify locations for collaboration with other parts of USAID and the private sector on recycling efforts at the humanitarian-development nexus
- Continue the work on the development of more durable polypropylene woven bags, pending additional funding
- Gather good examples from program participants of how packaging is repurposed to make sure that any of our future waste management efforts are not removing a key disaster recovery resource
- Continue Joint Initiative activities through USAID partners like WFP, Logs Cluster, and those involved with the QSE Procurement Group. BHA funding is shifting to donor coordination on greening to improve efficiencies and reduce the burdens on partners

3.1.1 The Joint Initiative (JI) for Sustainable Humanitarian Assistance Packaging Waste Management

The Joint Initiative (JI), a USAID-coordinated global effort comprises 26 humanitarian stakeholders, investing jointly on reducing the environmental footprint of humanitarian food assistance programs, using a holistic approach and fostering information and knowledge sharing, globally. Reducing packaging is crucial due to recycling challenges. Packaging can be reused or repurposed through innovative designs, but improper handling can be harmful to not only the local environment, but also human health. Collaboration among humanitarian organizations, donors, governments, and private waste management entities is essential.

Scope of work. Understanding the quantity and types of packaging used by humanitarian organizations is essential. An assessment revealed that in 2021, 6.77 million metric tons (MT) of food and non-food items (NFIs) were procured by 12

humanitarian organizations. This procurement resulted in 33,000 tons of primary and 35,600 tons of secondary packaging, totaling approximately 3 billion packaging units. The findings showed that 50% of packaging consisted of cardboard boxes, 32% plastics, 10% tin cans, and 8% sachets. Notably, 43% of the packaging weight comprised vegetable oil, followed by ready-to-use therapeutic foods (RUTFs) at 14%, lipid-based nutrient supplements (LNS) at 13%, rice at 6%, and other items at 24%.

Progress Report. The JI created a Packaging Baseline Assessment tool and a Working Group (WG) focused on metalized laminated sachets, which represented 13% of all primary packaging. The WG aims to address packaging waste challenges through collaboration with organizations and suppliers.

Reuse, Repurposing, and Recycling. The initiative developed a decision tree to guide appropriate packaging waste management methods in humanitarian operations based on material, country context, and the 5 Rs (reduce, reuse, recycle, recover, and redesign).

In 2024, the Joint Initiative slowly pivoted away from packaging waste management and towards donor coordination on greening of humanitarian assistance. The humanitarian community and private sector have made significant progress over the last five years, and are much more prepared to carry on with the activities that were coordinated by the JI. Humanitarian partners identified that better coordination amongst donors, to lower the burden of reporting and increase transparency of which environmental actions would be supported, would be a more transformational effort at this time. Packaging and plastics waste reduction and management is still included in the JI's mandate, as it is called out in the Humanitarian Aid Donors' Declaration on Climate and the Environment.

The Joint Initiative still made important progress on sustainable packaging and waste management in 2024. A compendium of case studies was published with insights including Action Contre la Faim's (ACF) pilot of kraft paper bags for food and seed storage in Madagascar, WFP's effort to create plastic-free e-voucher shops in Bangladesh, and Acted's holistic approach to reduce and manage waste in Lebanon. Another major line of work was to host panels and events across multiple events such as the Humanitarian Networks and Partnerships Week, the European Humanitarian Forum, and co-hosted events with the Climate Action Accelerator and Logistics Cluster. Find publications, recording, and follow along with future updates on the Joint Initiative's LinkedIn page.

3.2 Food Infestation Packaging Technologies, Management and Solutions

At the meeting, a panel discussion on "Packaging Technologies and Food Infestation" highlighted progress in designing sustainable, infestation-resistant packaging for food aid commodities. Experts from USAID's Technical and Quality

Division, the DoD's Natick Soldier Lab, ProAmpac, and USDA's Agricultural Research Service (ARS) presented updates on innovative solutions to enhance packaging durability and resistance against field infestations. Key considerations emphasized included scalability, affordability, puncture resistance, and heat-sealibility, with trials revealing areas of significant progress and opportunities for further refinement.

Dr. Deanna Scheff (USDA/ARS) shared findings from entomological studies that influence packaging design, focusing on the optimization of microperforation size and adhesive applications to enhance protective performance while balancing air evacuation. Nicole Cocuzzi (ProAmpac) discussed hybrid packaging innovations that combine structural resilience with improved sealant technology, showcasing the benefits of these materials enabling effective heat-sealing of bags and subsequently reducing insect penetration risks and maintaining food quality.

The workshop emphasized the importance of experimental designs that mimic real-world conditions—such as the heat and humidity typical in regions like East and West Africa—where food aid is stored, transported, and distributed. By simulating these environmental challenges, research would more successfully lead to developing packaging solutions with global applicability and scalability.

Looking forward, strategic priorities include:

a) Continued development and testing of high-performing packaging prototypes with enhanced heat-sealant performance and resistance to field stresses, specifically infestation.
b) Enhanced educational efforts at the last mile and beyond, on proper handling practices.
c) Exercise comprehensive cost-benefit analyses of improved packaging designs leading to scalable and cost-effective solutions.
d) Collaborative R&D efforts to identify scalable solutions addressing infestation challenges while reducing environmental impact.

The panel underscored ongoing challenges, such as improving heat-sealibility and preventing unintended bag openings, which increase vulnerability to infestation during field use. By leveraging partnerships and stakeholder feedback, the ultimate goal is to refine packaging systems that balance performance, sustainability, and cost-effectiveness.

3.3. Implementation of Key Performing Indicators (KPIs) for Packaging Quality Monitoring

The implementation of Statistical Process Control (SPC) in food aid manufacturing was a key focus of this session at the workshop, emphasizing the use of SPCAID, a USAID-funded open-source, excel-based tool developed to enhance quality

monitoring in global food aid production. SPCAID distinguishes between natural process variations and assignable causes, enabling manufacturers to maintain products within specification limits. The tool supports essential quality metrics such as nutritional content, packaging integrity, and process capability (CP/CPK) values. By allowing customization of KPIs, suppliers can focus on critical packaging elements like seal strength, nitrogen headspace levels, and leak detection, ensuring both product safety and durability.

Food aid industry experts highlighted how SPCAID is already contributing to preemptive quality management, identifying and correcting potential production issues before they escalate. Key metrics such as tensile strength, burst strength, residual oxygen in filled bags, and headspace analysis were discussed as early indicators of packaging integrity, with a focus on preventing failures during transport and storage. SPCAID's adaptability to various production scenarios makes it an effective and accessible solution for manufacturers across the supply chain. Additionally, the tool includes resources to standardize data collection, such as sampling calculators and adherence to ANSI ASQ Z1.4 guidelines, ensuring consistency and relevance in data analysis.

Strategic priorities for SPCAID for 2025 include expanding its application both in terms of relevant KPIs within a specific manufacturer, as well as in terms of a broader range of commodities (e.g., rice, oil, and flour) and integrating advanced features such as AI for predictive maintenance. Training and onboarding programs for suppliers are essential for ensuring effective adoption and customization of the tool. Plans for global accessibility include hosting SPCAID on a centralized platform, allowing interagency and supplier collaboration to refine the system and establish uniform quality standards. By leveraging feedback from pilot programs, SPCAID aims to improve operational efficiency, enhance food safety, and reduce waste across diverse production environments.

3.4. Packaging and Commodity Shelf Life and Raw Ingredient Quality

The discussion on "Packaging and Commodity Shelf Life and Raw Ingredient Quality" emphasized the challenges of ensuring the safety and stability of food aid commodities under variable conditions. The concepts of "best if used by" and "use by" dates was discussed, highlighting the need for clarity and improve decision making when managing commodity disposition in the field approaching or past their best if used by dates. Regulatory complexities might complicate global food aid distribution, with some countries enforcing strict shelf-life requirements, such as certain East Africa countries mandating that 75% of a product's shelf life remains upon arrival. These challenges are amplified by unpredictable transit conditions, including extreme heat and humidity, which can accelerate degradation of both packaging and food products. It was discussed the role of environmental factors impacting shelf life of commodities, such as wild temperature fluctuations and humidity in some regions, with direct influence on nutrient loss and product spoilage. Recent examples include sensitive micronutrients like Vitamin A in fortified oils,

prematurely aging super cereal plus and soy corn blends, leading to diminished nutritional value over time.

Current strategies, including accelerated shelf-life studies, were noted for their limitations in replicating real-world conditions. Stakeholders and experts called for more robust, data-driven solutions, such as real-time monitoring of environmental conditions and advanced predictive modeling, to better anticipate risks. Collaborative efforts between the agencies, US Government, packaging and commodity suppliers were highlighted as essential to improving shelf-life protocols, especially in regions with unique regulatory demands and challenging supply chains.

To address these issues, specific steps forward were proposed, including running additional shelf-life studies both accelerated and real life, of more vulnerable commodities currently showing accelerated aging and spoilage. It was also pointed as a necessity to continue improving packaging technologies both in terms ensuring appropriate film construction and designs, as well as packaging sealing and the monitoring of packaging integrity. Enhanced nutrient stabilization technologies, such as microencapsulation, were also recommended to prolong product integrity. Additionally, the importance of establishing standardized protocols for shelf-life testing, aligned with international agency standards, was underscored to ensure consistency and resilience across global food aid supply chains. Such steps aim to minimize spoilage, improve efficiency, and maintain the nutritional quality of food aid commodities in diverse and often unpredictable settings.

3.5. The Packaging Standardization Project[1]

Significant progress was reported on packaging standardization of key food aid commodities. The lack of standardization of humanitarian food packaging sizes and shapes has been associated with significant challenges throughout the supply chain. It includes issues with stackability in warehouses, traceability, containerization, handling, and challenges during final distribution at the last mile. For the last three years, suppliers of both Super Cereal Plus (SCP) and Ready to eat Therapeutic/Supplementary foods (RUTF and RUSF) have carried out re-evaluation of current packaging specifications for these products with the aim to identify designs that allow for standardization among suppliers.

[1] This packaging standardized approach addresses current logistical challenges while ensuring packaging resilience, shelf life of commodities, as well as operational (manufacturing) feasibility that allows economic sustainability of the food aid programs as a whole.

a) Technical and Implementable Instruction Summary for LNS Packaging Standardization

1. ***Dimensions***: Standardize carton footprints while tailoring heights based on product types: RUTF: 14.875" (L) x 11" (W) x 7" (H); RUSF: 14.875" (L) x 11" (W) x 8.25" (H). Additional heights continue to be under review to align with specific product sizes, aiming for efficient warehouse stackability and transit compatibility.
2. ***Strength Testing***: Transition to a 60 ECT (Edge Crush Test) for carton strength, replacing burst or Mullen tests. This ensures durability under extended stacking and harsh transportation conditions.
3. **Palletization Guidelines.** Pallet Size: Standardize to 40" x 48" pallets, per USAID recommendations.
4. ***Stacking Patterns***: First three layers column stacking for compression resistance. Remaining layers brick or interlock stacking to enhance stability.
5. ***Maximizing Efficiency***: Maintain a single pallet height of 43.8 inches to fit a 20-ft container with 900 cases per load.
6. ***Material and Handling Recommendations***. Stretch film of 23-micron blown polyethylene stretch film for secure containment, capable of stretching 250-300% to a 6 mm thickness.
7. ***Pallet Accessories***: Incorporate slip sheets between pallets and cartons to prevent compression and damage. Consider corner protectors or straps to secure the load.
8. ***Stack Alignment***: Ensure proper alignment and minimize overhang, which reduces pallet compression strength by up to 30%.
9. ***Harmonization with Global Standards***. Align with international best practices (e.g., ISPM 15) for pallet materials and loading. Incorporate recommendations from WFP and UNICEF in consultation with USG, such as breathable films for specific commodities and cross-stacking techniques to ensure transit stability.
10. ***Container Requirements***. Utilize Cargo-worthy containers (CWC) with at least Grade B certification for food-grade transit. Ensure compliance with IICL 5 standards and a valid CSC plate. Containers must have minimal internal markings, sufficient rust protection, and stable flooring to meet food safety requirements.

b) Technical and Implementable Instruction Summary for LNS Packaging Standardization

1. ***Primary*** **Packaging**
   a. Use **1.5kg multilayer metalized polypropylene bags** (e.g., PE60/Met polyester
   b. Oxygen permeability: ≤ 1.5 cc/m²/day at 38°C, 45% RH.
   c. Vapor permeability: ≤ 1.5 g/m²/day at 38°C, 90% RH.
   d. Flush with nitrogen or carbon dioxide to maintain ≤ 5% residual oxygen.
   e. Vacuum packaging not allowed to avoid caking.
2. ***Secondary Packaging***
   a. Corrugated fiberboard boxes holding 10 pouches (15 kg net weight per box).

b. Design must minimize headspace to avoid carton over-filling and enhance pallet stability.
c. Use 350BC grade waterproof adhesive construction for strength.

3. Palletization and Containerization

a. Optimize for 40-ft containers: 19 pallets, stacked in a 9x2 pattern.
b. Use pinwheel stacking for the top 3 layers to enhance stability.
c. Wrap pallets with 55-gauge stretch film, applying 6 wraps each for the top and bottom, and 3 wraps in the middle.

4. ***Quality and Safety Requirements***

a. Leak Testing: Pouches must withstand 20 inHG (9.8 PSI) for at least 30 seconds, using pressurized submersion or non-destructive methods (e.g., ASTM F2338).
b. Eliminate residual dust to prevent contamination and infestation.

5. Innovative Enhancements:

a. Explore reclosable bag designs and validated use of recycled materials, provided FDA compliance is met.

c) Strategic Recommendations for Implementation

1. **Validation Trials**: Conducting comprehensive testing in USAID warehousing systems to finalize pallet designs and container configurations is necessary.
2. **Collaborative Standards**: Harmonize practices with WFP and UNICEF for unified global operations is desirable.
3. **Enhanced Monitoring**: The use of SPCAID or similar system for real-time quality monitoring, as well as real-time environmental tracking to adapt packaging specifications to field conditions is desirable.

3.6. Down-sizing Packaging Efforts

Current efforts to improve commodity packaging in humanitarian food aid also focuses on exploring smaller, more practical packaging formats to enhance food safety, shelf life, and distribution efficiency. Under the understanding that due to the nature of the food aid supply chain, there is not a fit-all solution, discussions led by organizations such as WFP, USAID, and USDA highlighted the benefits of shifting from traditional 50 kg bags to 25kg and from 25kg to smaller sachets (1.5 kg and 3 kg). These sizes can help in unique settings in better maintaining food quality, reducing wastage, and facilitating easier handling and transportation. For example, smaller fortified rice packages currently being trialed by the Breedlove Foods Co have shown promise in improving logistical efficiency, ration preparation at distribution point and user accessibility in terms of more handling convenience at household levels. Smaller packaging also results in more material used, which has environmental consequences in manufacturing as well as waste management.

Stakeholders also underscored the importance of collaborative innovation, integrating beneficiary feedback. Improvements in food packaging smaller sizes, such as the ability to use “one at the time” pouch, adopting tamper-evident resealable sachets, not only can address last mile ration preparation and handling

needs but also can help in mitigating food fraud risks while enabling a more dignifying food aid at the last supply chain mile. Strategic priorities for 2025 include expanding trials in partnership with suppliers and implementing partners of key commodities such as fortified rice, soy corn blend and cornmeal. The need for real-time data/trails to monitor product conditions throughout the supply chain and assess the long-term impact of these innovations on food aid programs was also emphasized.

3.7. Reverse Logistics Technologies in Support of Sustainable Packaging

At the 2024 Food Assistance Sustainable Packaging Workshop, a key theme was exploring the current state of science and technology surrounding the concept of reverse logistics for food packaging. Reverse logistics, in the context of packaging waste, refers to the process of managing the return flow of packaging materials from consumers or end-users back to recycling facilities or other appropriate end-of-life management systems. This process is essential for achieving a circular economy, as it supports the recovery, recycling, or reuse of materials that would otherwise contribute to waste and environmental degradation. Specifically, reverse logistics for packaging waste involves the collection, transportation, and processing of discarded packaging to ensure that valuable materials are recycled or reused in a sustainable manner[23].

In the context of food aid, reverse logistics for packaging waste has the potential to significantly reduce the environmental footprint of food delivery operations, especially in areas where both food and packaging waste are prevalent. By enabling the collection and processing of used packaging materials—such as plastic containers or wrappers—reverse logistics systems help divert these materials from landfills, dumps, or burn pits. This approach is particularly relevant in humanitarian operations, where logistical support is vital, and the management of both food and waste is crucial for long-term sustainability. Integrating reverse logistics into food aid supply chains, especially in remote or rural areas, can contribute to waste reduction, enhance recycling efforts, and support local economies through the reuse of materials.
The group discussed the need to understand the current practice of repurposing of waste by beneficiaries. Indeed, it was acknowledged that some packaging (e.g. PP woven bag, plastic bottles, cans) are valuable for the community and a balance between social and environmental sustainability needs to be found for such projects.

Reverse logistics technologies that support sustainable packaging have the potential to play a transformative role in addressing the challenges of packaging waste in global food aid systems. These systems integrate circular economy principles to minimize waste, reduce environmental impact, and enhance resource efficiency,

[2] Reverse Logistic Definition, Reverse logistics process: How it works, it's role in retail returns and optimization strategies.
[3] Reverse Logistics: Meaning, Importance, and Components

which is particularly important in humanitarian contexts where packaging waste can accumulate quickly due to the high volume of distributed aid materials. At the workshop, three innovative approaches to addressing packaging waste in food aid systems were showcased:

3.7.1. Re3d: Converting humanitarian waste into useable items

Ms. Samantha Snabes, Co-Founder & Catalyst, Re3d presented on the Re3D printing technology enabling reverse logistics. Ms. Snabes shared with stakeholders re:3D, Inc.'s innovative journey into waste-based 3D printing, highlighting their development of large-scale additive manufacturing solutions. A key focus is the Gigabot X, a printer designed to process plastic waste, such as PET bottles, into printable feedstock. This process, which involves granulation and extrusion, aims to address global challenges like landfill overflow, post-disaster waste management, and the inefficiencies of traditional recycling systems. Despite technical hurdles such as labor-intensive waste preparation and variability in material properties, the initiative showcases scalable applications, from simple functional prototypes to community-driven projects.

In addition, re:3D emphasizes sustainability and adaptability, with pilot programs in regions like Puerto Rico addressing unique waste streams and infrastructure challenges. Their approach combines social responsibility with technical innovation, promoting decentralized supply chains and low-value plastic repurposing. Collaborative efforts with organizations like Habitat for Humanity and NASA explore further applications, including recycling in space and high-throughput off-grid printing. The presentation underscores the transformative potential of integrating recycled materials into additive manufacturing for sustainable, localized production.

As a next step, the food aid community and Re3D will explore joint efforts to leverage Re3D waste-based 3D printing potential for using food aid packaging waste in the production usable products, hopefully engaging local partners as a driver of the circular economy. Re3D will be called upon to explore joint reverse logistics initiatives with potential to repurpose food aid packaging waste in communities where food aid is distributed.

3.7.2. Washington University St. Louis: Compostable Packaging for LNS Products

Dr. Mark Manary, professor and humanitarian from Washington University, St. Louis, presented on an ongoing compostable LNS packaging research project. Dr. Manary, through his Project Peanut Butter (PPB) LNS manufacturer in Malawi has piloted the use of a metalized three-layer fully compostable polylactic acid (PLA) film. Initial results over three months have been promising, demonstrating robust seal strength, nutrient stability, and uncompromised organoleptic properties, with the empty film composting fully within 60 days. Key next steps include evaluating various compostable films, ensuring compatibility

with existing packaging machinery, and assessing long-term performance under USAID and Joint UN Agency shelf-life criteria, involving both standard and accelerated storage conditions.

The proposed next phase of the project includes a further testing plan to evaluate compostable films across five critical parameters—film feed and tension, sealing integrity, filling consistency, production efficiency, and environmental impact on machinery. It also encompasses a comprehensive study of nutritional, sensory, and physical integrity under diverse environmental conditions, leaching potential, and compostability in real-world scenarios. Additionally, a cost-effectiveness analysis by an agricultural economist will determine economic viability. Successful completion of this initiative will not only advance sustainable packaging solutions for U.S. food aid but also ensure a secure, eco-friendly supply chain by leveraging U.S.-manufactured materials, aligning with global regulatory standards.

3.7.3. Mad Plastic Lab: The decentralized plastic waste-to-product micro-factories for Circular Designs

Joseph Klatt, from MAD Plastic Labs presented on his project on reverse logistics as a promising concept for recovering packaging materials used in food aid supply chains. Mr. Klatt highlighted that trucks and containers transporting food aid to distribution sites can also be used for returning waste packaging to recycling facilities, provided such facilities exist nearby. An alternative approach focuses on transforming packaging waste into usable products directly onsite. A notable example involves decentralized plastic waste-to-product micro-factories, currently being piloted in rural Uganda in collaboration with a local product packaging distributor. These systems are designed to grind and extrude plastic waste into building beams, supporting both environmental sustainability and local infrastructure needs.

The micro-factories are housed in retrofitted shipping containers equipped with solar installations to address energy reliability challenges in rural areas. Each unit costs approximately $50,000, inclusive of machinery and solar components, and is easily transportable. This innovative solution could be highly impactful if deployed at food aid locations such as refugee camps and aid centers, providing a practical and sustainable method for managing plastic waste while generating valuable construction materials.

3.8. Packaging Dynamics for food packages with application of Machine learning

At the 2024 sustainable packaging workshop, it was discussed the potential and applicability of machine learning in packaging design. The discussion, led by Professor Amin Joodaky, from the MSU School of Packaging highlighted the integration of machine learning (ML) into research on sustainable packaging and distribution dynamics. Dr. Joodaky emphasized how ML can handle complex data trends that traditional methods, such as basic graphical analysis, cannot. Applications in packaging include optimizing shock-absorbing metamaterial designs and developing sustainable packaging for fruits. A significant portion of the presentation showcased advancements in equipment, including multi-axis vibration tables and sled motion machines, which simulate real-world conditions like rotational and horizontal motions during transport. These tools enhance the study of packaging stability and damage prevention.

This line of research also applies ML algorithms, such as KNN and LGBM, to predict compression strength and optimize ventilation holes in packaging. Recent findings indicate that LGBM provides the highest accuracy in modeling the effects of multiple factors, such as hole size and position, on buckling strength. This approach bridges gaps between computational simulations and experimental uncertainties, enabling the development of more efficient packaging solutions**.**

3.9. Exhibit Session at the 2024 Food Aid Packaging Workshop Series

The Food Aid Stakeholders Engagement Stations at the 2024 Food Aid Packaging Workshop Series offered a significant venue for networking and the exchange of innovative ideas among suppliers and key partners in food assistance programming. The session was highly valued for its interactive exhibits, which went beyond traditional networking by providing hands-on demonstrations of products and packaging technologies. These exhibits facilitated deeper understanding and engagement, helping participants explore practical applications of new packaging solutions tailored to food aid contexts, such as improved shelf-life packaging and environmentally sustainable materials.

This dynamic session highlighted the critical role of packaging in enhancing the efficiency and impact of food aid programs. By fostering collaboration and showcasing cutting-edge solutions, the event reinforced the value of partnerships in addressing logistical challenges and meeting beneficiary needs. The workshop is anticipated to feature an even more extensive array of exhibits in 2025, further enriching opportunities for knowledge sharing and collaboration among the food aid community. This focus aligns with broader trends in leveraging innovation to optimize food safety, reduce waste, and ensure the effectiveness of global food aid efforts. During the 2024 workshop, the following partners set up engagement stations:

No.	Stakeholder Details	Area of Work and Pertinence
1	**Didion Milling** POC: David Silver	• SCP, Cornmeal, CSB Plus Supplier • Working on Hermetic, heat-sealable packaging for fortified flour blends • Packaging integrity monitoring standard operating procedures. • Head-space management, secondary packaging optimization, palletization design, and containerization • Sustainable packaging
2	**Edesia Nutrition.** POC: Emily Fischer	• LNS Supplier • Working on primary and secondary packaging design realignment • Packaging integrity monitoring standard operating procedures. • Head-space management, secondary packaging optimization, palletization design, and containerization • Sustainable packaging.
3	**ProAmpac** POC: Nicole Cocuzzi and Mark Kosinski	.A flexible packaging technology company partnering with food aid suppliers in the development of high-performing packaging solutions, specifically heat-sealable bags for fortified flours and fortified rice.
4	**Breedlove Inc.** **POC:** Michelle Logan and Kim Brown	Breedlove is a humanitarian food relief manufacturer for both United States and International programs. Most recently, Breedlove has been supporting the humanitarian community in exploring retail size fortified rice packaging, as part of the solution to maintain food aid nutritional quality throughout the supply chain, as well as mitigate field infestation, while creating convenience at distribution point and reducing food aid fraud.
5	**TVS Inc.** **POC**: Beth Rich	TVS team is manufacturer and packager of dry food products for the U.S. Military, for food pantries across the U.S. and for humanitarian food assistance. Specifically, TVS manufactures SCP for USG food aid.
6	**Re3D** **POC:** Samantha Snabes	A reverse logistic project focused on repurposing packaging waste through existing 3-printing technologies. Re:3D is committed to empowering local change-makers by developing quality, industrial, large 3D printers that can be adapted in new markets. The food aid community looks forward to partnering with Re3D to tailor their technology to food aid waste and localization

		efforts aiming at reducing carbon footprint through reverse logistic technologies.
7	**World Food Program (WFP)** **POC:** Carole Manceau	WFP presented samples of food aid and packaging allowing the participants to familiarize the type of food and packaging used in humanitarian operations.

3.10 Reusable Oil Tin Can Functionality Improvement

The vegetable oil tin can improvement project faced delays in 2024, as the second field trial intended to validate the performance of newly developed tin can lids did not proceed. Planned for implementation in the Democratic Republic of Congo (DRC) and Kenya, the trial aimed to use 60 metric tons of oil in each country to address key research objectives. These include enhancing packaging functionality, ensuring resilience to the demanding conditions of humanitarian food aid supply chains, and improving pourability and the reuse potential of cans post-consumption. Notably, earlier project phases achieved progress in standardizing packaging and pallet configurations.

During the 2024 MSU workshop, next steps were discussed, confirming scaling up trial quantities to yield more robust data, evaluating the benefits and performance of detachable plastic lids, and assessing their functionality and end-use practicality. Sustainability is also being prioritized by exploring the continued use of steel cans by program participants for reusable storage containers. Plans are underway to manufacture additional tin can ends for broader trials, with Kenya and the DRC remaining as target locations for the second trial in 2025.

The original research agenda around oil tin can for this project still aims at addressing four primary objectives:

- Identifying packaging attributes critical for improving functionality and minimizing leakage and waste throughout the supply chain.
- Designing pre-packaged vegetable oil containers to improve pourability and enhance reuse potential after the oil is consumed.
- Minimizing processing and filling line modifications required for packaging improvements.
- Exploring traceability and trackability opportunities in real-world humanitarian food distribution scenarios.

These initiatives aim to optimize packaging for operational efficiency, field resilience, and sustainability in food aid program.

3.11 USAID-funded Food Assistance Sustainable Evidence-based Packaging Research and Innovation Award.

The concept of a Food Aid Packaging Research and Innovation Associate Award has been under internal discussion at USAID since early 2024, with the aim of advancing a sustainable packaging agenda that benefits both humanitarian and development programs. Building on the outcomes of the 2024 Food Aid Sustainable Packaging Workshop, a 2025 agenda has been outlined (Annex II) to address pressing packaging challenges across a range of food aid commodities. This agenda, encompassing ongoing and future workstreams, is intended to guide the strategic direction of the eventual award, emphasizing innovation in packaging solutions, optimization of packaging performance, extension of shelf life, and alignment with sustainability goals.

For vegetable oil, priorities include the second pilot of functional packaging, designed to optimize oil tin can performance in terms of oil pourability at distribution point and shelf life, as well as validating traceability mechanisms like QR codes to enhance supply chain visibility. Flours, including cornmeal and wheat flour, will see continued efforts to develop high-performance bags with a focus on infestation reduction, along with explorations into downsized packaging for efficiency. In Super Cereal Plus, the agenda includes completing packaging standardization initiatives, piloting pallet designs, conducting shelf-life studies, and improving quality control through statistical process control (SPC). Similarly, fortified blended flours and fortified rice will undergo further shelf-life evaluations and efforts to explore packaging downsizing for reduced waste and cost. . In grains packaging, efforts will target infestation reduction through improved fumigation standard operating procedures (SOPs). For Specialized Nutritious Foods (SNFs), the focus will be on enhancing SPC and process capabilities to improve packaging quality. The agenda also emphasizes support for reverse logistics, advancing methods to recycle and reuse packaging waste effectively

These workstreams collectively aim to provide USAID with robust operational evidence, technological insights, and practical approaches to sustainable packaging. By fostering innovation and sustainability in packaging practices, the agenda aligns with USAID's mission to reduce waste, enhance efficiency, and contribute to long-term environmental and operational goals in global food aid delivery.

Annex I: 2025 FASPA Workplan

Themes	Projects/Next Steps		Focus Group Lead/Members
1. Packaging Sustainability Global Joint Initiative	• The Joint Initiative on Packaging Waste • Identify Research opportunities • Implement Knowledge, evidence-Sharing Activities • Gather good examples from program participants of how packaging is repurposed • Options to replace metallized flexible laminate used for SNF: WFP will continue the work initiated to tests alternative materials (e.g. mono-material, paper based solution) in collaboration with the private sector • Pending funding: WFP / ICRC will continue the work on the development of more durable PP woven bag • Compostable film for LNS: shelf-life studies on going. Additional tests and trial will be planned as needed to validate the film		**Leads**: Greg Rulifson (USAID), Carole Manceau (WFP) **Other Group Members:** Rafael Auras (MSU), Yoorae Noh (MSU), Amro El Zoubi (JI/WFP)
2. Packaging Standardization project (SCP)	• Bring to full completion of the SCP Packaging Standardization project, including trialing pallets in Houston • Further validation of headspace/ residual oxygen in SCP using SPCAID		**Leads:** Brett Mears (Palmer Logistics) **Other Group Members:** (USAID), Mr. Brett Mears (Palmer Logistics), Carole Manceau, SCP and CSB+ Suppliers; Yussury Kallouche (BMI)
3. Improved Sustainable Oil Tin Cans/ Field Trial	• Implement of second and last field trial to assess performance of new improved tin can lids • Kenya and DRC as sites for a larger trial • Monitor reusability/ sustainability of newly improved tin cans		**Leads:** Steve Mihm (Reynold Services) and Ruffo Perez (USAID) **Other Group Members:** Carole Manceau (WFP); Greg Rulifson (USAID); Nafi-Aish Dio (WFP)

4. High Performing Bag Infestation Testing Project	• Intentionally infest most promising packaging bags to assess their resilience against infestation		**Leads:** Danielle Froio-Blumsack (DOD) and Ruffo Perez (USAID) **Other Group Members:** Deanna Scheff, Nicole Cuccuzi -ProAmpac; Danielle Froio-Blumsack (DOD)
5. Food Assistance Sustainable Packaging Research and Innovation Associate Award	• Consolidating a range of food aid packaging research, innovation, and piloting initiatives • Support field trials of prototype technologies and solutions • Sustain a network of collaborators and stakeholders		**Leads:** Ruffo Perez (USAID) and Jaime Fisher (USAID). **Other Group Members:** Suppliers, academia, technology vendors.
6. Process Capability Systems to Prevent Leaking in LNS Packaging	Further development and validation of auditable process capability SOP for LSN focused on packaging performance and product stability		**Leads:** Nicholas Vena (Pearl Auditing Services) Other members: Davor JANJATOVIC (WFP) and Odile Caron (MSF), David Todd (MANA Nutrition) and Jennifer Esterle (Edesia), Odile Caron (MSF), David Silver (Didion).
7. Packaging and Packaging Waste Reverse Logistic Approaches	Transformative Packaging Solutions for the repurposing of packaging and packaging waste.		**Leads:** Ruffo Perez (USAID); Nacasi Green -PSE/USAID **Other Group Members: Greg Rulifson (USAID), Carole Manceau (WFP),** Suppliers, Washington University St. Louis, technology vendors, Re3D, MadPlastic
8. Shelf-Life Studies of Key Commodities	1. **SCP** -Revisit SL for SCP with focus on ingredient quality and storability 2. **CSB+** - Revisit SL for CSB+ with focus on heat-sealable packaging, ingredient quality and storability 3. **HEB (Fortified biscuit)** - assessing more suitable packaging films, such as non-foil 4. **Veg Oil** -assessing stability of micronutrients through supply chain		**Leads:** Ruffo Perez (USAID); Carole Manceau -WFP **Other Group Members:** Suppliers, academia, technology vendors.

9. Food Aid Packaging down-sizing project	1. **Fortified Blended Flours.** Trialing 3-20 kg CSB+ bags to assess cost-efficiency **5. Fortified Rice.** Trialing 3-20 kg heat sealable fortified bags to assess cost-efficiency		**Leads:** Ruffo Perez (USAID); Carole Manceau -WFP **Other Group Members:** Suppliers, academia, technology vendors.

Annex II: Food Aid Packaging Agenda -2025

Veg Oil

1. Second Pilot/Functional Packaging
2. Shelf life
3. Traceability/QR

Flours (Cornmeal, wheat flour)

4. Cont. Perfecting High Performing bags/ Infestation Reduction
5. Explore down-sizing
6. Traceability/QR

Super Cereal Plus

7. Complete standardization project/ trial pallet designs
8. Shelf-life studies
9. SPC/ Packaging quality defect reduction
10. Traceability/QR

Fortified Blended Flours

11. Shelf-life studies
12. Down-sizing packaging
13. Support Reverse Logistics Projects

Grains (Packaged)

14. Infestation reduction (Fumigation SOP/Processes)

SNFs

15. SPC/Process capability
16. Traceability/ QR
17. Support Reverse Logistics/ Trial prototype Technologies

Annex III: VI MSU Food Aid Packaging Solutions Agenda

Food Assistance Packaging Solutions Workshop Series
November 13-15, 2024

Michigan State University James B. Henry Center for Executive Development
3535 Forest Rd, Lansing, MI 48910

Video call link: Virtual Participation Zoom Link
Meeting ID: 926 4088 7371; Passcode: 2024
Contacts: Ruffo Perez ruperez@usaid.gov ; Cimberly Weir cimberly@msu.edu

Day 1, November 13, 2024

Time (US EDT)	Topic	Speakers / Organizations
9:00-9:10	**Welcome Remarks**	**Laura Bix,** Professor and Interim Director, MSU School of Packaging **Greg Olson**, USAID Bureau for Humanitarian Assistance, U.S. Agency for International Development
9:10-9:15	**Introduction, Expectations, Review of the Agenda**	**Ruffo Perez**, Sr. Food Technology Advisor, USAID
9:15-10:45	**Food that is not safe is not food, food that is not packaged effectively is not safe.**	**A panel moderated by USAID/WFP**
	1. Packaging, food safety, health and nutrition 2. Packaging and Downstream Supply Chain Management: WFP East Africa Logistics Perspective 3. Update on Packaging Regulations and Labeling 4. Regulatory Science Perspective on the Analysis of Microplastics and Nanoplastics in Human Food	**Johannes Bergmair**, General Secretary of the World Packaging Organization (WPO) **Shahid Minhas and Emilie DUFOUR**, World Food Organization WFP **Carole MANCEAU**, World Food Organization WFP **Timothy V Duncan**, Center for Food Safety and Applied Nutrition US Food and Drug Administration
10:45-11:00	**Coffee / Tea Break**	

11:00 – 12:40	**Commodity Packaging Improvement, Pilots and Trials**	
	1. Packaging Down-Sizing as it relates to Programming and Last Mile Ration Distribution	**Carole MANCEAU and Nafi-Aïsha Diop**, World Food Organization WFP
	2. Fortified Rice Retail-size Packaging	**Kim Brown & Michelle Logan,** Breedlove Inc.
	3. Improving Palletization and Stacking Trials	**David Silver**, Didion Milling
	4. Second Oil Tin Can Pilot	**Ruffo Perez,** TPQ/USAID
12:40-1:30	**Lunch provided**	
1:30-3:00	**Packaging Technologies and Food Infestation: A Technical Panel**	
	1. Perfecting the Design of High-Performing Bags	**Nicole Cocuzzi** and **Mark Kosinski**, ProAmpac
	2. Examining Packaging and Film Construction	**Danielle Froio-Blumsack**, DoD Soldier Lab, Natick, Boston.
	3. Packaging Infestation Resilience Piloting and Research	**Deanna Scheff**, USDA/ARS **Dan Webber**, USDA/AMS
	4. Retooling and optimizing hybrid bag filling and sealing capability	**Terry Kleisinger**, SEMO Milling Inc.
3:00-4:00	**Implementation of Key Performing Indicators (KPIs) for Packaging Quality Monitoring**	
	The SPCAID Project updates, implementation and future work	**Nick Vena**, Pearl International
	Testing Packaging Integrity Technologies	**Chris Kelly,** TVS VP of Food Safety and Quality Assurance
	Filling Line Performance and in-process monitoring	**Randy Kleiboer** and **Paul Huebener**, Henry Broch Foods
4:00-4:10	**Coffee / Tea Break**	
4:10-4:40	Glue and Adhesive Packaging Systems: performance and shelf life. **Nicole Cocuzzi**, ProAmpac	
4:40-5:00	Packaging and Commodity Shelf Life and Raw Ingredient Quality Session, Open Discussion Led by USAID/WFP	
5:00-5:30	Wrap-up First Day	**Ruffo Perez**, Rufino (BHA/TPQ/PHN)
6:00-8:00	**Group Dinner and Keynote Speakers:** The Story of TVS: Investing in the well-being of communities, by: **Lora Allemeier**, TVS CEO	

Day 2, November 14, 2024		
Time (US EDT)	**Topic**	**Speakers / Organizations**
8:00-8:05	**Second day overview and Expectations**	USG/MSU
The Broader Food Assistance Sustainable Packaging Solutions and Systems		
8:05-10:05	**The Material Neutrality of Food Packaging: A Panel Moderated by: Greg Rulifson, USAID**	
	New and improved packaging for sustainability • **Speakers**: Carole Manceau, WFP; Tom Harrison-Prentice, UNICEF; Zoltan Laurincz, Mondi.	**Greg Rulifson**, USAID Contractor
	Packaging waste management initiatives • **Speakers:** Alice Occhilupo and Rie Ishii, WFP: Marianna Nigra, UNHRD; Gard Saabye, Human Brights.	**Amro ELZOUBI**, Joint Initiative Consultant to the World Food Programme (WFP)
	The multi-agency Sustainability Joint Initiative (JI): an update	**Greg Rulifson,** USAID Contractor, and **Amro El Zoubi,** Joint Initiative Consultant to WFP
10:05 – 10:15	**Morning break**	
10:15 – 12:00	**Reverse Logistics Technologies in Support of Sustainable Packaging**	
	1. PSE opportunities on Packaging Research and Development 2. Recycled Plastics for Circular Design 3. Converting humanitarian waste into useable products 4. Compostable Packaging for LNS Products	**Nacasi Green, USAID/PSE** **Joseph Klatt**, MAD Plastic Labs **Samantha Snabes**, Co-Founder & Catalyst, Re3d **Mark Manary and Kevin Stephenson**, Washington University, St, Louis
12:00 -12:30	**Packaging Standardization Project Update**	
	Didion Milling	SCP: **David Silver**, Didion Millin
	Edesia Nutrition	LNS: **Emily Fischer**, Industrial Engineer
12:30-1:30	**Lunch provided**	
	Sustainable Packaging Stakeholders Engagement Stations	
	1. Sustainable Packaging Joint Initiative (JI)	
	2. Transylvania Vocational Services -TVS	
	3. United Nations World Food Program (WFP)	
	4. The Henrry Broch Food	
	5. INFICON Americas Packaging Integrity Testing	

1:40-3:40	**6.** Re:3D Inc	
	7. Breedlove Foods	
	8. Heat-sealing Packaging Technologies	
	9. ProAmpac Packaging Company	
	10. Packaging Dynamics for food packages with application of Machine learning	
3:40-4:10	USAID Supporting Food Assistance Packaging Research and Innovation as an enabler of cost-effective food aid operations.	**Amin Joodaky**, Assistant Professor, MSU School of Packaging
4:10 – 4:30	Flash-card open discussion on food aid packaging: blue-sky topics, stakeholders say.	**Ruffo Perez**, USAID Bureau for Humanitarian Assistance, U.S. Agency for International Development
4:30 – 5:20	**Wrap up of main technical meeting**	**Ruffo Perez** (USAID), **Carole MANCEAU** (WFP), **Greg Rulifson** (USAID), **Dan Webber** (USDA), Suppliers, **David Silver**, Didion Milling.
5:20 – 5:30		

Day 3, November 15, 2024		
Time (US EDT)	**Topic**	**Speakers / Organizations**
9:00- 12:30 p.m. (With break at 10:30 a.m.)	**Group 1-** Options to Reduce Environmental Impact throughout the Supply Chain with a Focus on Packaging	**GROUP 1 Leads: Greg Rulifson, USAID Contractor and Carole Manceau, WFP**
	Group 2: Discussion on USG food assistance research and innovation project	**GROUP 2: Leads USAID/TPQ/FARO**
12:30-12:40 p.m.	**Wrap-up and end of workshop. Adjourn**	**USAID & MSU School of Packaging**