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WAGENINGEN
UNIVERSITY & RESEARCH

Navigating the Food Loss and Waste Paradox

Balancing Food Loss and Waste with Save Food Packaging

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ACE	Agro-Chain Greenhouse Gas Emission
AGR	Division of Agribusiness and Infrastructure Development
CEP	Center of Excellence on Packaging
CO2	Carbon dioxide
CoE	Center of Excellence
FAO	Food and Agriculture Organization of the United Nations
FLV	Fruits, Legumes and Vegetables
FLW	Food Loss and Waste
FPF	Food Packaging Forum
FSS	Food Security and Food Systems Unit
GDP	Gross Domestic Product
GHG	Greenhouse Gases
Gt	Gigatonne
HDPE	High Density Polyethylene
IOPK	Institute of Packaging Kenya
LCA	Life Cycle Assessment
MoU	Memorandum of Understanding
PE	Polyethylene
PP	Polypropylene
PPP	Public Private Partnership
SDG	Sustainable Development Goal
SMEs	Small and Medium Enterprises
SPGs	Sustainability Packaging Guidelines
SPS	Sanitary and Phyto-Sanitary
TBT	Technical Barriers to Trade
TTI's	Time Temperature Indicators
UNIDO	United Nations Industrial Development Organization
WPO	World Packaging Organisation
WTO	World Trade Organization
WUR	Wageningen University & Research

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ABSTRACT

This paper explores the complex interactions that exist between sustainability challenges posed by food loss and waste and the environmental impact of food packaging. It is critical to strike a balance between reducing food loss and waste and implementing sustainable packing techniques as the world's population grows and climate change worsens. This essay delves into the subtleties of this sustainability paradox, examining current trends, assessing potential solutions, and advocating for a holistic approach that considers the entire food supply chain.

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1. INTRODUCTION

The 21st century is faced with unprecedented challenges, where the world community struggles with a growing population while reducing the negative effects of human activities on the environment. At the nexus of these challenges lies a complex and multifaceted paradox. One that revolves around the balance between minimizing food loss and waste (FLW) and adopting responsible and sustainable food packaging practices. As our world becomes more interconnected, the need to navigate this sustainability paradox becomes more and more urgent, calling for thorough analysis of the intricacies within the global food supply chain.

Food Loss and Waste Paradox

In addressing the FLW paradox associated with food packaging, the link between food preservation and packaging is evident. Packaging, mostly plastic (lightweight, durable and versatile properties) has become the cornerstone in food industry for protection, preservation, convenience, hygiene, and food safety. However, the very characteristics, that make plastic effective also assesses challenges in its proper management in its end of life for correct disposal or circularity, avoiding environmental pollution, or other adverse effects such as climate change or loss of biodiversity. While reducing and recycling (plastic) packaging presents a positive trend towards alleviating these issues, it simultaneously introduces a potential risk to FLW prevention and reduction efforts, thus creating the FLW paradox. The challenge is to strike a balance between reducing environmental impact and ensuring the integrity and safety of the food supply chain.

The challenge is to navigate the complexity of the FLW paradox. Objective comparative research may show in a number of cases which newly developed alternatives are more sustainable than the existing packaging. However, due to the multifaceted functions of packaging, it is often not possible to predict in advance which solution offers the most sustainable packaging option in practice. The determination of the most suitable material hinges on answers to critical questions: How is it produced? What are the available alternatives? What is the overall energy consumption of a proposed solution? How much food loss and waste would the solution entail? Is it recyclable, and if so, what is the recycling process? The challenge, therefore, lies in deciphering these complexities to find a balance that serves both environmental preservation and the efficiency of the food supply chain.

Purpose of the Position Paper

The purpose of this position paper, jointly authored by the United Nations Industrial Development Organization (UNIDO), Wageningen University & Research (WUR), and the World Packaging Organisation (WPO), is to explore the intricacies of the FLW paradox, delving into the challenges, opportunities, and potential solutions that lie at the intersection of FLW and food packaging sustainability. This collaborative effort leverages the diverse expertise and perspectives of these esteemed institutions to provide a nuanced understanding of the complexities involved in achieving a sustainable and resilient global food system. By unraveling these intricacies, we seek not only to inform but to inspire actionable solutions that resonate across sectors, borders, and industries.

Image: Jacopo Maia/Unsplash

2. FOOD LOSS AND WASTE

A first estimate prepared for the Food and Agricultural Organization of the United Nations (FAO) in 2011 calculated that around a third of the world's food is lost or wasted every year. This estimate is still widely cited due to a lack of reliable information in this field, but it is typically considered a very rough approximation. To measure progress towards Sustainable Development Goal (SDG) 12.3, Global Food Loss and Waste, more carefully and precisely, FAO and the United Nations Environment Programme have introduced two new indices to monitor progress. The Food Loss Index gives an indication of how much food is lost in production or in the supply chain before it reaches the retail level. The Food Waste Index measures what is subsequently wasted by consumers or retailers.

Initial FAO estimates for the Food Loss Index show that around 14% of the world's food is lost from production before reaching the retail level (FAO, The State of Food and Agriculture, 2019). In terms of food groups, roots, tubers and oil-bearing crops report the highest level of loss (25%), followed by fruit and vegetables (22%), given their highly perishable nature. Levels of food loss for meat and animal products are estimated at 12%, however their contribution to the land footprint of food loss and waste is high; livestock production requires substantial amounts of agricultural land to produce animal feed or for grazing.

Preliminary estimates for the Food Waste Index show that global food waste from households, retail establishments and the food service industry totals 931 million tons each year, 17% of the world's food. Almost 570 million tons of this waste occurs at the household level, with a global average of 74 kg food waste per capita each year. This is remarkably similar from lower-middle income to high-income countries, suggesting that most countries have room to improve (UNEP, Food Waste Index Report, 2021).

The most recent data additionally show that about 8% of all food produced in the world is lost on the farm (WWF-UK, 2021). These new estimates focusing on food losses on farms around and during harvests and slaughter, indicate that of all the food grown, approximately 40% is uneaten, higher than the previously estimated figure of 33%.

Benefits of Reducing Food Loss and Waste

Reducing Greenhouse Gas Emissions

Food loss and waste is a major contributor to climate change. About 8-10% of all human-induced greenhouse gas emissions (GHG) can be reduced if we stop wasting food (IPCC, 2020). This is because food supply chains are responsible for a third of global anthropogenic GHG emissions. According to the Emissions Database of Global Atmospheric Research the emissions stemming from the food supply chains in 2015 totaled 18 Gt CO2 equivalent annually, comprising 34% of total GHG emissions. The largest contribution came from agriculture and land use/land-use change activities (71%), with the remainder from supply chain activities: retail, transport, consumption, fuel production, waste management, industrial processes and packaging (Crippa, 2021).

Sustainable and equitable food supply chains

Developing sustainable and equitable food supply chains involves multifaceted approaches within supply chains. Firstly, mitigating and preventing and reducing food waste is one of the strategies contributing to increased food availability. Secondly, remaining food surpluses and side-streams from food production offer opportunities for local and innovative repurposing into alternative products suitable for human consumption. Upcycling inconsumable human food leftovers via livestock systems as nutritious feed is an important mechanism that can be introduced more widely to re-purpose immense volumes of organic resources. The food-use hierarchy delineates an effective utilization pathway for food and biomass. Primary emphasis is placed on food waste prevention, followed by redirecting for human consumption. Subsequently, repurposing to animal feed then becomes the next viable option to keep resources within the food supply chain. Waste management options, such as recycling through anaerobic digestion or composting, should

be considered as a last resort, aiming to minimize their utilization whenever feasible, Figure 1. These strategies align with the overarching goal of reducing food loss and waste while simultaneously curbing greenhouse gas emissions within the food system.Developing sustainable and equitable food supply chains involves multifaceted approaches within supply chains. Firstly, mitigating and preventing and reducing food waste is one of the strategies contributing to increased food availability. Secondly, remaining food surpluses and side-streams from food production offer opportunities for local and innovative repurposing into alternative products suitable for human consumption. Upcycling inconsumable human food leftovers via livestock systems as nutritious feed is an important mechanism that can be introduced more widely to re-purpose immense volumes of organic resources. The food-use hierarchy delineates an effective utilization pathway for food and biomass. Primary emphasis is placed on food waste prevention, followed by redirecting for human consumption. Subsequently, repurposing to animal feed then becomes the next viable option to keep resources within the food supply chain. Waste management options, such as recycling through anaerobic digestion or composting, should be considered as a last resort, aiming to minimize their utilization whenever feasible, Figure 1. These strategies align with the overarching goal of reducing food loss and waste while simultaneously curbing greenhouse gas emissions within the food system.

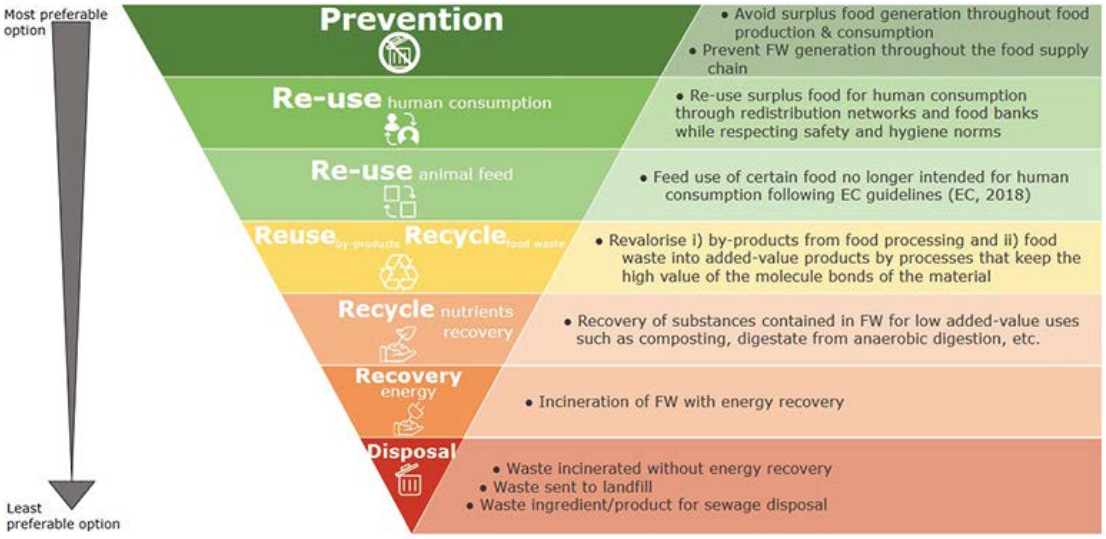


Figure 1 - Practical application of the waste hierarchy for food (European Commission Joint Research Centre, 2020)

Reducing Food Loss and Waste – How?

As we strive to make progress towards reducing FLW, we can only be truly effective if our efforts are informed by a solid understanding of the problem: where, why and how much food is lost; what are the underlying objectives and reasons to reduce food loss and waste; and what measures are effective. In 2019, a Global Action Agenda to help reduce food loss and waste and achieve SDG 12.3 was put together by a group of global experts. This agenda includes 10 interventions designed to scale the approach and to-do list (Flanagan, 2019). A follow up report explores these 10 '"scaling interventions'" (Hanson, 2019). The action agenda calls for a Target-Measure-Act approach to be adopted by countries, regions and businesses: Adopt a target to halve food loss and waste by 2030, measure how much and where food is being lost and wasted, and act on the hotspots.

Food Loss and Waste Hotspots: Necessity for Regional Solutions

By pinpointing "hotspots", the focus is on interventions that can yield the most substantial reductions in FLW-related impacts. Guo et al. (2020) drafted a comprehensive global hotspot analysis on FLW, considering associated GHG emissions. The research underscores that food items with high FLW and GHG emissions vary, providing essential information for strategic decision-making. For instance, while fruits and vegetables contribute significantly to global FLW volumes, bovine meat stands out for its high FLW-associated GHG emissions, particularly at the consumer stage in North America and Oceania, Figure 2.

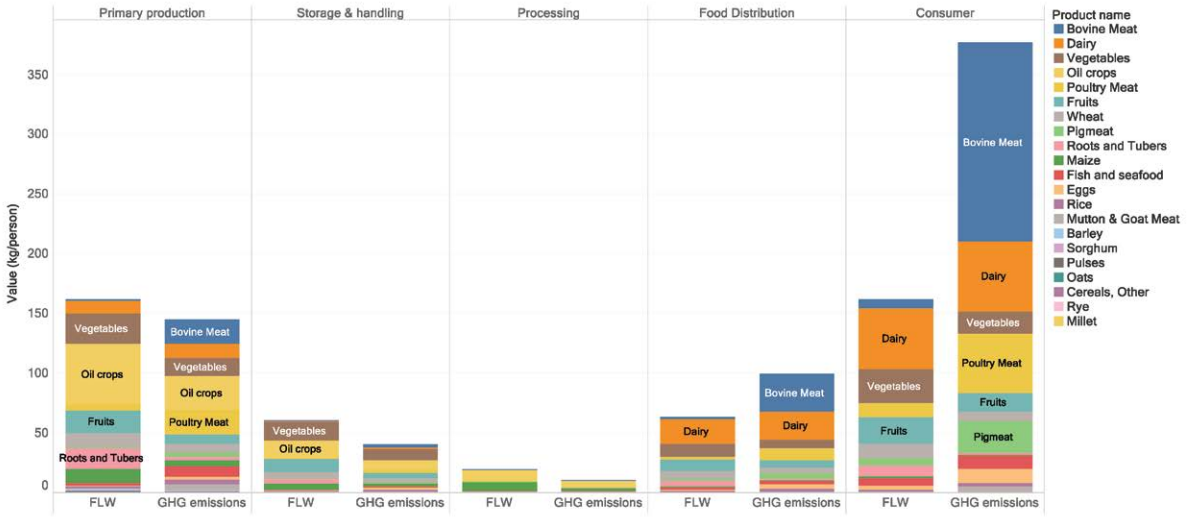


Figure 2 - FLW and associated GHG emissions for North America and Oceania by chain stage in 2017 on 0 to 350 kg per person scale (Guo et al., 2020)

Whereas in Sub-Saharan Africa, contributions to FLW are significant at the primary production and storage & handling stage with a large contribution from root & tubers, oil crops and bovine meat.

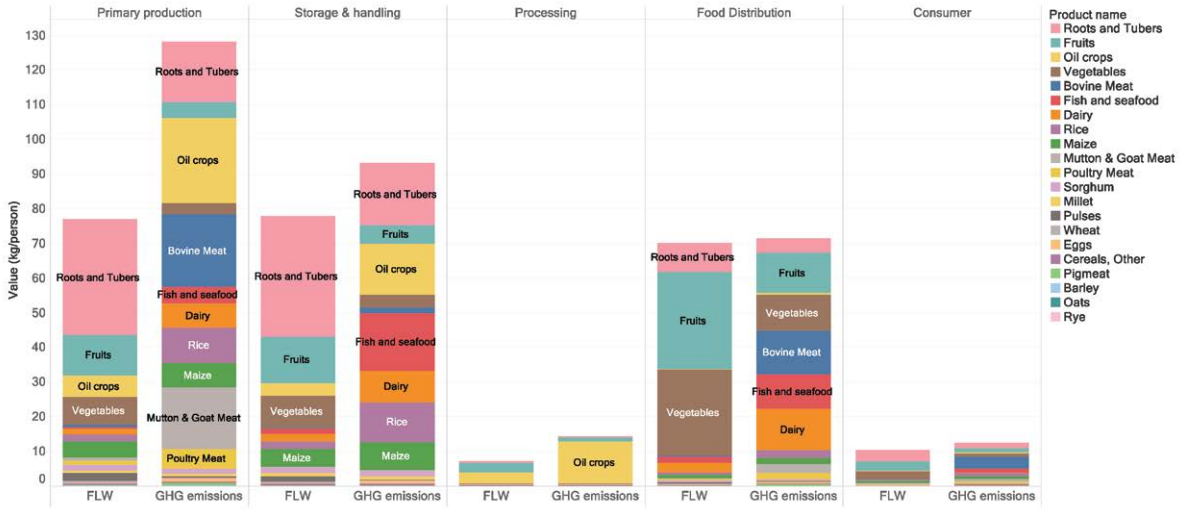


Figure 3 - FLW and associated GHG emissions for Sub-Saharan Africa by chain stage in 2017 on 0 to 130 kg per person scale. (Guo et al., 2020)

As different regions (see annex 5 for additional regions) encounter diverse challenges leading to food losses, the need for regional solutions becomes evident. A nuanced understanding of the root causes of these losses within specific local contexts is essential for developing targeted strategies that align with regional dynamics. Tailoring interventions to regional needs not only enhances their effectiveness but also fosters sustainable practices that resonate with the challenges faced by different communities. This regional approach ensures that efforts to reduce food loss and waste are not only impactful but also adapted to the distinctive circumstances of each area, thereby contributing to a more sustainable and resilient global food supply chain.

The Role of Consumers and Industry: Navigating Consumer Behavior and Industry Innovations

With an estimated contribution of 17%, the consumer is the large contributor to food waste across the food chain globally. The need for behavioral change among consumers is evident, considering that a substantial portion of this waste is avoidable. On the other hand, the same consumer is confronted with the negative effect of packaging and voicing a societal demand to eliminate or reduce the use of plastic packaging, even in the context of food.

Consumer behavior towards emerging packaging techniques, whether specifically designed to reduce food waste or not, is intricately linked to their knowledge, awareness, interest, and appreciation levels, creating a barrier to efficient food-saving practices (ARCARDIS, 2019). Numerous studies emphasize the importance of consumer education regarding the benefits of packaging technologies as a means to foster more sustainable practices (Aday and Yener 2015; Barska and Wyrwa 2016; Licciardello 2017; Verghese et al., 2015; Williams et al., 2012).

On the industry front, collaboration between food industry and packaging manufacturers becomes paramount. Continued investments in research and development are crucial to create packaging solutions that strike a balance between food preservation needs and sustainability goals. Collaboration across the supply chain, from producers to retailers and consumers, is essential to implementing effective and scalable solutions.

The packaging industry, in tandem with consumer demands and regional waste routes, seeks solutions that align with existing sales markets. The recyclability, reusability, industrial composability, or biodegradability of packaging materials become pivotal considerations. Recent initiatives by food companies in the United Kingdom, as reported by The Guardian, highlight changes aimed at enhancing environmental friendliness of plastic food packaging. These changes range from the removal of packaging components like hard plastic yogurt lids, to shrink wrapping food to use less plastic, or simply changing colors to make packaging more recyclable. However, as with any change, consumer adaptation proves challenging, as noted by Jayne Paramor from the UK civil society organization Wrap emphasising that “Change is always difficult for people.”

The transformation of packaging materials and design represents a complicated process for food brands and retailers. While many life cycle assessments (LCA) focus on GHG, it is crucial to recognize that food packaging contributes to various environmental effects, including water use and chemical exposure. Organizations like the Food Packaging Forum (FPF) actively engage in projects that facilitate comparisons between packaging options and support companies in navigating the complexities of transitioning to more sustainable packaging practices. As the industry struggles with the food packaging paradox, a delicate equilibrium between consumer demands, industry innovations, and environmental sustainability emerges as a crucial imperative.

Image: Sydney Rae/unsplash

3. SAVE FOOD PACKAGING

Packaging Plays an Important Role in Minimizing Food Loss and Waste

First and foremost, the true role of packaging is its functionality. Packaging needs to be designed to ensure that a product is protected, preserved, contained and transported all the way through the value chain from production until it is used in the household.

Packaging also plays a vital role in ensuring the health and safety of the products and consumers that product waste is kept to a minimum and the efficiency of the packaging can withstand the rigors of transport.

When re-designing packaging to meet global and local packaging waste and sustainability targets, the functionality simply cannot be ignored. 'Sustainable Packaging', in the simplest of terms, is packaging that performs the primary role of functionality but is also designed with the lowest possible environmental impact when compared to an existing or conventional pack. Finding the balance between functionality, commercial reality, consumer demands, and environmental criteria is the real challenge for packaging technologists and engineers across the globe.

With so much focus right now on plastic and packaging waste, we must not lose sight of the key role packaging plays in the protection of a product. Inadequate packaging that results in wasted food defeats the whole purpose and is a much bigger waste of resources and environmental impacts.
The challenge for packaging technologists & engineers is to be able to design optimum packaging with the lowest environmental impact at the start. It is about finding the balance between meeting food waste targets, at the same time as achieving packaging waste targets.

If the balance is tipped either way it will create unintended consequences which could see over packing (wasting packaging materials) or under packing (wasting food). Finding the perfect balance can be challenging and requires technical knowledge and understanding of packaging design.

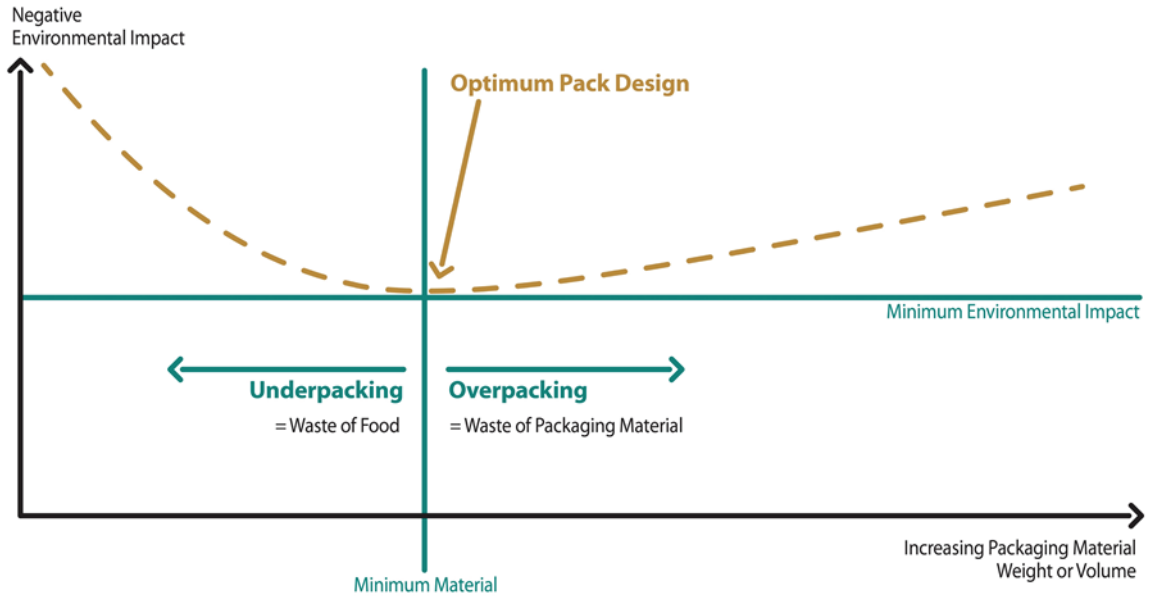


Figure 4 - Optimum Packaging Design

Life Cycle Assessment

To optimize circular and sustainable design packaging technologists need to look at the potential environmental impacts of the product across its lifetime. Environmental impact categories can include carbon/GHG emissions, water depletion, mineral consumption, land transformation, eutrophication, toxicity, and many more and can be undertaken through a LCA. This assessment can look holistically at environmental impacts of products, and associated packaging, from raw materials, to production, through to household, and then at end-of-life.

Now more than ever science-driven information that is derived from LCA is such an important step in ensuring that product and packaging have the lowest environmental impact wherever possible across the entire value chain. LCA can eliminate second-guessing and assumptions about 'Sustainable Packaging' choices and can provide concrete information that crosses all areas of the supply chain.

Efforts to reduce the environmental impact of packaging may unintentionally lead to increased FLW and therefore lead to increased greenhouse gas (GHG) emissions. To make informed decisions about strategies for improved sustainability, it is crucial to consider the trade-offs involved.

To address this challenge, WUR developed two methodologies to incorporate FLW into the equation.

First a sustainability assessment tool calculates multiple sustainability indicators that includes the most important aspects of packaging sustainability (MuDiSa): the effect of FLW, the circularity of the packaging, the (circular) recycling of the packaging and the effect packaging has on plastic soup formation due to littering (Brouwer et al. 2023).

Second a practical tool called the Agro-Chain Greenhouse Gas Emission (ACE) calculator (Broeze et al. 2023). This tool offers a simplified representation of a generic fresh food supply chain, where environmental impact can be quantified. By using scenario calculations with different chain parameters, the net effects of FLW-reducing interventions on GHG emissions and FLW per unit of food sold to consumers can be easily compared. While FLW-reducing interventions are generally found to decrease total GHG emissions associated with a unit of food, there are cases where the interventions themselves lead to additional GHG emissions. One of the scenarios studied was international transport of melons, with or without packaging, Figure 5.

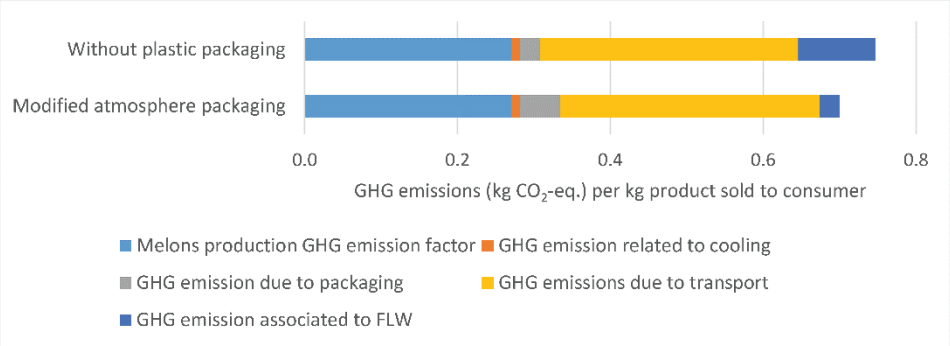


Figure 5 - GHG emissions induced by different operations along the supply chain for melons from Honduras to UK. (Broeze et al. 2023)

While the associated GHG emissions for packaging increased, the overall FLW GHG emissions increased, outweighing the impact of the packaging. In such scenarios, the intervention for not using packaging material may not be an effective strategy for reducing overall GHG emissions.

Roles of Save Food Packaging

Whilst the primary function of packaging has always been to protect, contain, preserve and transport a product from paddock to plate, the function of intuitive Save Food Packaging Design to minimize FLW is only now being discussed across the globe.

Save Food Packaging is designed to minimize or prevent food waste from paddock to plate using innovative and intuitive design features that can contain & protect, preserve, extend shelf life, easily open and reseal, provide consumer convenience and portion control; all the while meeting global sustainable packaging targets (Francis et al., 2023).

Opportunities for packaging design to minimize food waste can include better facilitation or communication around portion control, date labelling, extension of shelf life, protection, reseal-ability, easy to open, grip, dose and empty, contains the correct quantity and serving size food safety/freshness information, information on storage options and improved communication on packs. The packaging should also highlight a wide range of design factors that help to prevent food waste including mechanical protection, physical-chemical protection, expiry date and best before date. The packaging should also facilitate sorting of household waste – easy to clean, separate, recycle or reuse.

Without adequate design features and packaging that is fit-for-purpose, food can potentially be wasted all the way through the value chain to the household. The costs of such waste can be significant for a business and leaves an indelible footprint on the environment. By modifying packaging design at the start and ensuring that Save Food Packaging design guidelines are followed in the New Product Development process, FLW can be minimized across a value chain.

The ideal scenario for packaging technologists is to start by using the 10x Sustainable Packaging Design Guidelines and then deep-dive into using Save Food Packaging Design Guidelines to create innovative and intuitive packs.

Sustainable Packaging Guidelines

Figure 6 - Sustainable Packaging Guidelines

The Sustainable Packaging Guidelines are to assist the design and manufacture of packaging that meets the sometimes-conflicting demands of the market, consumer protection and the environment.

Save Food Packaging Design Guidelines

Figure 7 - Save Food Packaging Design Guidelines

The 5x Save Food Packaging Design Guidelines have been developed to help Packaging Technologists to design Save Food Packaging to minimize food waste from paddock to plate using innovative and intuitive design features that can contain & protect, preserve, extend shelf life, easily open and reseal, provide consumer convenience and portion control; all the while meeting global and local sustainable packaging targets (Francis et al., 2023). The Save Food Packaging Design Guidelines have been developed by the Royal Melbourne Institute of Technology (RMIT), Australian Institute of Packaging (AIP), and the End Food Waste Cooperative Research Centre.

1. Design to contain & protect the product from spoilage and damage through manufacturer, warehouse and the various stages of distribution

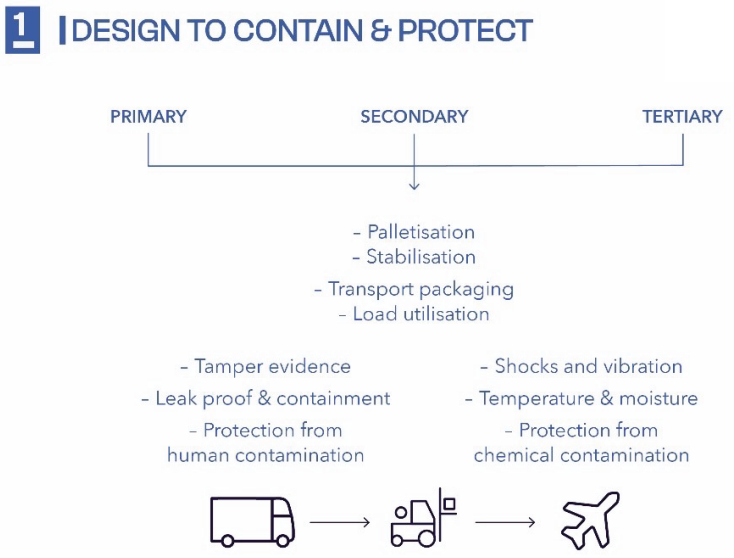


Figure 8 - 1. Design to contain & protect the product from spoilage and damage through manufacturer, warehouse and the various stages of distribution.

Design to contain and protect needs to cover primary, secondary and tertiary applications and how it is transported to the consumer. Considerations need to include palletization & stabilization, transport packaging and load utilization, tamper evidence, shocks, vibrations, temperature, moisture, infestation, chemical contamination.

2. Design to preserve & extend shelf life and enhance product appeal

Figure 9 - 2. Design to preserve & extend shelf life and enhance product appeal

This is one of the most important Save Food Packaging design principles, as the primary purpose of packaging is to protect and preserve a product. Following the Design to Preserve & Extend Shelf Life guideline, packaging technologists need to consider managing the product environment in the pack, reviewing extension and barrier protection and also looking at an underutilized area of Active & Intelligent Packaging (Francis et al., 2023). The design needs to include delivery of usable shelf life throughout the supply chain, food service and household. Product that is fit for consumption throughout all probable environments and timelines is the critical function of sustainable food packaging.

The Benefits of Intelligent Packaging

Intelligent Packaging communicates product changes and monitors the condition of the packed food to provide information about the quality of the food from farm to plate. Intelligent Packaging includes Time Temperature Indicators (TTI's), Shelf-Life Sensors, color-changing thermochromics inks and labels and more.

Intelligent Packaging can contain either an external, or internal, indicator for the sole purpose of sensing, detecting and recording determined information about the food all the way across the supply chain. This information can identify whether any environmental changes have occurred to the product during the materials handling, logistics and transportation of the goods to the consumer. Intelligent Packaging systems can also be used for tamper evidence, product protection, as an anti-counterfeiting device, all the while providing real-time data for track and trace.

The Active & Intelligent Packaging industry continues to develop innovative systems that can improve quality control, extend shelf life, optimize freshness, control shipping and transportation routes, access food that has spoiled at any point within the supply chain and communicate with consumers. Consumers can also reap the benefits of being informed about everything from the freshness of the product, whether the food has been stored at the right temperature, through to whether it is fit to eat or about to turn.

3. Design to preserve & extend shelf life and enhance product appeal

Figure 10 - 3. Design to prove consumer convenience

Considerations need to include portion control, ease of opening, re-closing, dispensing and inclusive design. Designing packaging that offers an effective resalable pack, to protect the product from spoilage after multi-use occasions (a necessary feature for flexible packaging) is just one design feature that can be effective.

Resealable Packaging to Minimize Food Loss and Waste

A very important Save Food Packaging criteria is resealable packaging. Under the umbrella of resealable packaging there are many intuitive technologies including resealable zippers, resealable lidding films, resealable reseal adhesives, resealable packaging, sliders, resealable zipper tapes & labels, valves and more.

Resealable packaging provides a myriad of benefits including extension of shelf life, reduction in spillages, retention of nutritional value and freshness of product, ingress of flavors, prevention of further product contamination, consumer convenience, controlled dispensing and pouring, allowance for multiple uses of the same pack and easy storage.

Through this innovative packaging design consumers have the ability to retain the product in the original pack and not add additional plastic film, foil, bags or containers to maintain freshness and quality of the product. All of these benefits in turn ensure the prevention of unnecessary FLW.

Is your Packaging Openable and Accessible?

All too often Accessible Packaging is not considered when designing products which in turn leads to unnecessary frustration when opening & closing packs, reading the ingredients and opening instructions on packaging.

It is important that packaging technologists consider how their packaging design could affect someone's ability to eat, drink and the flow on of wasting food.

For packaging to be accessible, it must be designed to be easy for the consumer to open, have legible labelling, and not compromise safety or quality. Sustainable packaging cannot meet consumers' needs and expectations if it is not accessible. Easy-to-open and functional packaging is a major consumer concern, as well as a health and safety issue.

Some sections of the community have difficulty with product labelling and packaging. For a consumer to get full satisfaction from the product, the packaging needs to be functional and usable – this includes the ability to open and close, and with legible labelling (consider font size and print contrast). Packaging that is difficult to open can contribute to food waste, particularly in hospitals and aged care facilities.

4. Design to communicate to consumers & promote how to handle, store, prepare and reuse food products

Figure 11 - 4. Design to communicate to consumers & promote how to handle, store, prepare and reuse food products

Information is essential to ensure the household and/or consumer understands the most appropriate ways to store, handle and prepare food to stop possible spoilage and food being thrown away. Consistent communication to consumers on a range of information is needed i.e. recipe ideas for leftovers could be provided to ensure all the product is used in multiple meals.

Best Before & Use-by

The selection and understanding of 'Best Before' or 'Use By' dates needs to reflect the manufacturers and retailers' warehouse and distribution timing and provide the consumer understanding of when the product is no longer suitable or safe to consume. It's a complex issue and needs focus and increased levels of understanding.

How does the Packaging Promote Save Food Packaging?

In addition to this information, there is an additional need for manufacturers and retailers to communicate to the consumers why the packaging format is being used to extend the product quality and promote consumer use, not waste. This could be both on pack, off pack or, in store. Such information will help educate consumers on why packaging is being used, and assist in navigating the current, significant, negative consumers perceptions of packaging, especially plastic packaging.

Designing to communicate to consumers includes Usage & Storage instructions, date labelling – including Best Before, Use By and Good After and On-Pack communication. On-Pack communication can include everything from why the product is packaged a certain way to extend shelf life, resealable functionality, any intuitive design features all the way through to preparation and left-over ideas. Consider packaging impacts during the use phase in consumer homes. Pack access, correct portion sizing, dispensing and convenience all impact food waste and your brand perception.

5. Design to balance food & packaging waste targets for optimal packaging

Figure 12 - 5. Design to balance food & packaging waste targets

Consideration must include a balanced evidence-based approach to ensure that the packaging meets all necessary Sustainable Packaging Guidelines and be able to be truly collected, sorted, recycled and reprocess in the country in which it is sold.

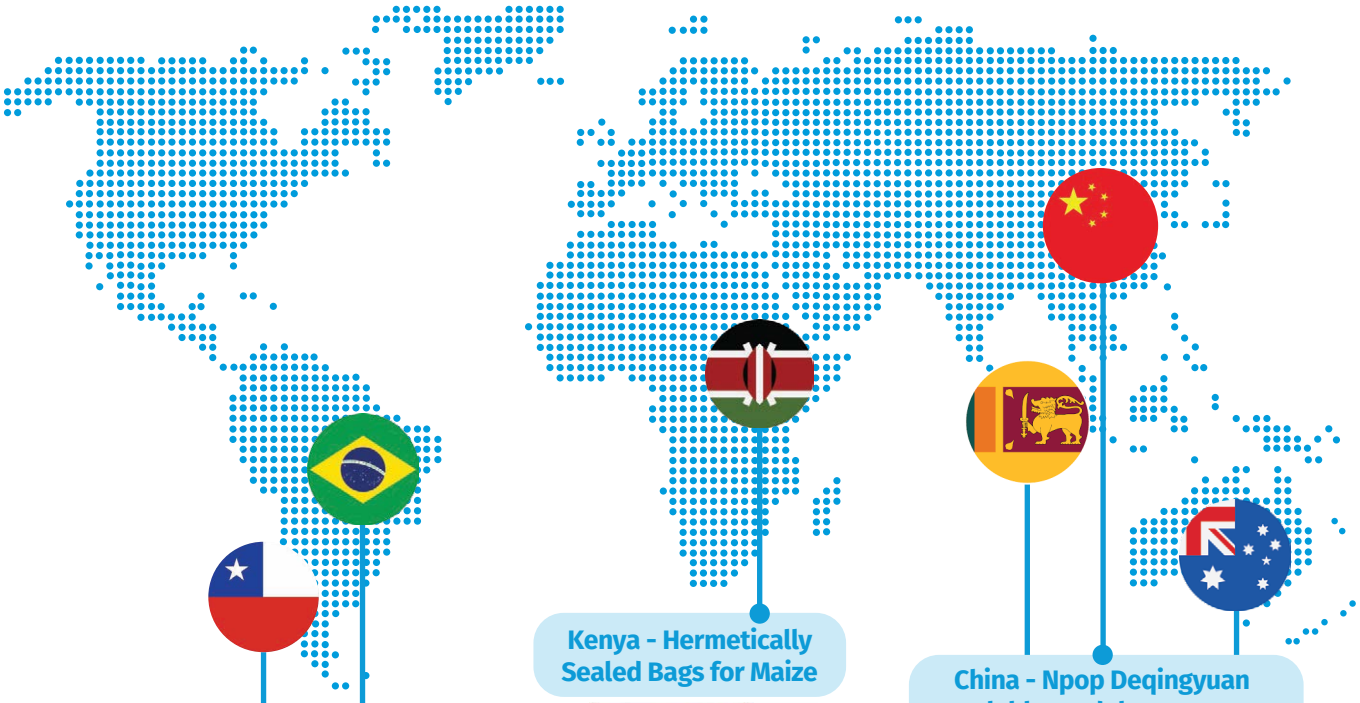
Packaging technologists and designers need to understand that in using the Save Food Packaging Design guidelines to contain, protect, preserve, extend, increase appeal, assist in handling and usage, they also need to balance the design criteria with the Sustainability Packaging Guidelines (SPGs) selecting a sustainable packaging outcome with the lowest environmental impact available.

We also need to see improved communication, on and off pack, showcasing the added value of Save Food Packaging designs and functions to increase consumers awareness of the benefits and services packaging plays in reducing overall environmental food waste impacts.

Avoiding FLW across a value chain is a critical packaging issue and one that food producers, manufacturers, brand owners, retailers and consumers need to better understand. The intersection between innovative and intuitive Save Food Packaging design and food loss and waste needs to be discussed more openly in the industry across the globe. If Packaging Technologists and Designers across the globe follow the Save Food Packaging design guidelines the industry can design better packaging for more people that will ultimately contribute to minimizing FLW. Everyone has a role to play.

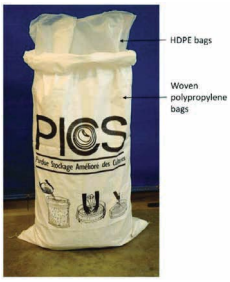

Image: Thomas Le/Unsplash

4. CASE STUDIES AND BEST PRACTICES



Brazil - FarmFresh Conserver 'Dacolheita' for fruit

Kenya - Hermetically Sealed Bags for Maize



China - Npop Deqingyuan recyclable modular egg carton

Sri Lanka - Active Packaging System for Prawns - JF Packaging

Australia - Junee Prime Lamb – premium meat for export markets

Chile - LifeSpan copper-based film that was developed by Amcor Chile in partnership with Copperprotek

Australia - ThermoShield Temperature Monitoring System – Food by Caps & Closures

Chile - LifeSpan copper-based film that was developed by Amcor Chile in partnership with Copperprotek

Figure 13 - Chile - LifeSpan copper-based film that was developed by Amcor Chile in partnership with Copperprotek

The Copperprotek technology is ideally suited for cheese and fresh processed meat such as ham, bacon and fresh chicken and contains copper micro particles that inhibit the development of microorganisms such as bacteria and fungi that spoil food. The micro particles extend the shelf life of the product by up to 250% and are designed to protect and preserve the product all the way through the value chain. This revolutionary technology of adding copper particles to the packaging material not only improves shelf life but also reduces FLW across the value chain.

Copperprotek can extend shelf life of Process Meat by 30 days, Fresh Poultry by 11 days, Fresh Pork by 23 days and Fresh Cheese by 5 days. The impact on shelf life will depend on the product, process, ingredients and each case will be treated accordingly to understand shelf-life extension.

Australia - ThermoShield Temperature Monitoring System – Food by Caps & Closures

Figure 14 - Australia - ThermoShield Temperature Monitoring System – Food by Caps & Closures

The core innovation of the ThermoShield Temperature Monitoring System lies in the integration of thermochromics technology seamlessly within the packaging. This intelligent material acts as a visual monitor, instantly changing its color appearance at a pre-selected temperature switching point. Doing so provides an immediate and easily recognizable indication of any temperature fluctuations during the product's journey.

By promptly identifying these deviations, ThermoShield empowers stakeholders to take immediate corrective measures, preserving the product's freshness and integrity during manufacturing, warehousing, and distribution.

ThermoShield's temperature-sensitive capabilities play a crucial role in extending the product's shelf life. By continuously monitoring the temperature during its journey through the cold chain process, ThermoShield helps maintain optimal storage conditions. Any deviations from the recommended temperature range are promptly detected and addressed, significantly reducing the risk of premature spoilage and degradation. This proactive approach ensures that the product remains in top-notch condition for an extended period, maximizing its shelf life and overall appeal to consumers.

ThermoShield continues to play a pivotal role as the product moves through various distribution stages. From transportation to retail shelves, this innovative visual monitoring system ensures that the product's ideal temperature is maintained, reducing the risk of spoilage and ensuring its integrity is upheld.

Kenya - Hermetically Sealed Bags for Maize

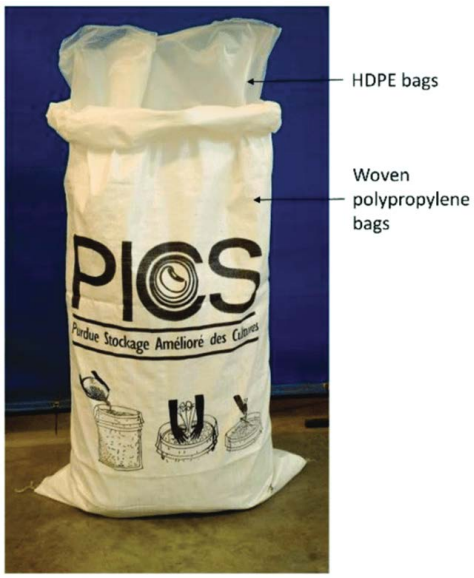


Figure 15 - Kenya - Hermetically Sealed Bags for Maize

Maize Farming in Kenya is the single most extensively grown crop in the country. It is the staple food for more than 80 per cent of the population and the average per capital consumption is 103kg per person. Maize farming accounts for 3 per cent of Kenya's gross domestic product (GDP).

A recent project undertaken by WPO Member, the Institute of Packaging Kenya (IOPK) identified that 40% of the Ugali Maize food staple was being lost and wasted all the way from production to storage in one farming area. The key losses were at the drying stage where there is limited access to affordable drying sheets and then during storage due to the lack of access to affordable hermetically sealed bags.

Ugali Maize Food Loss Areas and Challenges

The maize is dried naturally by the sun. If it rains it needs to be protected with an HDPE tarpaulin or sheeting. This is where the highest losses occur as many farmers don't have access to the drying sheets as they are expensive. One crop can equate to anywhere from 200 to 100 bags of maize and approximately 20 bags are wasted in drying process.

Ugali Maize Food Waste areas and challenges

Once the crop reaches the right moisture level the maize is placed into Hermetic woven PP bag (inside HDPE inner bag) after several days of drying in the sun. The maize is store for family consumption and sale. (Stored util next season 12 months away.) Protection in storage is critical for no further losses. The store will be fumigated against weevils and mice/rats.

Kenyan PICS is a double liner hermetic storage bag that is chemical free. No chemical fumigants are required for grain storage when using PICS hermetic bags to prevent insect infestation and ultimate post-harvest losses for all dry grains. PICS preserves and maintains the quality of grain by keeping it airtight/hermetic. The Hermetic Bags are better to protect against weevils but are more expensive for the farmers.

Actions recommended out of the WPO and IOPK project were that the farmers need access to affordable drying sheets such as HDPE sheets or LDPE 100 micron in roll film ($50 US for 20 metre sheet). They also need a UV inhibitor in the sheet – could be woven PE. The farmer also need access to affordable Hermetic Bags (approx. $2.50 US a bag for a 90 kilo bag). PP bags are significantly cheaper but weevils get in the bags. (.60c US)

Australia - Junee Prime Lamb – premium meat for export markets

Figure 16 - Australia - ThermoShield Temperature Monitoring System – Food by Caps & Closures

The Meat category generates 21% of the total food waste carbon footprint globally which is a substantial impact on the environment. Junee Lamb, one of Australia's leading producers of premium quality lamb. Export a large amount of their products and were finding that they had 40% food waste in their export value chain due to the meat with bones puncturing the packaging material during transportation. The food waste was at a significant cost to the business and every time a pack failed it cost all the stakeholders across the value chain and was also a burden on the environment. The challenge was about understanding where the damage occurred and why, and then coming up with a new innovative design that could provide robustness to prevent future damage and losses.

The new customised built-in bone guard protection vacuum pack is designed to be tear and puncture proof, which in turn protects the bones from splitting through the packaging material. There are no more leaking packs during the export value chain and the new pack can withstand the rigours of storage & transport. The new design extends the shelf life of the product to 90 days which is a significant improvement. In addition, the packaging to product ratio has been improved so that it meets both food waste and packaging waste targets and extends the shelf life of the product to 90 days.

China - Npop Deqingyuan recyclable modular egg carton

Figure 17 - China - Npop Deqingyuan recyclable modular egg carton

This intuitive modular and flexible egg carton solution was designed for a specific region in China that has a high diet of eggs. The families travel to the markets to purchase their eggs and found that during transportation back to their homes and also during storage they were wasting about half of the eggs. This new modular solution is designed not only for transportation and handling but also for storage protection. Since moving to this new pack the families have found that they have 50% reduction in egg damage, shelf life has extended by 50% and packaging efficiencies have improved by 20%. The design is ideal for transport, logistics and also e-commerce solutions. In addition, the pack meets both food waste and packaging waste targets as it has been designed to be reusable, reducing single use egg cartons in the region.

Brazil - FarmFresh Conserver ‘Dacolheita’ for fruit

Figure 18 - Brazil - FarmFresh Conserver ‘Dacolheita’ for fruit

FarmFresh EPS conservers, manufactured by Termotécnica and sold in the Brazilian market under the DaColheita brand, guarantees added safety in protecting, storing and transporting fruits, legumes, vegetables (FLV). With patented technology and designs, FarmFresh EPS conservers allow high thermal insulation, impact absorption, ease in stacking, transport and product display. This also represents an extension of shelf life with healthy, fresher FLV on store shelves providing many advantages for the retailer.

FarmFresh EPS packaging can extend the shelf-life of fresh produce by up to 30%, providing benefits to all stakeholders in the FLV supply chain. EPS packaging delays the ripening processes, inhibits microbial decomposition and preserves the quality and nutritional value of packaged fruits and vegetables, prolonging the time in which they can be consumed. The exclusive formulation also preserves the nutritional value of fresh produce after prolonged storage, maintaining quality for longer while also avoiding food waste.

The innovation ensures that any fresh produce that is purchased through the e-commerce value chain reaches the customer's home while still maintaining freshness, quality and safety.

Sri Lanka - Active Packaging System for Prawns - JF Packaging

Figure 19 - Sri Lanka - Active Packaging System for Prawns - JF Packaging

Sri Lankan summer temperatures, long supply chains and deliveries that sit on a doorstep for 12+ hours present Black Tiger Prawn products very challenging environmental challenges. Food spoilage and food safety are the highest concerns for the company that needed to be resolved.

From a health and safety aspect they wanted to minimize toxic microbial growth, prevent bad odors when the pack is opened and ultimately enhance shelf life and retain freshness of the prawns.

JF Packaging partnered with Black Tiger Prawn to develop an Active Packaging system with easy openable tear notches, a resealable and reclosable zipper and a built-in active process to extend shelf life.

The Active pack design retains oxygen absorbed by Albis plastic Shelf plus master batch and the CaCO3/CaO white master batch absorbs the moisture. In addition, the anti-microbial, anti-fungal master batch inhibits aerobic and anaerobic microbial growth, incorporated to inner layer extruded, PE film, which in turns protects and preserves and extends the shelf life of the Black Tiger Prawn. Since re-designing the packaging, the company has seen significantly reduced food waste and spoilage during the transportation process.

5. CALL TO ACTION

Global Challenge: Food Security and Food Loss and Waste

Food systems lie at the heart of some of the world's most pressing challenges, influencing food security, environmental stability, and economic development. Despite sufficient global food production, enough to feed 1.5 times the current world population, hunger persists. Today, 733 million people, or about one in every eleven globally, still face hunger. Without significant intervention, projections show that hunger levels of 2030 may surpass those of 2015, when the SDG on Ending Hunger was set (UNIDO & FAO, 2024).

This crisis is not solely due production, but about systematic inefficiencies across food systems. Barriers in access, distribution, and post-harvest losses combined with socioeconomic inequalities, conflict, and climate extremes prevents food from reaching those who need it most. Food loss and waste (FLW) are central to this problem, leading not only to lost resources, but also to reduced food availability and higher market volatility.

Addressing FLW is therefore critical to advancing global food security. The joint UNIDO-FAO report titled *Ending Hunger is Possible: An Income-Generating Approach Through Value Addition* identifies six action areas to end hunger sustainably:

- **Enhancing farm productivity through agricultural research, technology adoption, and mechanization.**
- **Investing in infrastructure such as irrigation, electricity, rural roads, and storage.**
- **Investments in agrifood processing, distribution and retail, particularly by agrifood SMEs in domestic and regional markets.**
- **Increasing access to finance for small scale producers and agri-food SMEs.**
- **Strengthening social protection programs to improve education, empower women, and build financial confidence in vulnerable communities.**
- **Advancing trade policies and regional integration.**

Among these priorities, strengthening investments in agri-food processing, packaging, and distribution, collectively referred to as the **Hidden Middle**, is recognized as key to building resilient, efficient food systems.

Unlocking the Hidden Middle: A Critical Link in Sustainable Food Systems

The Hidden Middle plays a crucial yet often overlooked role in ensuring food security. Positioned between agricultural production and final consumption, these segments are responsible for converting raw agricultural goods into safe, accessible, and marketable food products. Together, they account for up to 40% of the total value added in food value chains, making them a powerful driver of both economic development and food system resilience.

Despite its importance, the Hidden Middle is often overlooked in policy frameworks and investment strategies. Strengthening this segment is essential to reducing food loss, improving food safety, and extending the shelf life of products, essentially ensuring that food reaches markets and consumers in optimal condition.

Packaging in particular, is a key pillar of the Hidden Middle. It protects food during transport and storage, extends shelf life, and allows producers to meet food safety and quality standards required for market access. By investing in sustainable, context-appropriate packaging solutions, food systems can simultaneously reduce waste, support trade, and contribute to broader sustainability goals.

As global efforts transition from commitments to implementation, unlocking the Hidden Middle within food systems, with packaging as a central pillar, emerges as crucial for global food resilience and climate security. This growing recognition of food system's pivotal role in achieving sustainable outcomes is gaining significant momentum on the global stage, setting the foundation for the next phase of action.

Global Momentum: Food Systems at the Heart of Climate Action

The Conference of the Parties (COP) serves as the world's platform for climate action, bringing together governments, policymakers, and stakeholders to negotiate and implement solutions to the climate crisis. Established under the United Nations Framework Convention on Climate Change (UNFCCC), COP has played a pivotal role in global climate governance, most notably through the adoption of the Paris Agreement at COP21 in 2015. This legally binding international treaty set the goal of limiting global warming to below 2°C and pursue efforts to limit it to 1.5°C above pre-industrial levels.

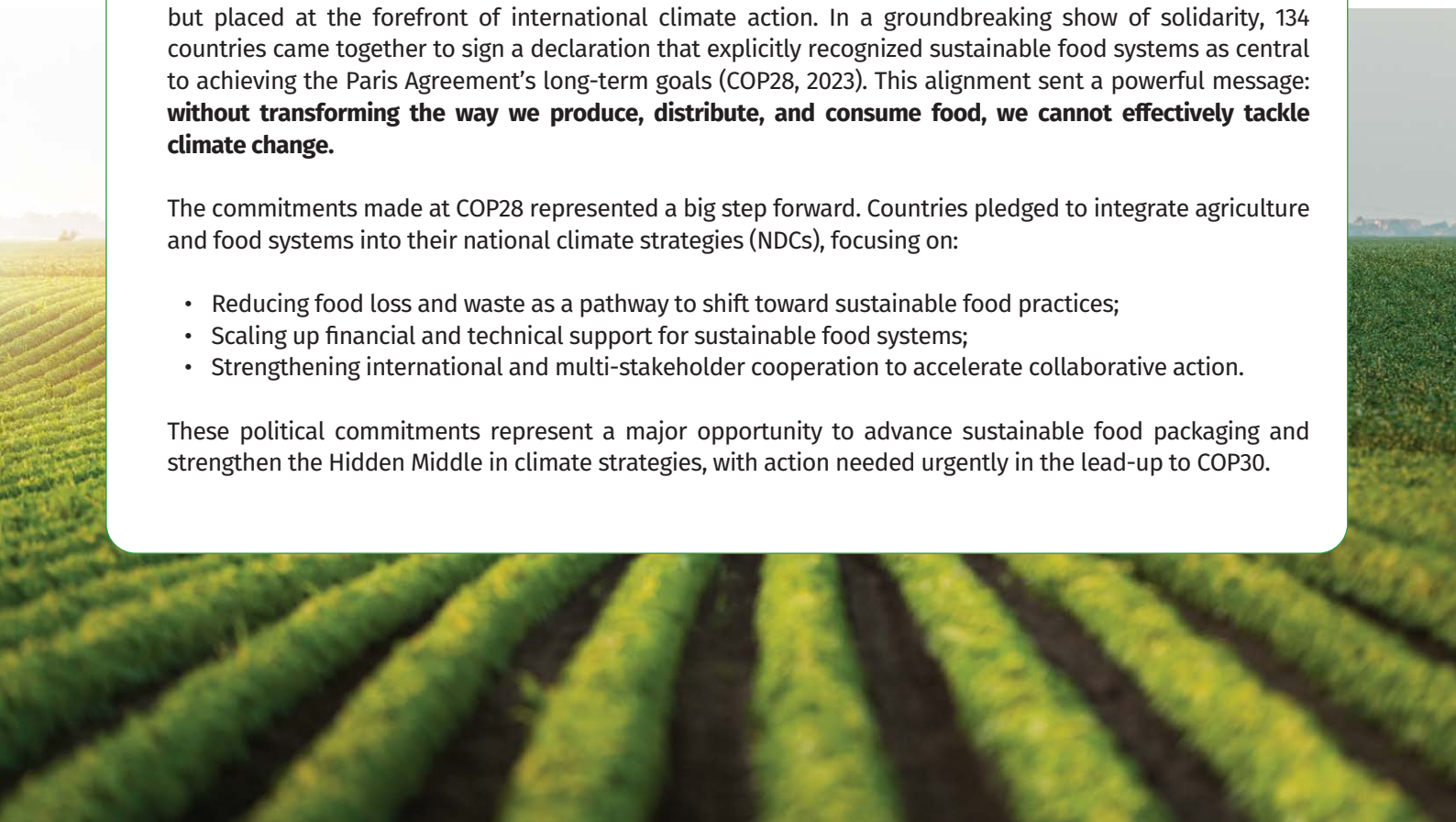
COP28: Critical Milestone for Agriculture and Food Systems

Held in the United Arab Emirates from 30 November to 12 December 2023, COP28 marked a historic turning point in global climate dialogue. For the first time, agriculture and food systems were not only acknowledged but placed at the forefront of international climate action. In a groundbreaking show of solidarity, 134 countries came together to sign a declaration that explicitly recognized sustainable food systems as central to achieving the Paris Agreement's long-term goals (COP28, 2023). This alignment sent a powerful message: **without transforming the way we produce, distribute, and consume food, we cannot effectively tackle climate change.**

The commitments made at COP28 represented a big step forward. Countries pledged to integrate agriculture and food systems into their national climate strategies (NDCs), focusing on:

- Reducing food loss and waste as a pathway to shift toward sustainable food practices;
- Scaling up financial and technical support for sustainable food systems;
- Strengthening international and multi-stakeholder cooperation to accelerate collaborative action.

These political commitments represent a major opportunity to advance sustainable food packaging and strengthen the Hidden Middle in climate strategies, with action needed urgently in the lead-up to COP30.



Global Perspectives on Sustainable Food Systems: A Consultation Journey

Bringing together representatives from across sectors and regions allows for critical dialogue needed to identify concrete priorities, challenges, and opportunities within global food systems. In this context, a global and regional consultation journey was initiated.

These sessions brought together experts from industry, academia, and international organizations to explore the role of sustainable industrial development of food packaging in advancing food security, improving trade and market access, and its contributions to environmental sustainability address the critical challenges and opportunities in their food systems.

By engaging diverse voices and regional perspectives, these consultations provided valuable insights to shape the next steps in strengthening food systems through innovation in packaging.

Global Consultation Journey

A central part of the global consultation journey are the roundtable discussions, which were held across four key regions: Middle East and Africa, Asia, and Latin America, as well as a Global Dialogue that took place at the Vienna Sustainable Food Packaging Forum (VSFP). These discussions explored region-specific challenges and opportunities in sustainable packaging, food security, and trade, providing key insights to inform global strategies.

Overall, the global consultation journey successfully brought together 147 representatives, from 53 different countries to exchange insights and experiences.

Middle East and Africa (MEA) Roundtable

The MEA region faces significant food loss challenges, with rates reaching up to 60% in certain areas, primarily due to inadequate storage, poor transportation, and high temperatures accelerating spoilage (UNIDO, 2025a). Addressing these issues requires improved cold chain logistics, better handling practices, and community-based initiatives such as the establishment of aggregation hubs to support small businesses with shared packaging facilities/centers. The region is also heavily reliant on imported packaging materials, particularly from Europe, which increases costs and exposes supply chains to external

disruptions. Developing local sustainable packaging industries through regional cooperation and investment in domestic manufacturers is essential to improving affordability and strengthening supply chain resilience.

The impact of evolving global regulations presents further challenges, particularly new European Union packaging laws affecting exports from MEA countries. Stronger regional regulatory alignment is necessary to help businesses adapt while maintaining market access.

Funding constraints also limit the expansion of promising initiatives, such as returnable crates for transport and sustainable packaging hubs. Integrating food waste reduction efforts into global climate finance mechanisms, including COP discussions, would facilitate investment and donor support. Expanding Extended Producer Responsibility (EPR) policies, as for example implemented in South Africa, can drive circular economy progress across the region. However, collaboration alone is insufficient and achieving real impact requires clear roadmaps, defined milestones, and measurable actions to ensure sustainable and effective implementation.

Asia Roundtable

Similar to the MEA region, countries in Asia face significant challenges with sudden regulatory changes, such as plastic bans and Extended Producer Responsibility (EPR) laws, often implemented without clear transition strategies (UNIDO, 2025b). As packaging plays such a central role in food value chains, this leads to large disruptions in supply chains and uncertainty for businesses. A phased implementation approach is

needed to ensure sustainability targets are met while allowing industries sufficient time to adapt. Stronger collaboration and knowledge exchange between governments and packaging experts is essential to developing realistic, long-term strategies that support both regulatory goals and industry needs.

A major gap in Asia's packaging sector is the lack of specialized knowledge and access to advanced equipment, particularly for SMEs and vocational schools. Capacity-building programs, technical training, and investments in packaging education are necessary to strengthen industry expertise. Similar to the MEA and African regions, SMEs in Asia struggle with high costs and limited access to sustainable packaging solutions. Financial incentives, collaborative training programs, and industry support can help bridge this gap.

Waste management remains a key issue, especially for low-value packaging materials that are not economically viable to recycle. Strengthening recycling infrastructure, investing in biodegradable alternatives, and raising public awareness on the role of packaging in food protection are critical priorities. Stronger partnerships among governments and packaging centers across the region will be essential in developing tailored solutions, aligning packaging regulations with global standards, and driving research into cost-effective sustainable materials.

Latin America (LATAM) Roundtable

The discussion highlighted the region's diverse challenges and opportunities in advancing sustainability within the packaging sector (UNIDO, 2025c). Countries in the region vary significantly in their level of

development, with some, such as Mexico, having well-established packaging centers, while others, like Paraguay and Peru, have only recently launched associations. This disparity reinforces the need for regional collaboration to facilitate knowledge exchange, technology transfer, and policy alignment. Similar to challenges observed in the MEA and Asian regions, inconsistent regulations, limited infrastructure, and unclear policies create obstacles to effective sustainable packaging adoption, and through that also waste reduction. While many countries are making efforts to phase out single-use plastics, high costs and limited availability of biodegradable alternatives present barriers to adoption, particularly for SMEs.

LATAM also faces significant waste management challenges, mirroring issues in the MEA and Asian regions. Many countries lack efficient waste collection, recycling, and composting systems, limiting sustainability efforts. Waste collection in the region is highly dependent on informal waste pickers, who focus on materials with financial value such as aluminum cans and paper. Establishing economic incentives for post-consumer packaging materials could improve recycling rates and contribute to a circular economy.

Global Dialogue at the Vienna Sustainable Food Packaging (VSFP) ConFex

Packaging plays a dual role in global food systems. It is essential for protecting food, extending shelf life, and reducing FLW, yet when mismanaged, it becomes a significant environmental pollutant. Navigating this tension requires integrated approaches that both maximize the benefits of packaging and minimize its environmental impact.

At the policy level, global packaging regulations are evolving rapidly. Emerging policy frameworks such as Europe's Packaging and Packaging Waste Regulation (PPWR) reflect the growing global momentum, but also the growing complexity (UNIDO, 2025d). Meeting these requirements needs more than just recyclable materials but requires a full lifecycle approach, supported by consideration of the entire value chain. more importantly a holistic system with robust infrastructure for collection, sorting, and recycling. Regulations must carefully balance recyclability, food safety, and circularity, supported by clearly defined responsibilities across the value chain. For example, effective Extended Producer Responsibility (EPR) schemes ensure producers contribute to managing packaging throughout its lifecycle.

Yet regulations must not be "copy and paste" but approached context-specifically. Packaging value chains must be adapted to reflect the realities of local infrastructure, recycling capacity, and consumer behavior, particularly in developing countries with highly localized value chains and limited infrastructure. Without such adaptation, even well-meaning policies risk being ineffective or counterproductive. Investments in packaging education, material recovery systems, and centralized data collection are foundational to ensuring sustainable systems.

To scale solutions globally, clear standards and localized policy frameworks must be paired with international collaboration and inclusive representation. It is essential that underrepresented regions, such as those in the Global South, have a voice in shaping strategies that reflect their unique challenges and capacities.

In the lead up to COP30, integrating agriculture and food systems, and more particularly sustainable food packaging into national climate commitments is a critical next step. Developing standardized methodologies to measure carbon emissions related to packaging and FLW is essential to effectively guide data-driven policymaking and investments. As emphasized throughout the Global Dialogue, this transformation will require sustained cross sector collaboration, context-specific policies, and shared commitment to building resilient and sustainable food systems.

Driving Global Momentum at COP29

Continuing the global momentum set at COP28, discussions on sustainability of agrifood system continued at COP29. The underrepresentation of the Hidden Middle in global policies were highlighted, and actionable next steps were discussed (Devex Partnerships, 2025). A key focus on communication was deemed essential to elevate the visibility the hidden middle's importance. Without greater recognition by policymakers and the public, this part of the value chain risks remaining underprioritized and underfunded, despite its pivotal role in improving food security and enhancing climate resilience.

Second, while many proven technologies already exist, such as solar-powered cold chains, aseptic processing, and advanced packaging, scaling them in rural areas remains a significant challenge. Small and medium-sized enterprises (SMEs), which form the backbone of food systems, often lack access to the financing and support needed to adopt these innovations.

To address this, the roundtable underscored the importance of fit-for-purpose financial solutions, including simplified access to funding for SMEs and stronger collaboration between public and private financial actors. Equally important is the creation of inclusive partnerships that integrate perspectives from governments, the private sector, international organizations, and local communities, including those from the Global South and Indigenous groups. Their

lived experience offers valuable insights into developing context-appropriate and sustainable solutions.

Finally, the discussions underscored the urgency of action. Food systems are already being disrupted by climate impacts, and without immediate intervention, these disruptions will intensify. As echoed by speakers across the session, no NFCs 3.0 should be complete without addressing food systems and packaging. Acting now to transform the hidden middle can deliver both immediate benefits and long-term resilience, helping to build climate-smart food systems that are efficient, equitable, and secure.

Looking Forward: Key Areas for Action

Sustainable and inclusive industrial development plays a critical role in building food systems that are resilient, resource-efficient, and sustainable. These efforts are particularly important for supporting livelihoods and improving food security in developing countries, where communities often face heightened vulnerabilities related to poverty and food scarcity. This approach not only supports food security and economic development but also contributes to broader climate and sustainability goals.

Insights from the consultation journey reaffirms this, and highlights the need for a comprehensive, systems-based approach addressing the entire food supply chain, with targeted focus on food processing and packaging technologies. This is essential to building effective, resilient and sustainable food supply chains that minimize food loss and waste.

To achieve this, the following areas of action are recommended:

Strengthening Centers of Excellence on Packaging

Building capacity of existing national packaging centers to serve as Centers of Excellence and establishing new ones in countries where they do not yet exist is key. These centers are positioned as national hubs for packaging expertise, supporting governments and industries with technical guidance, policy input, training, and innovation in sustainable packaging. Centers with sufficient capacity enables them to offer context specific support to both public and private sectors, serving as a one-stop-shop for all packaging related matters in the country.

Public Awareness and Education

Raising awareness and educating the public on the fundamental roles of packaging in food preservation, along with proper disposal practices, is essential to positioning sustainable food packaging as a key solution for reducing FLW, and a key component of sustainable food systems and global sustainability efforts.

Quantification and a Systematic Global Approach

Development of a coherent methodology to quantity FLW and the impact of sustainable packaging interventions is urgently needed. Standardized data collection and analysis across food value chains will enable benchmarking, guide decision making, and strengthen accountability.

Partnerships

Cross sectoral partnerships at the national, regional, continental and global levels are essential to bring together key stakeholders and jointly address the FLW paradox. Through synchronized efforts and joint initiatives, collective action will be accelerated achieving the 2030 agenda and halving the amount of global food loss and waste as set out in SDG 12.3.

Global Outreach and advocacy

Highlighting success stories and narrative work, as well as advocating for joint efforts on national, regional, and global platforms is necessary for advancing the sustainable packaging agenda. Continued advocacy, especially in follow-up to the COP28 Declaration on Sustainable Food Systems, will help secure funding and political commitment.

Support in developing realistic national and regional policies

Navigating the food loss and waste paradox is a challenging landscape for governments, and therefore require tailored support to develop actionable, coherent, and context-specific policies. Aligning national regulations with international frameworks while considering local production and waste infrastructure is critical to ensure effective implementation and sustainable industrial development.

Financing

Investments are essential to improve agrifood systems, driving both increased food production and sustainable practices. By focusing on value addition, these investments can create income opportunities and promote resilience for vulnerable communities. To end hunger and ensure long-term food security, financing must support both economic growth and sustainability.

ANNEX

Annex 1 – United Nations Industrial Development Organization Organizational Background

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Progress by innovation

UNIDO's mandate is reflected in Sustainable Development Goal (SDG) 9: "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation", but UNIDO's activities contribute to all the SDGs. UNIDO's vision is a world without poverty and hunger, where industry drives low-emission economies, improves living standards, and preserves the livable environment for present and future generations, leaving no one behind. UNIDO provides support to its Member States through four mandated functions: technical cooperation; action-oriented research and policy-advisory services; normative standards-related activities; and fostering partnerships for knowledge and technology transfer. UNIDO's work is concentrated on three focus areas:

- Supporting sustainable supply chains so that developing country producers get a fair deal and scarce resources are preserved;
- Limiting climate breakdown by using renewable energy and energy efficiency to reduce industrial greenhouse gas emissions;
- Ending hunger by cutting post-harvest losses and developing agri-business value chains.

Division of Agribusiness and Infrastructure Development (AGR) supports Member States in their efforts to pave the way to sustainable rural development and a structurally transformed and modernized agribusiness sector by addressing emerging global trends, in particular food security, poverty alleviation, climate change and agro-innovation. The Division provides technical cooperation services to assist developing countries, contributing to rural economic development and structural transformation by adding value to the output of their agricultural sector (food and non-food), as well as generate off-farm employment opportunities in rural communities. Furthermore, to assist the modernization of agriculture and agroindustry, especially in less-developed countries, ensuring that the imports of food and other value-added agricultural products are substituted, and enterprises participate effectively in local, regional, and global value chains.

Within the Division, the Food Security and Food Systems Unit (FSS), promotes the development of food industries and food value chains and the production of local food products in less-developed countries to end hunger and ensure food and nutrition security while generating income and employment adhering to principles of sustainable industrial development. Moreover, FSS promotes the setting up of Centers of Excellence (CoEs) to enhance food value chain performance and ensure the centers access appropriate and affordable technology, knowledge, and support services. The Unit is also supporting developing countries in establishing or strengthening their food safety systems, legal and regulatory capacities, and infrastructure to improve the safety and sustainability of food production and build capabilities among food processing industries to comply with quality, food safety, and other standards and requirements of local and international markets.

Annex 2 – World Packaging Organisation Organisational Background

The World Packaging Organisation is a non-profit, non-governmental, international federation of national packaging institutes and associations, regional packaging federations and other interested parties including corporations and trade associations. The WPO has 65 Member countries representing various peak professional bodies, training organizations and packaging industry groups from all corners of the globe. The WPO is a strong strategic partner of UNIDO, Save Food Org and Messe Düsseldorf, and Interpack.

https://www.worldpackaging.org/

WorldStar Packaging Awards

Owned & Operated by the WPO the WorldStar Packaging Awards are the pre-eminent awards program in the world. Only packaging that has won recognition in a recognized national or regional competition, either in the present year or the previous year is eligible to apply for WorldStar Competition. Each WorldStar award winner is judged by a large team of experts from over 35 countries and as a part of the judging process they recognize that the nominated products have already been awarded a local recognition in the country in which the product is sold. The judges understand that the nominated packaging has already been reviewed by the country-based WPO packaging organization through their own awards program as meeting local governmental and country legislations including recycling capabilities, sustainable packaging design targets and more. The judges understand that not all winning solutions can be transferred across multiple countries, but rather may be country-specific.

There are currently, 73 competitions from 39 countries and regions are recognized by the WPO as qualifying for entry to the WorldStar Packaging Awards program.

There are 18 General award categories and 5 special awards including Accessible Packaging Design, Marketing, Sustainable Packaging Design, Packaging that Saves Food and the President's Award.

https://worldstar.org/

WorldStar Special Award – Save Food Packaging Design

The Save Food Packaging Design Special Award is designed to recognize companies that are working to minimize or prevent food waste from paddock to plate using innovative and intuitive design features that can contain & protect, preserve and extend shelf life; all the while meeting global sustainable packaging targets.

Annex 3 – Wageningen University & Research Organizational Background

Wageningen University & Research (WUR) is a world-renowned institution that blends academic excellence with applied research in life sciences, food, environment, agriculture, and biobased resources. It consists of two legal entities: Wageningen University and Wageningen Research, both overseen by a common executive board. This structure allows WUR to merge academic learning with practical, project-based research under a unified brand.

WUR's mission is: "To explore the potential of nature to improve the quality of life."

Wageningen University focuses on educational programs and pioneering fundamental research, driving innovation in life sciences, environmental sustainability, and agricultural sciences.

Wageningen Research includes eight specialized research institutes that conduct applied, project-based research and offer services to governments, businesses, and international organizations. These institutes function like contract research organizations, providing custom research, consultancy, due diligence, policy advocacy, and capacity-building solutions.

WUR's unique strength lies in its ability to integrate the expertise of its research institutes and the university. By combining knowledge from various natural and social sciences, WUR fosters a collaborative environment that accelerates breakthroughs and ensures that advancements are quickly applied in practical settings and integrated into programs.

For more information, visit:

- WUR: www.wur.eu

- Wageningen Food Biobased Research (dedicated to the food packaging domain): www.wur.eu/wfbr

Annex 4 - Region-Based FLW Overviews

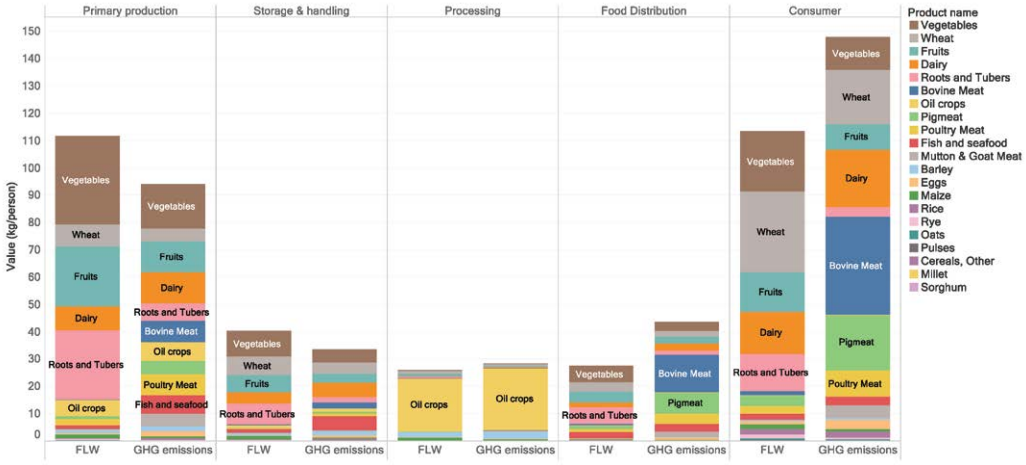


Figure 20 - FLW and associated GHG emissions for Europe by chain stage in 2017 on 0 to 150 kg per person scale (Guo et al., 2020)

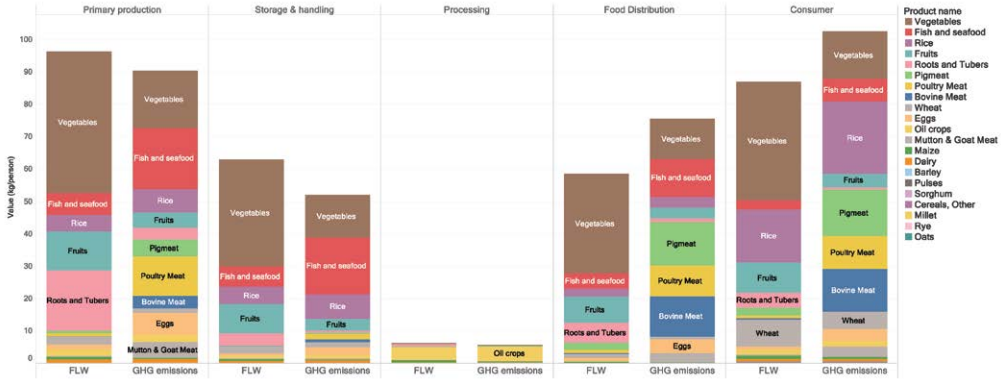


Figure 21 - FLW and associated GHG emissions for Industrialized Asia by chain stage in 2017 on 0 to 100 kg per person scale (Guo et al., 2020)

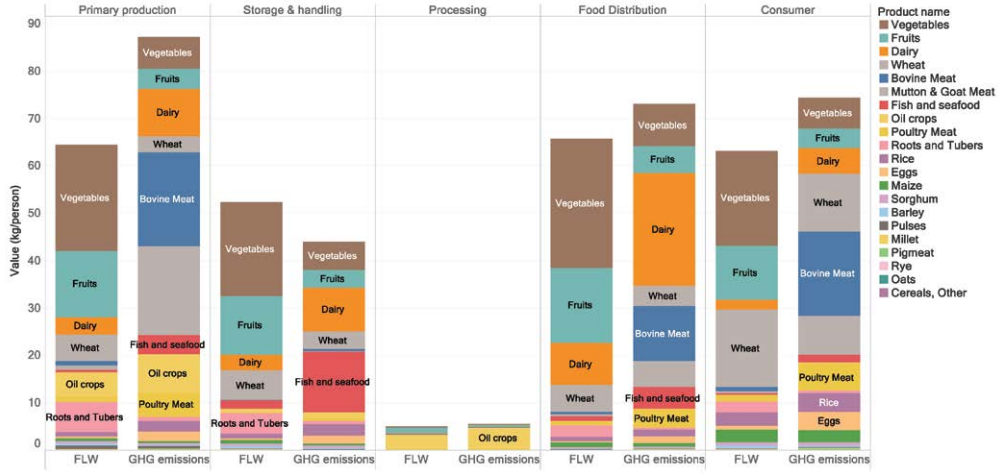


Figure 22 - FLW and associated GHG emissions for North Africa, West and Central Asia by chain stage in 2017 on 0 to 90 kg per person scale (Guo et al., 2020)

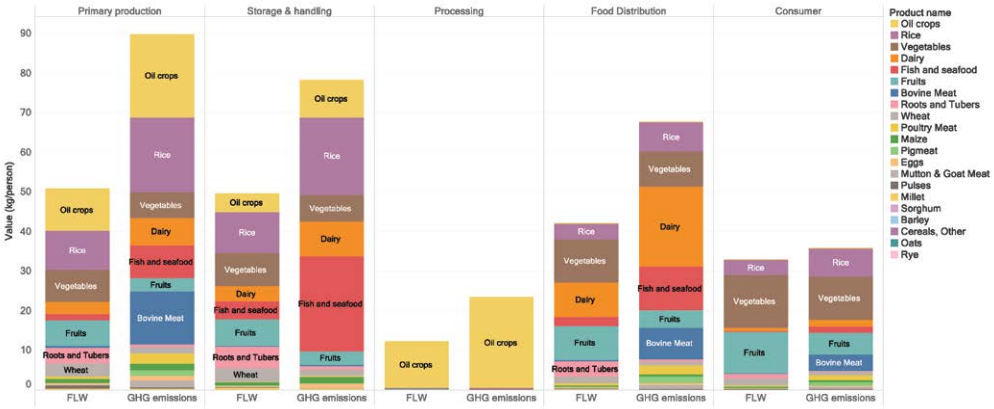


Figure 23 - FLW and associated GHG emissions for South and South-East Asia by chain stage in 2017 on 0 to 90 kg per person scale (Guo et al., 2020)

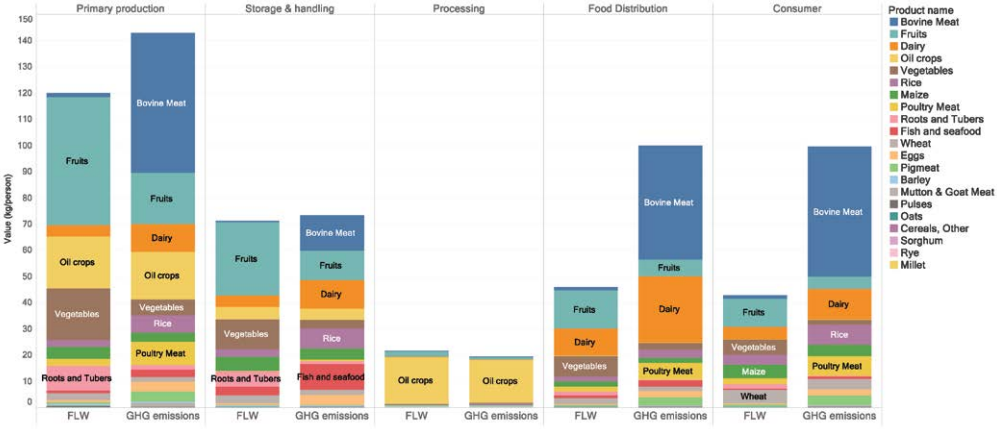


Figure 24 - FLW and associated GHG emissions for Latin America by chain stage in 2017 on 0 to 150 kg per person scale (Guo et al., 2020)

Annex 5 – Save Food Packaging Guidelines

SFP Guidelines (Francis, C., Kelton, N., Ryder, M., Lowenstern, B. Lockrey, S., Verghese, K) have been developed by WPO Member the Australian Institute of Packaging in partnership with RMIT University as a part of the End Food Waste Cooperative Research Centre. The information is sourced from leading literature, food packaging expertise and research insights. It is to provide recommended strategies that are co-created by researchers and industry experts. This initiative aligns to the 2030 UN Sustainability Goals and 2025 Sustainable Packaging Targets.

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WPO Case Studies & Position Papers https://worldpackaging.org/resources/46/

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