

Reducing Food Loss and Waste by Strengthening Resilience of APEC Food System and Enhancing Digitalization and Innovative Technologies

APEC Agricultural Technical Cooperation Working Group

May 2024



**Asia-Pacific
Economic Cooperation**



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1. Introduction

We are at the cusp of several global transformations: energy transition, AI technological leap forward, climate change, etc. This two-day hybrid workshop, held physically from 20-21 July 2023 in Chinese Taipei, touches upon these issues as it tackles the use of digital solutions, including AI and waste-to-energy technologies, in minimizing food loss and waste (FLW), which will help in reducing greenhouse gas (GHG) emissions and mitigate the risks of climate change.

Furthermore, as Mr Vincent Lin, the Project Overseer reminded us in his opening remarks, because the APEC region is the world's largest in terms of food production and exports, reducing regional FLW has become a key element of ensuring a sustainable global food system. From the perspective of agricultural economics, food losses represent a waste of agricultural investment, a loss of profits for producers, and higher prices for consumers, thereby weakening food security. On the other hand, food waste occurs at the retail and consumer levels, including at restaurants, supermarkets and school cafeterias. Discarded yet edible food inevitably ends up in landfills, where it decays and creates a major source of methane, which is a potent GHG, more harmful than CO₂. From a sustainable environment or development standpoint, FLW also entails a huge waste of precious resources, including land, energy and water. Faced with this challenge, our economies are now engaging with the key issue of how to use innovative technologies to reduce FLW along the supply chain, and enhance the resilience of the food system.

More on food security, Dr Su-San Chang, Lead Shepherd of the APEC Agricultural Technical Cooperation Working Group (ATCWG), cited the latest UN statistics, which shows that there are still 828 million people suffering from hunger, and yet 14% of food produced is lost between harvest and retail, while an estimated 17% of total global food production is wasted. However, as Brian Lipinski mentioned in Session 1, the latest estimates suggest that the amount of food lost and wasted is as high as 40% of food production.

The ATCWG Strategic Plan for 2021-2025 puts priorities on strengthening regional food security and food safety including by reducing food loss and waste, enhancing the research and development and extension of smart agriculture, building climate smart and resilient agricultural systems, and fostering sustainable agricultural systems. On the issue of food security, the ATCWG's work is aligned with the Aotearoa Plan of Action, the Implementation Plan of the APEC Putrajaya Vision 2040, which emphasizes individual and collective actions that economies would take to ensure lasting food security, food safety and improved nutrition for all, as well as reductions in FLW across the region by promoting agricultural food trade, agricultural sustainability and innovation.

Following the above APEC Leaders' Declarations, ATCWG worked with the PPFS and other food security related APEC fora to come up with the APEC Food Security Roadmap Towards 2030 and its Implementation Plan. This workshop is dedicated to the Implementation Plan 17(e), "to provide capacity building and best practice sharing workshops to support member

economies' individual and collective efforts to align with the UN Sustainable Development Goals 12.3, i.e., *'by 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses,'* with specific indicators based on each economy's respective situation such as measured by the UN/FAO Food Waste Index (FWI) or other appropriate index. And APEC members should promote public-private investment in infrastructure and cold chains to reduce the current levels of food loss and waste and review progress in this area by 2025."

This workshop also aligns with the theme of APEC 2023, hosted by the US, "Creating a Resilient and Sustainable Future for All," especially its sub-theme "Together achieving sustainable, equitable, resilient agrifood systems through climate smart agricultural policies."

The COVID-19 has triggered the transformation towards a digitally-enabled economy. While this has obvious benefits, it also comes with potential risks (e.g., data privacy, trust, affordability and regulatory issues), as Teddy Pavon, Program Director at the APEC Secretariat, warned us in his opening remarks. These are issues that were covered during the workshop. In these two days, member economies were able to obtain, share, strengthen, and develop knowledge, abilities, skills and technical know-how to improve their policies and regulations or their institutional structures or processes on strengthening the transparency, resiliency and efficiency of APEC food system and harnessing circular approaches, digitalization and innovative technologies to reduce FLW.

The two-day workshop consisted of 6 main sessions, including Challenges on reducing FLW through digitalization and innovations along the food supply chain; Digital and financial solutions to FLW reduction; Building a sustainable food system; Member economy reports and pre-workshop survey report; Target-Measure-Act with the aid of technology; and finally, a panel discussion on various issues tackled during the workshop. The proceedings are in [Section 2](#).

Prior to the event, a pre-workshop survey was conducted to gauge the state of FLW and food system resilience across the different APEC economies. An evaluation survey was also distributed to participants after the workshop. Results of these two surveys are summarized in [Section 3](#).

There was a total of 78 participants who attended physically from 10 member economies, including Chile; Indonesia; Republic of Korea; Malaysia; the Philippines; Singapore; Chinese Taipei; Thailand; the United States; and Viet Nam. We also had 57 who participated online from 13 member economies including China; Japan; Republic of Korea; Malaysia; Mexico; New Zealand; Peru; the Philippines; Russia; Singapore; Chinese Taipei; Thailand; and the United States.

2. Workshop Proceedings

The presentation slides of each speaker are available on:
<https://apec-flows.ntu.edu.tw/report-detail.aspx?seq=1027>

2.1 Opening Session

The opening remarks were given by Mr Vincent Lin, the Project Overseer; Dr Su-San Chang, APEC Agricultural Technical Cooperation Working Group (ATCWG) Lead Shepherd, Chinese Taipei; and Mr Teddy Pavon, PPFS Program Director, APEC Secretariat.

Mr Lin welcomed the guests and thanked the co-sponsoring economies of this workshop. He highlighted the importance of the workshop and recalled the past projects by Chinese Taipei related to food loss and waste. After giving a brief background on the effects of food loss and waste, he emphasized the role of digital technology in solving this problem, as well as in strengthening the food system.

After greeting all the participants, Dr Su-San Chang also underscored the importance of tackling FLW. Then, she shared with us the ATCWG and PPFS efforts to strengthen food security and food safety in the APEC region, including by reducing FLW. In this regard, she reminded everyone of the APEC Food Security Roadmap Towards 2030 Implementation Plan 17e on reducing FLW. Lastly, she also expressed the importance of innovative technologies in this fight.

Both Mr Lin and Dr Chang thanked the co-sponsoring APEC economies for this event—viz. Australia; Japan; the Republic of Korea; Thailand; and the United States—and all the participants attending the hybrid event online and in person.

After greeting everyone, Mr Teddy Pavon commended the efforts of Chinese Taipei since 2013 in gathering different member economies to discuss this multifaceted and ever-evolving issue. He then expressed his hope that this workshop may contribute to the APEC goals and help participants navigate through the risks and benefits of using digital innovations to reduce food loss and waste and ensure food security.

2.2 Session 1 – Challenges on reducing FLW through digitalization and innovations along the food supply chain

Global challenges and the need to strengthen evidence gathering and capacity development in reducing FLW

Dr Maximo Torero Cullen, Chief Economist, Food and Agriculture Organization (FAO)

Dr Torero sent us a pre-recorded speech, in which he briefed us on the state of food security and nutrition in the world (FAO 2023). The upper bound estimate of chronic undernourished in 2022 is 783.1 million people. From 2019 to 2022, there was an increase of 122.3 million people under chronic undernourishment. Without COVID-19 and the conflict in Ukraine, the numbers would have been lower. Beyond chronic undernourishment, Healthy diets are out of reach for 3.1 billion people. He then reiterated the latest statistics on FLW based on estimates by FAO (2019) and UNEP (2021), and their impact on food security and GHG emissions. He also reminded us that reliable data is critical to informing action and strengthening the evidence base to guide FLW reduction is essential. For this, FAO offers the Food Loss and Waste Database (last update, 2021): <https://www.fao.org/platform-food-loss-waste/flw-data/en/>.

“The database contains data and information from openly accessible databases, reports and studies measuring food loss and waste across food products, stages of the value chain, and geographical areas. ... Data can be queried, downloaded, and plotted in an interactive and structured way.”

Moving forward, Dr Torero emphasized that we should improve the way we measure food loss (i.e., not just post-harvest stage); have a framework to identify hotspots and their underlying causes; consider trade-offs and identify solutions to reduce the underlying causes of food loss at hotspots; and focus measurement efforts on hotspots.

FAO also offers FLW courses using case study methods (<https://www.fao.org/food-loss-reduction/resources/flaelearning/en/>) and a technical platform on measurement and reduction of food loss and waste (<https://www.fao.org/platform-food-loss-waste/en>). He presented a case study of FLW reduction project for tomatoes in South Asia.

In terms of measuring food loss, they recently used category method and attribute method, which allowed them to measure not only quantity losses but also value losses. The category and attribute methods are higher than the food loss estimated from the previously used subjective method and are believed to be closer to the truth. Subjective method is based on the farmer’s own estimate. For both volume and dollar estimates, most of the losses are within the farmer level, regardless of the method used. The smallest proportion is in the middlemen. Hence, the focus should not only be post-harvest, but also pre-harvest and harvest stage.

Lastly, he underlined the triple wins (i.e., economic, social and environmental) of reducing FLW; the need to tailor mitigation strategies per economy to tackle pre- and post-production emissions; and the elements of an enabling environment that can be supported by governments.

Challenges on digital solutions and implementation to foster collaboration among stakeholders to reduce FLW in the US

Dana Gunders, Executive Director, ReFED

Joining us via live video, Dana showed us the recent 2021 estimates of food surplus in the US: USD444 billion, which is equivalent to 2% of GDP in the US. That’s equivalent to 38% of all food in the US goes unsold or uneaten. To put this into perspective, this food surplus used 16% of the US croplands (an area the size of California and New York combined), as much as 22% of freshwater use (as much as that used by California, New York and Texas altogether), and 6% of US GHG emissions (equivalent to driving 84 million cars for a year).

She then focused on the ReFED Insights Engine (<https://insights.refed.org/>), which has great potential to end FLW across the food system by advancing data-driven solutions to the problem. It is an “online hub for data and solutions featuring the most comprehensive examination of food loss and waste in the United States – includes the Food Waste Monitor, Solutions Database, Solution Provider Directory, Impact Calculator, Capital Tracker, and Policy Finder.” There have been more than 50,000 users of their tools.

The Food Waste Monitor allows us to understand the extent of the problem. Users can filter through different destinations (landfill, composting, animal feed, etc.), sectors, food types, causes, US states and year. This tool is a “centralized repository of information built with data from more than 50 public and proprietary datasets and providing granular estimates of how much food goes uneaten in the US, why it’s happening, and where it goes.

The Solutions Database allows one to “learn which food waste reduction solutions are the most relevant and impactful for meeting specific goals.” Solutions are divided into seven key action areas (optimizing harvest, enhancing product distribution, refining product management, maximizing product utilization, reshaping consumer environments, strengthening food rescue, and recycling). This tool allows one to filter through different types of stakeholders (consumers, government, manufacturers etc.), and to find a specific solution for them. Then, it shows the net financial benefit and annual investment requirements for each solution. Users may dive deeper into each solution for more detailed information on financial cost and benefit, challenges, examples, environmental impact metrics and more.

She moved directly into the Capital Tracker tool, which “visualizes overall funding activity in the food waste space, allowing both funders and solution providers to understand the landscape, identify key players, and plan out future funding strategies. The Capital Tracker currently houses private investment data sourced from PitchBook and classified according to food waste solution type (prevention, rescue, recycling, or general).”

Then, she spoke briefly about the Solution Provider Directory for those who are interested to find organizations that can “help implement food waste reduction initiatives.” Their repository includes over 1,500 profit and not-for-profit organizations. Again, users can filter through solution types, location by state, sectors, legal status and more. The tags can also be filtered. It includes tags like artificial intelligence, IoT, software solutions, etc.

The third part of her talk focused on showing examples of digital solutions such as (i) machine learning in demand planning & inventory management, (ii) image recognition for waste tracking, (iii) markdown alert applications for dynamic pricing, (iv) hyperspectral imaging, and (v) temperature monitoring and cold chain. But she warned us about the fixation over digital solutions because sometimes the best solution is as simple as putting a knife in the serving plate so that people can get smaller portions, instead of getting a big piece which will end up not finished. Lastly, she spoke about the Pacific Coast Food Waste Commitment, which is a collaboration with several food growers, manufacturers, retailers, and food service providers, as well as government and other non-profit organizations to reduce food waste across the food supply chain. Their partnerships ensure they have the most impact and allow them to get up-to-date data on food waste and to pilot solutions on the ground. Last year, they produced a case study report on the use of artificial intelligence in reducing food waste in grocery retail (Pacific Coast Collaborative 2022).

The role of food loss and waste reduction in sustainable food systems

Brian Lipinski, Research Associate, Food Program at the World Resources Institute

Our third keynote speaker from WRI, Brian, provided us with updated information and emphasized the important role of FLW reduction in sustainable food systems. Brian told us that recent data suggests that FLW is an even larger concern than previously thought. The estimate of food lost or wasted globally is 40%, not 33%; and its associated greenhouse gas emission is 10% of global emissions, not 8%. Brian also pointed out that a major opportunity to strengthen the link between climate and FLW is through the consideration of FLW in NDCs.

The latest UNEP (2021) report also gave us a new understanding of where FLW is occurring. The previous conception was that food loss happens in less wealthy economies, while food waste happens in wealthy economies. But the UNEP Food Waste Index found that food waste is significant in all economies, regardless of income level.

He stressed that the food supply chain (not just FLW) generates about a quarter of global GHG emissions. Food systems must be treated as a whole to address climate change, so just focusing on efficiency or yields is not enough. If this is combined with consumption-based solutions and reducing FLW, estimates by World Wide Fund for Nature (WWF) show that the world can better achieve the 1.5°C target. Fortunately, the media is bringing this to the attention of the public more.

Lastly, he promoted the integration of FLW targets into GHG commitment plans of each economy, which is a major opportunity to strengthen the link between climate and FLW. Despite food loss and waste having a significant contribution to climate, relatively few NDCs mention food loss and waste, although the number is increasing. The WWF has perused all the NDCs and found that 36 of them now consider post-harvest loss (compared to 21 previously), while 19 NDCs now consider both food loss and food waste (compared to two previously). This latter group includes Canada and the People’s Republic of China. For instance, Canada references phasing out food waste to landfill, to reduce methane emissions. Chile plans to develop a Circular Economy Roadmap and an Organic Waste Strategy. China references the “empty plate” campaign to reduce consumer food waste and promote a low-carbon lifestyle. Viet Nam discusses the construction of new waste treatment facilities to produce compost, rather than having material go to landfill.

He ended his speech with suggestions on how economies can integrate FLW in their climate action plans: (i) including general statements identifying mitigation and adaptation opportunities associated with FLW, and even general actions (reduced losses, reduced waste, increased recycling), (ii) identifying specific actions needed to support that aim, (iii) adding supplementary documents, strategies or laws, and (iv) setting specific targets or indicators.

2.3 Session 2 – Digital and financial solutions to FLW reduction

Innovative digital solutions MaSS – An Inclusive mobility solution for on-demand food services and social resilience

Samuel Hou, Graduate Institute of Management of Technology, Feng-Chia University

Prof Hou introduced the innovative digital solution (MaaS, Mobility as a social service), an inclusive mobility solution for on-demand food services and social resilience that has been implemented in Chinese Taipei. The main target of such service is the underprivileged (especially the elderly) in remote areas that are difficult to reach due to complicated landforms and long transportation distance. He took inspiration from models abroad that implement Mobility as a Service (MaaS) and transformed it into Mobility as a Social Service (MaaS). They combined catering, medical care, and social services with mobility to create a comprehensive rural care system, emphasizing the needs of care recipients and the participation of drivers in the transportation supply. Among other things, they have partnered with 1919 Food Bank and Donkey Move, which also held exhibits during the workshop, to deliver food to these remote areas. Donkey Move developed a user-centered shared transportation technology platform that connects taxi drivers and private transportation service providers with service seekers (e.g., elderly, those with long term disabilities, etc.). Prof Hou also explained their Mulan Program, which “trains women [from the local community] to get professional driving skills and home care professionals.”

Role of infrastructure/skill investment and enabling environment to speed up digital adoption/integration

Kanjana Kwanmuang, Director, National Agricultural Big Data Center

Dr Kwanmuang first enumerated the different APEC initiatives on food loss and waste, as well as on food security, in general. Then, she gave us several examples of technologies for reducing FLW along the food supply chain. Upstream technology includes harvesting robots that use AI. Midstream technology includes natural coating that helps keep fruits fresh, and scanners used to predict the shelf life of fruits and vegetables which helps in deciding where to deliver products. Downstream technology includes online marketplaces, food waste trackers for restaurants and consumers, and dynamic pricing. She also spoke about approaches to FLW policymaking, and key factors for successful adoption of robots in developing economies and their challenges. During the Q&A, she explained that digitalization does not imperil just transition, at least, not in Thailand, where there is a growing shortage of farm laborers.

Role of inclusive financial solutions and the growing use of ESG/CSR

Sophia Cheng, Chief Investment Officer, Cathay Financial Holding Co.

Ms Cheng presented some statistics on food security and highlighted the fact that Asia is home to most hungry people. Then, she spoke about the agricultural losses due to extreme weather and the conflict in Ukraine, and how this has affected the most vulnerable people. Then, she gave us examples of projects that empower farmers and enhance the resilience of the food system: Impact Terra’s Golden Paddy digital platform in Myanmar; Blended finance for small coffee producers in Latin America; large fast-food chain in the Philippines directly sourcing from farmers. She also gave examples from Chinese Taipei: agricultural loans for young and middle-aged farmers, food traceability, local consumption, and several non-profit initiatives to reduce food waste. Another case is that of a dragon fruit farm cooperating with a local university in Chinese Taipei to develop an AI technology that uses light control, flower

thinning and pollination and image analysis to adjust production from summer to winter. Another example was several pig farms teaming up to establish a biogas power generation plant, which is also able to obtain carbon credit certification. Finally, she enumerated inclusive and environmental solutions by Cathay Financial Holdings.

2.4 Session 3 – Building a sustainable food system

Best practices sharing on sustainable food upcycling and waste valorization from Singapore

Prof Matthew Tan, CEO, Assentoft Aqua Asia Pte Ltd.

Prof Tan, who is also APEC's PPFS' Working Group chair for sustainable development in agri-food sectors, focused on the concept of valorization of food waste using the case of Kosmode Health. Valorization is a way to extract the nutritional value of food waste, and reprocess it into normal edible food. In the case of Kosmode, he presented how they recover protein and fiber from food waste and reprocess them into noodles. Those that do not get used in the process are used as fertilizers. They also make sure that their process is carbon neutral. He also introduced us to the concept of "food commodity footprint" and "functional food".

During the Q&A, Prof Tan also shared with us a project they did to measure food waste from a hospital. They used blockchain to track food from the supplier to the consumer. They found that the hospital in their project generates about 30,000 Kg of food waste annually.

Food waste policies and management system in Korea

Dr Kwang-Yim Kim, Director, Korea Zero Waste Movement Network

Dr Kim shared with us the food waste statistics from the Republic of Korea, which has been generally stable. She also showed us how the statistics for recycling food waste has increased throughout the years. In the second part of her sharing, she gave us an overview of the different policies in the Republic of Korea that helped them to keep food waste at bay: volume-based waste fee system, "pay as you throw" system, use of RFID for food waste payment system, different campaigns to reduce food waste and redistribute food waste, biogas production from food waste and other forms of food waste recycling.

Advancing food waste prevention: Monitoring and benchmarking hospitality performance in Asia Pacific

Ms Rubina Srikureja, Senior Manager of Operations, Lightblue Environmental Consulting

Ms Srikureja introduced Lightblue Environmental Consulting. Their main goal is to reduce food waste (raising awareness, monitoring, wholistic certification). Their framework is basically to reach zero food waste to landfills. They work mostly with the hospitality industry, but they also partner with educational and other institutions. Their approach is to help establishments set up a food waste monitoring system. To encourage them, Lightblue Consulting makes them see how much they can save in terms of food costs (on average, 6 to 14% of the food revenue).

She then focused on two of their projects: (a) Food Intel Tech (FIT) food waste tech, a cloud-based dashboard that help their customers to track what, when where and why food is being wasted, and (b) Pledge on food waste certification, which is a globally recognized third-party audit and certification system.

The FIT tech helps food service providers to track where, what, when, why and how much food they are wasting. It does not require a special machine, unlike other tech solutions. Their clients can simply use any smart devices that can connect to their cloud system, and they are good to go. The system sends weekly reports on food waste per cover/diner (their main KPI) for different commodity categories. One of their main clients is Hyatt Hotel, which was able to reduce 36% food waste. When they train the kitchen staff, they focus a lot on the why. During the Q&A, she mentioned that the main source of reluctance among the staff is fear that they will be held accountable for high food waste, so building trust with them is important. Another fear is the monetary investment required, so they show the return-on-investments to convince clients.

The Pledge on Food Waste commits their partners to reduce food waste that goes to landfills. The application process and audit are all done online. The audit is done externally. Lightblue Consulting only offers capacity building through a team that trains the kitchen staff for the audit. There are four levels of Pledge certification depending on the number of points garnered during the audit. The bottom line for their partners is that they can include food waste in their ESG reports.

2.5 Session 4 – Member Economy and Survey Report on progress and challenges in the food system

Chile

Ms Macarena Espinoza introduced to us the government programs from Chile: National Commission for Prevention and Reduction of FLW, micro food banks, solidarity eco-markets (which are similar to micro food banks, except that donations are from large supermarkets and food industries), information dissemination and awareness raising initiatives, centralized repository of FLW initiatives, and collaboration with the Ministry of Environment to create a strategy for organic waste towards 2040.

Indonesia

Mr Noor Syahlani presented statistics about the FLW situation in Indonesia, then introduced us to their National E-Agriculture Strategy Roadmap for 2027, and other initiatives for reducing food loss and waste like the use of a game application to create a sense of food adequacy and food security awareness, and a mobile application for grocery planning. There is also a private start-up that uses AI and APPs to combat food waste through a hyperlocal meta-farming food ecosystem and farming-as-a-service model (<https://www.dw.com/en/indonesian-startup-taps-into-ai-to-combat-food-waste/video-65870650>).

Malaysia

Ms Nor Azlin Razali showed us the training courses and workshops that they have been holding

in Malaysia, especially around collecting data for measuring food loss. They recently concluded the pilot data collection and measurement of fruits and vegetable losses under SDG 12.3.1.A in selected regions of Malaysia. They followed the UN Food Loss Index framework. They were able to identify critical loss points, causes of postharvest losses, and viable and sustainable solutions.

The Philippines

Ms Cherry Romero focused on the FLW in the Philippine fisheries sector. She told us about the Philippines' commitment to reduce post-harvest losses by 10% in 5 years. She also gave us examples of digitalization in the fisheries sector: fisherfolk and fishing boat registration (FishR and BoatR), and a digital marketing app for fishermen to sell directly to consumers (E-Kadiwa). Other programs to improve food system resilience include seminars for capacity building, equipment and logistic support for fishermen, the Philippine Cold Chain Industry Roadmap.

Chinese Taipei

Ms Liz Nien focused on government actions and private initiatives in Chinese Taipei to fight FLW: (i) Food and Agricultural Education (FAE) Act, (ii) government investment in cold chain logistics, (iii) a biomass energy center in New Taipei City to process 200 tons of food waste every day, (iv) a smart cold chain fresh food logistics center by a Fu-Fruit Co., Ltd., which is the field trip site for this workshop, (v) company that uses of black soldier flies to digest food waste, and (vi) other government-sponsored capacity building activities.

Thailand

Ms Patchararatana Limsirikul explained Thailand's project from 2020 to 2022 that studied food loss related to 16 types of crops, livestock, and fishery produce. These indicators will be used as a baseline to monitor annual progress. As for food waste, she shared Thailand's plan to conduct research and collect data on the proportion of food waste compared to solid waste at the community level, which will be used to monitor the annual decrease in food waste per person. She also shared private sector initiatives. For example, the grocery chain Lotus's set a clear goal to reduce its own food waste by 2030 and aims to support Thailand in reducing overall food waste by 50% by the same year. Similarly, Marriott hotel branches in Thailand have partnered with the Scholars of Sustenance Foundation (SOS) to work towards this goal. Currently, the SOS Foundation is donating surplus food to communities in need, and in 2022, 27 Marriott hotels donated over 33,000 kilograms of surplus food, providing nearly 140,000 meals to underserved communities. Then, she introduced companies in Thailand that sell or upcycle imperfect foods, and phone apps that help reduce food waste (e.g., Oho! And Yindii).

Viet Nam

Ms Pham Thi Hong Hanh gave us statistics of food loss (25% of agricultural products) and food waste (87% of households) in Viet Nam. Afterwards, she shared with us the developments in the agricultural sector of Viet Nam: green growth strategy, and their sustainable agriculture and rural development strategy. Among other things, they target to keep the forest cover rate at 42%, make the area for organic arable land reach 2% of the total arable land area, and make

the proportion of organic livestock products reach 2–3% of the total livestock products produced.

Survey Report

Dr Kenneth Dy, Postdoctoral Fellow, Academia Sinica

The results of the survey are reported in [Section 3.1](#).

2.6 Session 5 – Target-Measure-Act with the aid of technology

Mr Asch Harwood, Vice President of Data & Insights, ReFED

The second day of the workshop opened with Session 5, in which we invited Asch Harwood, who has been heavily involved in the design of REFED’s Insights Engine, an interactive digital learning tools to monitor food waste, identify solutions and calculate impacts.

Joining us via live video, Asch elaborated on the ReFED Insight Engine, an interactive digital learning tool to monitor food waste, identify solutions, and calculate impacts. He walked us through how ReFED calculates food loss and waste, and how they compute for what they call “diversion potential” of a particular solution, i.e., “The amount of food surplus that ReFED estimates a particular solution could avoid if fully implemented along with other ReFED-proposed solutions. It is applied only to the portions of food surplus that are considered addressable by that solution.” He also clarified the meaning of “food surplus” as used by their organization, which is different from the usual food loss and waste concept that others use in their definitions. We had a lively Q&A afterwards, especially about the formula for computing food loss and waste. He explained that because of the Pacific Coast Food Waste Commitment,² they can have better and more up-to-date estimates of ‘item surplus rates’, which is the coefficient or parameter they use to calculate food surplus from sales data. However, he encouraged everyone not to be paralyzed by the lack of measurement from devising and implementing solutions. Since Asch also spoke about the customized roadmaps that ReFED create with the aid of the Insights Engine for partner companies in the US, Kenneth asked whether such services can be extended to other APEC member economies, to which Asch replied, “It is feasible.”

2.7 Session 6 – Panel Discussion

On the last session for this year’s workshop, we had five panelists including Mr Brian Lipinski, Prof Matthew Tan, Ms Kanjana Kwanmuang, Dr. Kwang-Yim Kim and Prof Shih-Hsun Tony Hsu. Among other things, they aimed to discuss (i) key challenges and opportunities associated with capacity development and implementation for governments, NGO/NPO, domestic and cross-border supply chain stakeholders; (ii) strategic planning associated with inclusivity,

² “The Pacific Coast Food Waste Commitment (PCFWC) is one of the largest public-private partnerships dedicated to food waste reduction, bringing food businesses and local jurisdictions on the West Coast together to implement measurable action to halve food waste in the region by 2030. The PCFWC is a voluntary agreement, [among other things, to] establish a streamlined methodology for measurement with the support of the PCFWC technical team and contribute to anonymized reporting through your own individual online dashboard.” (https://refed.org/case_studies/engaging-stakeholders-the-pacific-coast-food-waste-commitment/)

gender equity, public-private partnerships, financing gap, e-certificates, infrastructure investment, coordination in data accountability/security and more; and (iii) the role of digital transformation for reducing FLW and target-measure-act cooperation under the APEC Food Security Roadmap Towards 2030.

Most of the speakers emphasized the importance of Public-Private Partnership (PPP) for reducing FLW. They agree that APEC plays a key role in PPP for promoting the reduction of FLW. The public sector should understand the difficulties of the private sector and help them solve the problem. Furthermore, the public sector also should support the private sector in infrastructure investment and financial support. Brian suggested finding the solution through the whole-system approach to tackle the issues of FLW. Prof Hsu reiterated the importance of integrating FLW goals with GHG reduction goals. He also suggested combining the issue of FLW with food security, medical care, and education.

Prof Tan also emphasized the importance of innovative technology for reducing FLW. He gave an example of FLW during COVID-19 lockdowns and suggested using the innovative technology to prevent the period of lockdown in the future. Dr Kanjana also pointed out the 10 steps to reduce FLW through digitalization: (1) data-driven decision, (2) digital system to monitor the food supply chain, (3) smart packaging, (4) optimizing the supply chain, (5) AI quality control, (6) coverage, (7) platform, (8) precision agriculture, (9) data-driven policy, (10) capacity building.

2.8 Closing Session

The closing remarks were given by Prof Ching-Cheng Chang, adjunct research fellow from the Institute of Economics of Academia Sinica; and Mr Vincent Lin, the Project Overseer.

Prof Chang recapped the main points from each speaker during the workshop. Then she offered three key themes for our next steps. First, ReFED has the great potential for reducing food loss and waste across the food system by advancing data-driven solutions to the problem. We hope ReFED can bring Insight Engine from the US to APEC in the near future. Second, the GHG emission associated with FLW is 10% of global emissions now and it is too important to be ignored in NDC. Third, the innovative digital solution (MaaS, Mobility as a social service) combining food, medical care, and social services in a holistic way may provide an inclusive social mobility solution for on-demand food services, reducing food loss and waste, and enhancing social resilience.

Mr Lin once again thanked all the speakers and participants for their contribution. He reiterated the Implementation Plan 17e of the APEC Food Security Roadmap Towards 2030, which demonstrates the importance with which APEC member economies regard the issue of reducing FLW. Finally, he encouraged all member economies to continue working towards the attainment of the goals set in the Roadmap.

2.9 Exhibition and Field Trip

Throughout the workshop, there were three institutions that set up stalls for exhibition:

1. 1919 Food Bank (<https://1919.org.tw/2021/e-ccra/foodbank.html>)

With 13 years of experience, 1919 Food Bank has become one of the major food banks in Chinese Taipei. Their organization started collecting and distributing perishables such as bread, fruit, meat, and vegetables, left unsold due to some imperfection. Part of their food redistribution operations involve coordinating between hundreds of churches serving the underprivileged and nearby food retailers with excess food. In 2014, they worked with Carrefour, a large retailer in Chinese Taipei.

2. Social Welfare Department, New Taipei City (<https://surplus-food.ntpc.gov.tw/>)

The New Taipei City government showcased their partnerships with organizations that do FLW-related operations across the supply chain such as retail and wholesale markets that sell imperfect or ugly fruits and vegetables, food banks and logistics companies for redistributing surplus food, and catering schools. They also coordinate with companies to donate leftover food, guide at least 200 businesses every year to improve their food utilization and reduce their food waste, clean plate campaigns at schools. The New Taipei City Surplus-Food Network, organizes cooking activities for rural and disadvantaged children using imperfect products as ingredients.

3. Donkey Move (<https://www.donkeymove.com/>)

Founded in 2018, this organization is a social enterprise that uses technology to create various vehicles services needed for Chinese Taipei's disadvantaged population. Many elderly people find it difficult to go out for medical treatment, rehabilitation, shopping, travel or social participation. Donkey Move has developed a long-term care transportation vehicle dispatch system that integrates government long-term care special vehicles, rehabilitation buses and private rental car companies or barrier-free taxi drivers through the sharing economy concept. They partner with 1919 Food Bank to redistribute food surplus to those in need in remote areas. They developed the app to provide cloud service for the MaaS introduced by Prof Hou during Session 2.

After the workshop, we also organized a field trip to Fu-Fruit Co., Ltd., which has been specializing in the fresh fruit business since 1971. In order to preserve the food safety and quality for their customers, they established a new factory in 2021, which utilizes state-of-the-art cold chain logistics equipment and intelligent warehouse management systems. They have obtained FSSC22000 food safety certification. Moreover, being dedicated to carbon neutrality and environmental protection, they have installed rooftop solar panels and recycling facility for processing water, as well as investing to meet green building and other ESG standards. They are committed to promoting sustainable agriculture and traceability of agricultural products to minimize food loss along the supply chain. They employ advanced individual quick-freezing (IQF) technology to guarantee freshness and nutritional value.

There were 43 participants who joined the field trip. Upon arrival, the Chairman of Fu-Fruit, Mr Jin Fu Chiu, gave us a brief company introduction. They also explained how they

incorporate environmental features in their building and company operations. For example, they provide shuttle bus services and transportation allowance to their employees in order to encourage them to rely less on their motorcycles which emit a lot of GHG. Then, the workshop participants were given an exclusive one-hour guided tour around the processing facility, including the cleaning and packaging sections. During the tour, they explained the quick-freezing IQF technology they used. Afterwards, Prof Chun-Ta Wu, who specializes in postharvest handling techniques for tropical fruits, spoke to us about “Utilizing Technology to Address Food Losses: Advancements in Post-Harvest Processing Techniques”. During the Q&A, Matthew Tan expressed his awe at the use of controlled atmosphere technology to preserve the atemoya. He then shared with us a technology they use in Singapore to preserve salad: hydrodynamic cavitation, which involves dipping salad in a specially treated water for a few seconds to prolong the shelf life of the salad for a couple of weeks. He suggested that this technology can be used in tandem with controlled-atmosphere technology. The company representatives were enthused to learn about this and took down notes.

3. Survey Results

There were two surveys conducted within the project period: the “Survey on Reducing Food Loss and Waste (FLW) by Strengthening Resilience and Digitalization in the APEC Food System” and the “APEC Project Evaluation Survey.” The former was designed to gather information regarding the role of digital and related innovative technologies in building an open, productive, sustainable, and resilient APEC food system including ways of measuring FLW. Then, after the two-day workshop, the latter survey was distributed among the workshop participants to gather their opinions on the project.

3.1 Pre-Workshop Survey

This survey follows up on a survey done two years ago for the “*Workshop on Reducing Food Loss and Waste along the Food Value Chain in APEC during and post COVID-19*” (PPFS 03 2020). The summary of previous survey results can be downloaded from the APEC-FLOWS website: <https://apec-flows.ntu.edu.tw/report-detail.aspx?seq=1027>.

This year’s pre-workshop survey has four parts:

- Q1:** Post-COVID-19 situation of FLW along the food supply chain
- Q2:** Digitalization or innovative technologies used to manage FLW
- Q3:** Strengthening food system resilience
- Q4:** Inclusion of FLW targets in greenhouse gas (GHG) emission reduction goals

A copy of the questionnaire is available in [Section 5](#).

3.1.1 Respondents

The team was able to gather a total of 37 responses from 15 economies. Table 1 shows the breakdown of the respondents according to economy. As usual, majority of the respondents

are from Asia (76%, mostly from the Philippines), followed by North America (14%, mostly from Mexico), South America (8%) and Oceania (3%).

Table 1. Respondents by economy

Member Economy	Member Economy	Member Economy	Member Economy
Chile	1	Malaysia	2
Indonesia	1	Mexico	4
Japan	1	Papua New Guinea	1
Republic of Korea	1	Peru	2
		The Philippines	1
		Russia	1
		Singapore	1
		Chinese Taipei	4
		Thailand	2
		The United States	1
		Viet Nam	3

Survey respondents were gathered through different channels. Primarily, the questionnaire was circulated among the APEC Agricultural Technical Cooperation Working Group (ATCWG) and Policy Partnership on Food Security (PPFS). Apart from this, individual emails were also sent out to the registrants and speakers of this workshop. Individual emails were also sent out to previous respondents to the 2021 survey from government, not-for-profit organizations and academic institutions in different member economies.

Looking at sectoral breakdown, most of the respondents are from the government agencies related to agriculture and rural development. More than a quarter of the respondents are from private and non-government organizations. Table 2 shows the breakdown by continent and by sector.

Table 2. Respondents by continent and sector

	Government	Private or NGO	Academic	Total
Asia	19	8	1	28
Oceania	0	1	0	1
South America	3	0	0	3
North America	3	0	2	5
Total	25	9	3	37

The responses do not represent the official stance of economies where they come from.

3.1.2 Post-COVID-19 situation of FLW along the food supply chain

In May 2023, WHO declared that COVID-19 is no longer a global health emergency. However, for purposes of this survey, post COVID-19 period is understood to mean after an economy has allowed fully vaccinated cross-border non-business travelers to enter without hotel quarantine. This is different per economy, so we will not specify an exact cut-off month or year. For instance, one expert respondent from Mexico mentioned that food chains returned to normal as early as December 2020-January 2021, whereas two years after that, the zero-

COVID strategy in the People’s Republic of China remained the prevailing norm, and its strict lockdown measures still an everyday reality for many of its people.

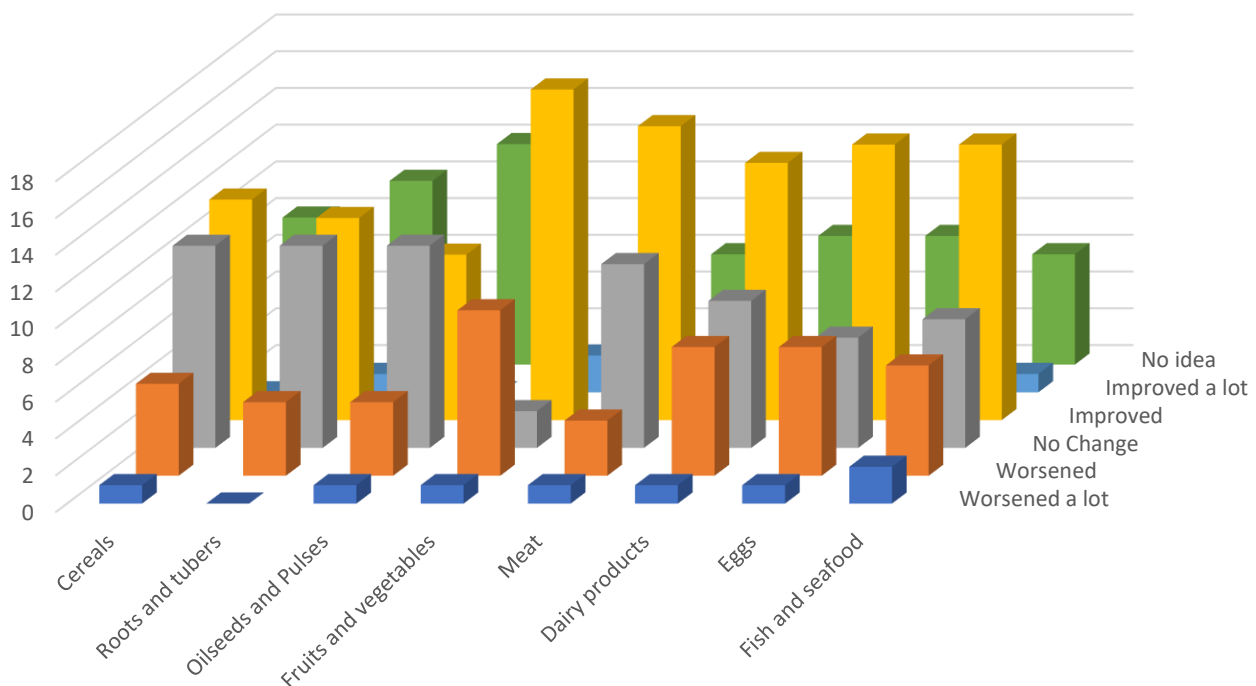


Figure 1 Post-COVID-19 Food Loss and Waste by Commodity (all respondents)

In the first question, we asked how each commodity group has fared after the pandemic. Back in our 2021 survey, the results showed that fruits and vegetables were the hardest hit commodity group in terms of FLW. This year, about half of the respondents believe that the FLW in fruits and vegetables has improved (See Figure 1). That’s the commodity group with the largest percent of respondents perceiving it as having improved in terms of FLW. This is followed by meat (43%), eggs (41%), and fish and seafood (41%). In general, respondents perceive that FLW has improved across all commodity groups, except for oilseeds and pulses, for which most of the respondents either responded that there was no change or that they had no idea. We can assign a rank of 1 to 5 from “worsened a lot” to “improved a lot”, then calculate the weighted average score by commodity group. This is shown in Figure 2.

The more optimistic respondents believe that the following factors have contributed to the improvement in managing FLW in different commodities: (a) lessons learned during the pandemic, (b) consumer demand bouncing back, (c) introduction of precision technologies in the food supply chain, (d) application of Good Agricultural Practices (GAPs) in agricultural production,³ and (d) logistic restrictions have been lifted. There were also factors that are generally seen as negative situations, yet somehow helped to reduce FLW: (a) persistent food inflation post-pandemic and other causes such as African swine flu and bird flu, and (b) lower

³ As defined by FAO, GAPs are a “collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-food agriculture products, while taking into account economic, social and environmental sustainability”. This involves traceability, which is an important component in minimizing food spoilage in the supply chain.

incomes so lower consumption. According to some respondents, these two economic reasons have forced people to tighten their belts and manage their food purchases and utilization more wisely, which consequently reduced FLW across commodities and different stages of the food supply chain.



Figure 2 Weighted Average FLW Scores by Commodity Group

Those who reckon that FLW has worsened have cited food supply chain disruptions, which have not abated since the pandemic. For instance, a respondent from Mexico said that food carriers and distributors that had shut down during the pandemic were not able to recover and were not replaced by new entrants, causing a break in the distribution chains, which led to higher FLW. The respondent from Chile also said, “Supply chains were altered at the [economy-wide] level, affecting the fishing sector; and at the level of [cross-border] trade too—Chile depends on the import of a significant amount of food (cereals, pulses). This situation led to the need to promote a series of initiatives to reduce FLW in the food system and thereby respond to the [economy]’s food needs.” Another respondent from Mexico has done a study among farmers and found that the general perception among them, except for honey producers, is that their food production loss has increased due to the pandemic.

If one filters for non-government (i.e., non-profit organizations and academics), the generally optimistic perception described above is no longer as overwhelming. For instance, although 6 of the 12 non-government respondents say that the FLW in fruits and vegetables category have improved, about 5 believe it has gotten worse. This more or less equal share of respondents saying things have improved or gotten worse is also present in all other commodities.

In the second question, we asked how FLW has changed along the different stages of the food supply chain after the pandemic. Back in 2021, when we searched for information and surveyed regarding this during the pandemic, we saw that FLW along the food supply chain presented different challenges: in the agricultural production stage, the most problematic issue was products left unsold; in the post-harvest stage, it was delays in travel time or obtaining permits for crossing borders; in the processing stage, it was restricted factory activity; in the distribution stage, it was the restrictions on supermarkets; in the consumption stage, it was lack of consumer awareness.

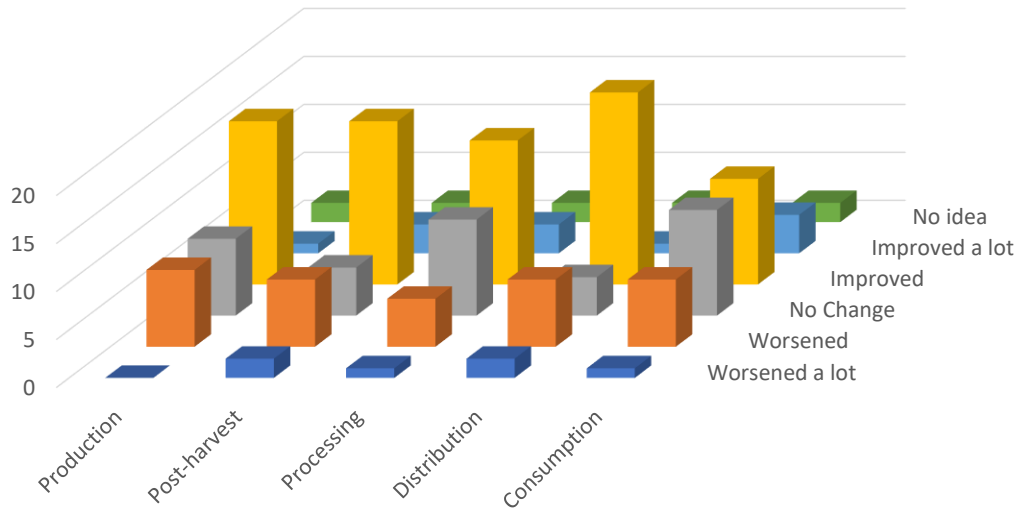


Figure 3 Food loss and waste along the food supply chain

This year, the respondents were generally positive about the FLW across the different stages of the food supply chain, similar to their perception for commodity groups in the first question. Only the consumption stage has a less encouraging result; about 30% of the respondents think it has improved, and another 30% believe there was no change. Although the distribution stage had the highest percentage of respondents indicating that it has improved (See Figure 3), the weighted scores show that respondents believe it's the processing stage that has improved the most insofar as FLW is concerned (Figure 4). The same reasons given above apply to this set of responses. Likewise, non-government respondents are more pessimistic in their outlook. In this set of questions, there are 4 to 5 out of 12 non-government respondents who think that FLW across the supply chain has gotten worse. This is worth considering since the private sector and non-profit organizations are relatively more in touch with the situation on the ground.

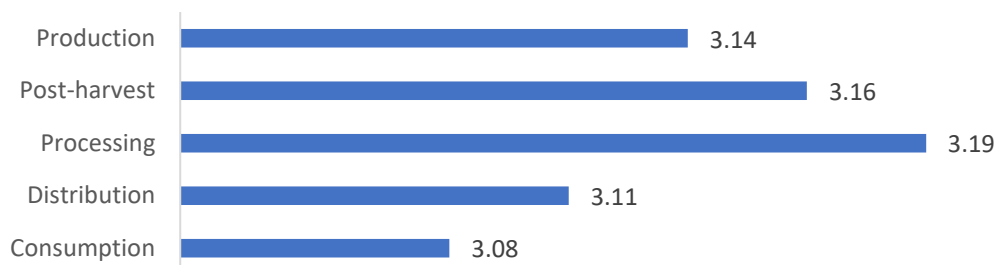


Figure 4 Weighted Average FLW Scores by Stage of Food Supply Chain

One of those who believe that FLW has improved along the supply chain cites e-commerce as his reason. He believes this has pushed the cold chain industry to make huge improvements. One government respondent mentioned that foreign and domestic investments in agriculture have reduced food loss in the post-harvest stage. In the processing stage, a Peruvian respondent shared that they have “policy guidelines related to FLW and have also been strengthened by the circular economy model. In this context, companies are implementing agricultural

sustainability practices.”⁴ On the consumption stage, one respondent said that social media posts on home gardening and use of food waste as organic fertilizers. Another one said, “Pre-prepared food thru home delivery service reduced home resource use thus reducing food waste in the household.”

With the distribution and consumption stages having the lowest scores, the respondent from Chile shared with us that “The actions that were promoted in the post-pandemic situation included a strong effort to recover food in the distribution and consumption stages, through coordination, awareness, and education initiatives. However, only in 2023 are actions focused on a productive level, since they require more technological development (it is slower).”

We have received very helpful answers from Thailand, which we partly reproduce here, since some of the things were already explained in the economy reports ([Section 2.5](#)):

[We] have plans to enhance food waste reduction. For instance, we aim to establish a knowledge hub to share valuable information and raise public awareness about food loss and waste. Additionally, we plan to develop an information system focused on food waste management, along with other network platforms that can facilitate the exchange of best practices, especially within communities, to prevent further increases in food loss and waste. Moreover, we are encouraging people to adopt useful strategies for reducing food waste, such as composting, recycling food waste for petfood or animal feeds, and utilizing innovative waste disposal technologies.

The last question in this part of the survey asked about the respondents’ impressions on the state of their economy's post-pandemic situation vis-a-vis the APEC Food Security Roadmap Towards 2030, specifically, on its Implementation Plan 17e, which states, “*Provide capacity building and best practice sharing workshops to support member economies' individual and collective efforts to align with the UN Sustainable Development Goals 12.3 'by 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses,' with specific indicators based on each economy's respective situation such as measured by the UN/FAO Food Waste Index (FWI) or other appropriate index. And promote public-private investment in infrastructure and cold chain to reduce the current levels of food loss and waste and review progress in this area by 2025.*”

Back in the 2021 survey, we asked respondents what they expect about the FLW situation two years from then, and 61% of the respondents said they had become slightly more positive, and about 29% said they expect that the food supply chain only needs 6–12 months to recover after the pandemic. Having arrived at 2023, about 78% of the respondents have become either slightly more positive or significantly more positive (See Figure 5).

⁴ The original answer in Spanish reads, “En el Perú, existe lineamientos de política vinculado a PDA y también ha sido afianzados por el modelo de economía circular. En ese contexto, las empresas están interiorizando con la puesta de prácticas, vinculadas a la sostenibilidad agraria.”

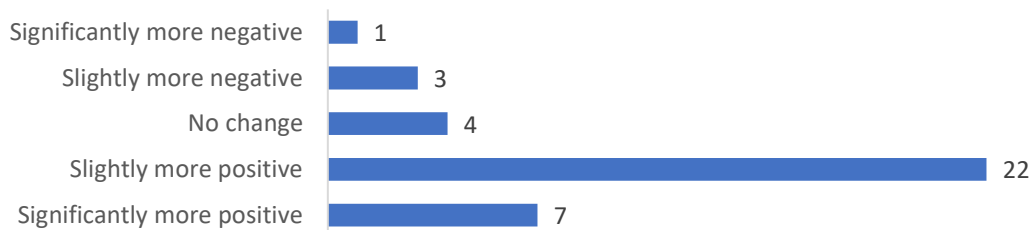


Figure 5 Outlook on APEC Food Security Roadmap, Implementation Plan 17e

Again, it seems that government respondents are more optimistic (84%), while those from the private sector and NGOs are less so (67%). One respondent from the private sector who was significantly more positive about the prospects of food security and food loss and waste provided cautionary reason for his answer: “The Pandemic experience is an evolutionary filter for those practitioners of the Food Supply Chain to survive and sustain or to weaken and die off, in the competition ahead. If the APEC Food Security Roadmap could assist the member economies with the new technological adaptations, the practitioners who are able and willing to undertake the adaptations will thrive. But for those Practitioners who are not capable to adapt the innovations, they will have a bleak future at hand. A different approach would be needed for them. There are 2 words that are fundamental to this APEC Roadmap, that is, Capacity and Change.” Again, several respondents reiterated that the pandemic and the skyrocketing food prices have forced people to utilize food better.

Two of the respondents from Asia, who were both slightly more positive, noted that there is more global cooperation on this matter, including the annual workshops that Chinese Taipei has been organizing under APEC. This has served as a “platform for facilitating the exchange of new technologies and best practices.” FAO has also been involved in APEC economies like Malaysia for projects such as “measuring FLW and identifying critical loss points in the food supply chain.” In Chinese Taipei, a respondent from a food bank said that the government has ramped up its efforts to disseminate more information on this issue through the media.

However, some respondents from Mexico lament the lack of resources and attention being given to this issue, although they did recently pass a law on circular economy that mentions FLW, and which has been adopted by several Mexican states. In Peru, they have a Multisectoral Commission on Food Security which is able to influence policies to reduce FLW.

Answers from other respondents were still centered on what happened during the pandemic; it’s as if for several of the respondents, the effects of the pandemic still linger on, and the food system is still grappling with its aftermath.

The Implementation Plan 17e includes a provision about measurement. And in this regard, one respondent still expresses disappointment over the lack of a unified measure for FLW, which hampers the accurate assessment of the situation. In connection to this, one respondent from Thailand explained their plan to do an economy-wide food loss assessment, the same one that they shared during the economy report.

3.1.3 Digitalization or innovative technologies used to manage FLW

In 2021, through internet search and the survey, we were able to gather several technological solutions for FLW. For this year's survey, we listed most of them below in the choices and arranged them according to the different stages of the food supply chain. We highlight the top answers here. Kindly refer to Section 5 for the full list of solutions included in the questionnaire.

Figure 6 shows a summary diagram for answers to Question 2.1. The base for the percentages is the total number of respondents (i.e., out of 37).

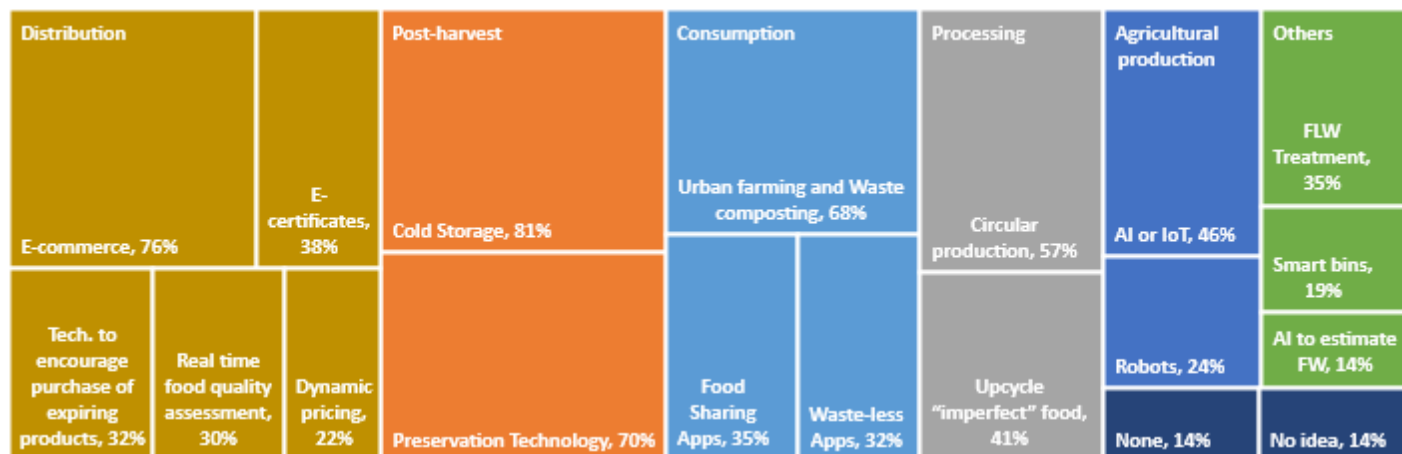


Figure 6 Technological and Innovative Solutions to FLW

About 46% of the respondents said their economies use AI or IoT for reducing food loss in the production stage. In the post-harvest handling and storage stage, both the cold storage and preservation technology are quite extensively used among the economies that responded to the survey. Preservation technology includes packaging innovations, dehydration technology, edible coating that prevents food loss, water-resistant and air-tight containers, and small-scale drying machines. In the processing stage, the circular model of food production (e.g., recovery for energy production or other means of using unavoidable organic by-product) got about 57%. In the distribution and marketing stage, Digital solutions to sell food (e.g., e-commerce that allows farm-to-consumer) had about 76%. Lastly, in the consumption stage, 68% of the respondents said their economies promoted urban farming or waste composting by consumers. Unfortunately, when it comes to food waste measurement, the adoption of technology is still very low. We hope that after this workshop, especially with the sharing of Rubina in Session 3 and Asch in Session 5, more economies can learn how to measure food loss and waste, which would facilitate the monitoring of FLW reduction by 2025 as stated in the Roadmap implementation plan 17e.

Others also mentioned the use of blockchain. One use for this is for tracing the agricultural produce as it goes along the supply chain and to track its quality. It is also used to facilitate e-certifications. Both of these are included under the choices for distribution stage. Matthew, during the Q&A in Session 3, also shared how they used blockchain to monitor and measure food loss and waste along the supply chain of a particular hospital. Another respondent said,

“comprehensive digital farm monitoring devices to assist farmers at farm level to keep track of pest and disease control on their crop”. This would fall under AI or IoT solutions for reducing food loss in the agricultural production stage. Lastly, a respondent said “inter-agency initiatives on cold chain.” Indeed, inter-agency collaboration, especially those in charge of primary industries, food and environment, is essential to managing FLW, which was also emphasized in the 2021 workshop and survey report.

3.1.4 Strengthening Food Resilience

Food security *per se* is not enough, it must be able to adapt and recover from sudden shocks to its system or supply chain. Ever since the pandemic became a household term, the word resilience has come to the fore in policy discussions. Although one of the respondents from a food bank organization laments that FLW is often a distraction from addressing the root problems related to food security or food system resilience, and that often the connection made between food security and FLW is more emotional than real (according to the respondent), but as Dr Maximo Torero reminded us in Session 1, food loss and waste negatively impacts food availability, food access, and sustainability of resource use.

For this section, the survey follows the FAO 2021 State of Food and Agriculture definition for agrifood systems’ resilience, “The capacity over time of agrifood systems, in the face of any disruption, to sustainably ensure availability of and access to sufficient, safe, and nutritious food for all, and sustain the livelihoods of agrifood systems’ actors.” (p.7) This definition draws heavily from Tendall et al. (2015, p.19), who defined food system resilience as “the capacity over time of a food system and its units at multiple levels, to provide sufficient, appropriate, and accessible food to all, in the face of various and even unforeseen disturbances.”

FAO breaks down the definition further. Agrifood systems in their framework “Encompass the entire range of actors, and their interlinked value-adding activities, engaged in the primary production of food and non-food agricultural products, as well as in storage, aggregation, post-harvest handling, transportation, processing, distribution, marketing, disposal and consumption of all food products including those of non-agricultural origin.” (p.xii) In other words, it considers the whole food supply chain from production to consumption. Interestingly, it includes non-food agricultural products.

We asked respondents to rank the different dimensions of agrifood system resilience in their economy from one to five, with five being the most resilient. The different dimensions include stability over time, sustainability, availability, accessibility, utilization (Sufficient, safe, and nutritious), agency (for all), and livelihood of agrifood actors. Four of these are the familiar pillars of food security (availability, access, utilization, and stability).

Figure 7 below shows the results for this question. Most of the respondents stayed in the middle. The weighted average scores for each dimension are shown in Figure 8. The two dimensions with the highest scores were availability (3.30), utilization (3.27) and accessibility (3.24). The first and third are among the dimensions in which FLW reduction has the greatest impact according to Dr Torero. However, the respondents reckon that the livelihood of our agrifood

actors and stability of food security over time needs more attention. Unlike the first part of the survey, there is no notable difference between the answers from government and non-government respondents.

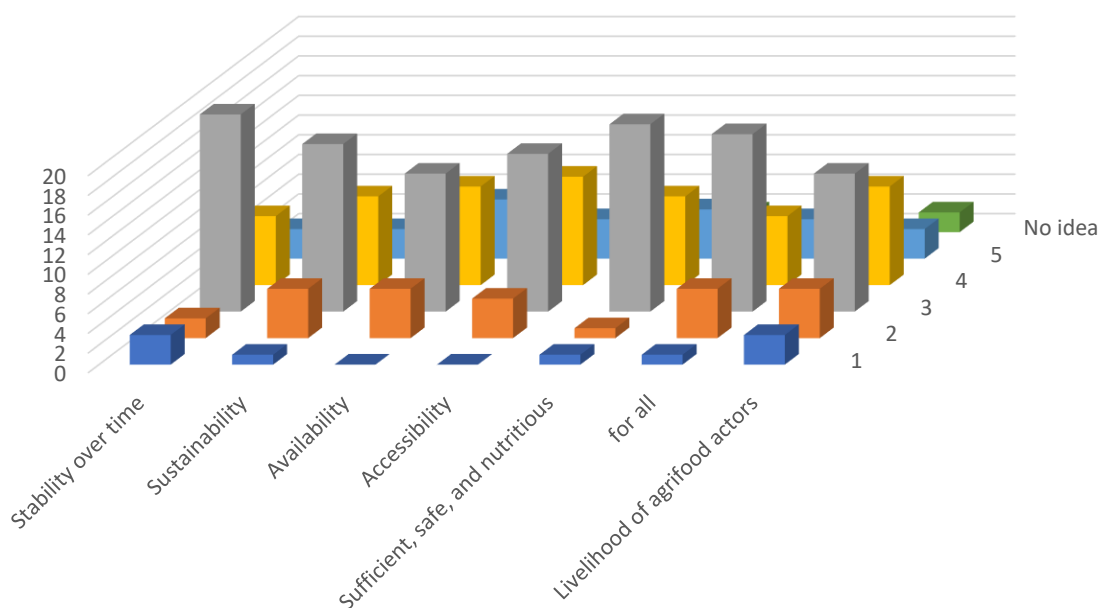


Figure 7 State of Food System Resilience

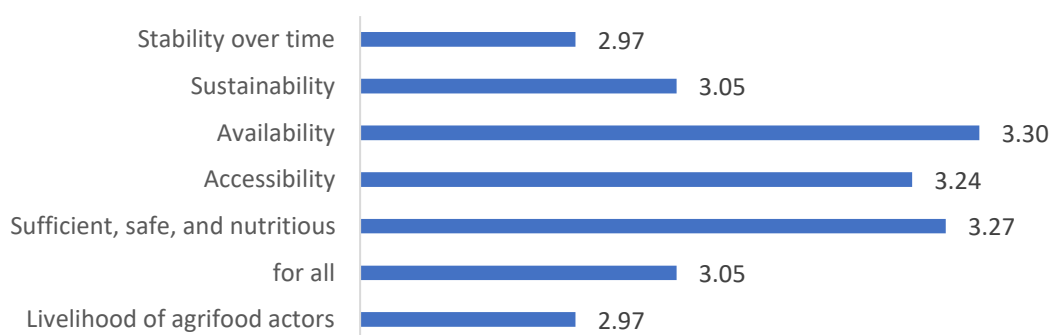


Figure 8 Weighted Average Scores for Each Dimension of the Food System Resilience

Some of the respondents mention factors that inhibit the food system resilience: (a) economic inequality and poverty, (b) typhoons and natural disasters, and (c) lack of political will and policy support. A respondent from Mexico also shares, “It is necessary to improve the farmer-consumer chain because some regions are producing enough food, but it can't be distributed to other communities. It is necessary to improve the price to the farmers (the workers for agriculture is every time less).”

3.1.5 Inclusion of FLW targets in greenhouse gas (GHG) emission reduction goals

In the fourth part of the survey, we asked about how the economies integrate their efforts to reduce FLW with their GHG reduction strategies, and whether they have exact measures that help them monitor progress in this regard.

This has been included in this year’s survey since one of the main benefits of reducing FLW is lower emissions, particularly methane. It has been frequently cited and has become proverbial to say that if FLW were an economy, it would be the third highest emitter of GHG gases. Hence, it’s no wonder that some people have called for governments to include FLW targets within their GHG reduction plans as Brian Lipinski explained in Session 1. Dr Torero in Session 1 also reminded us that FLW account for 8–10% of global GHG emissions. Dana also explained that the GHG emissions from total food surplus in the US is equivalent to driving 84 million cars over a year. Finally, Brian’s updated database shows that the problem of FLW was worse than previously estimated (now at 40%), so consequently its contribution to global GHG is likewise higher (now at 10%).

All APEC member economies have their GHG reduction targets by 2030, whether binding or not. See Table 3 for the latest available GHG reduction strategies/plans and their URL links. Since we have this actual data, the results for Question 4.1 don’t need to be presented.

The results for Questions 4.2 and 4.3 will be presented together since they are related. The inner circles Figures 9 and 10 show the number of respondents who said that their economy measures food loss and food waste, respectively. It will be clear later why these two need to be separately accounted for. The outer semi-circle shows the number of respondents, among those who said that their economy measures FLW, who also indicated that their economy at the same time also measures the GHG equivalent of their food loss or food waste.

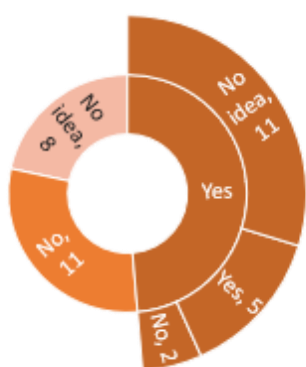


Figure 9 Measuring Food Loss and its GHG Equivalent

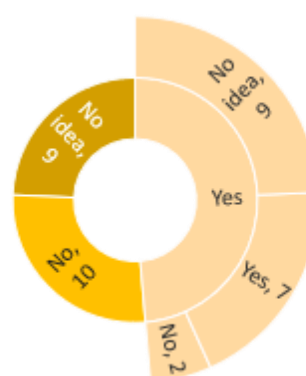


Figure 10 Measuring Food Waste and its GHG Equivalent

In the case of food loss on Figure 9, there were 11 respondents (from 8 economies) who said their economy does not measure food loss for monitoring. On the other hand, 18 respondents (from 7 economies) said their economy does measure food loss for monitoring; of which 5 respondents (from 3 economies) said that their economy measures the GHG equivalent thereof, 2 out of the 18

said they don't, and 11 out of the 16 said they do not know whether their economy measures the GHG equivalent of their food loss.

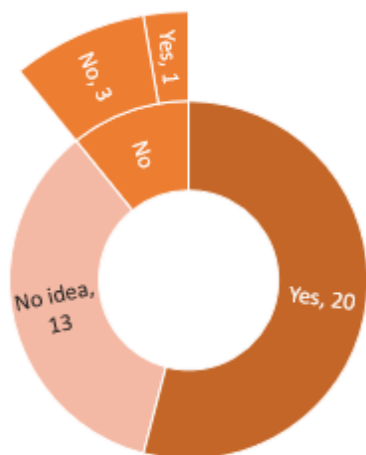


Figure 11 Reducing Food Loss to fight GHG emissions

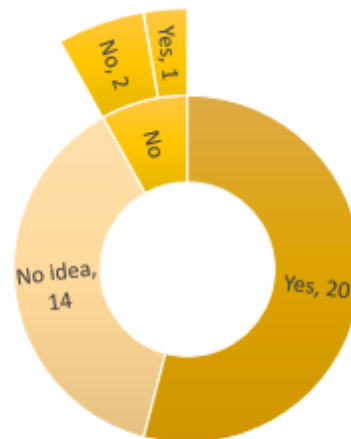


Figure 12 Reducing Food Waste to fight GHG emissions

In the case of food waste on Figure 10, ten respondents (from 6 economies) said they do not measure food waste for monitoring; whereas 18 respondents (from 8 economies) said their economy does. Of those who said yes, 7 respondents (from 5 economies) said that their economy measures the GHG equivalent of their food waste, 2 out of the 18 said they don't, and 10 out of the 18 said they do not know. It makes sense that there are more respondents who said that their economy measures the GHG content of their food waste than their food loss. Those that have FLW in their GHG commitments—i.e., NDC—mostly have food waste, not food loss. This will be expounded below.

Responses for Questions 4.4 and 4.5 will likewise be presented together. The inner circles on Figures 11 and 12 show the number of respondents who said that their economy includes FLW reduction in their GHG reduction strategy. The arcs jutting out indicate the answers to Question 4.5, in which those whose economy do not currently have FLW in their GHG reduction plans are asked whether they intend to include FLW in the future.

In the case of food loss on Figure 11, there were 20 respondents (from 10 economies) who said that their economy already includes food loss in their GHG reduction strategy. On the other hand, 4 respondents (from 3 economies) said no, but one of them said that their economy plans to include food loss in their GHG reduction strategy. The rest said they had no idea.

As for food waste on Figure 12, twenty respondents (from 11 economies) indicated that their economy already includes food waste in their GHG reduction strategy; whereas 3 respondents said no, but one of them said that their economy plans to include food loss in their GHG reduction strategy. The rest said they had no idea.

Apart from asking the respondents, we also checked the GHG reduction strategy of each APEC member economy. This complements their answers to Question 4.4. Many of the APEC member economies just mention agriculture and waste among the sectors covered in their plans. But this is ‘waste’ in general, which may include industrial waste, water waste, etc. See Table 4. Neither does agriculture necessarily include food loss, although it can be theoretically subsumed within that scope. Some economies do include actions related to food loss and waste in their implementation plan, although they do not specifically mention FLW. Most of these strategies include organic waste-to-energy. Organic waste includes food waste, but it also includes other things like livestock manure, crop by-products, etc. Brunei Darussalam aims to “Reduce municipal waste to landfills to 1kg/person/day by 2035 ... through adoption of best practices and innovative technologies.” Municipal waste most likely includes a lot of food waste. Dr Kim in Session 3 also mentioned that the strategy of the Republic of Korea is to monitor the food waste in municipal waste. Indonesia and Viet Nam have specific targets for reducing GHG emissions from waste (in general). None of them mentions monitoring food loss or waste in particular.

According to the information presented by Brian Lipinski in Session 1, Canada and China have provisions in their GHG reduction commitments pertaining to food loss. Canada has a separate implementation plan per province; and in British Columbia, they are pushing for circular economy, which will theoretically reduce food loss.

As for food waste, only four member economies categorically included food waste. The GHG commitment of Ontario, Canada includes eliminating food waste that goes to landfills by 2030. The People’s Republic of China includes the “Clean Plate Campaign” as their main strategy to reduce food waste in the context of their GHG emissions reduction plans. Hong Kong, China includes food waste reduction as part of their Climate Action Plan 2030+, under the renewable energy targets. They plan to redirect food waste to facilities that will convert it to energy. Lastly, Chinese Taipei has specified that its government will aim to reduce food catering waste as part of its strategy to achieve Net Zero by 2050.

It is also worth noting that several economies, in their GHG reduction plans, include food security as a concomitant issue to be addressed together with emissions and climate change. This once again underscores the inextricable nexus between FLW and food security; in this case, through the effects of FLW on greenhouse gases.

Table 4. Food waste in GHG reduction plans of APEC economies

From the GHG reduction plans of each economy	Number of economies
Mentions reduction of food waste as part of strategy to reduce GHG emissions	4
Has implementation plans that tackle waste (in general)	9
Mentions agriculture and waste (in general) as part of the sectors covered by GHG reduction plan, but no concrete strategy.	8
Total	21

3.1.6 Conclusion

In general, most of the respondents believe that the FLW situation has improved across commodity groups and different stages of the supply chain after the pandemic. Food loss and waste at the consumption stage though may require more attention. Most of them are also more positive about the prospects of achieving the FLW implementation plans within the APEC Food Security Roadmap. However, non-government respondents are less optimistic.

Among the technologies used for reducing FLW, (a) investment in more cold storage facilities and training courses, and (b) Digital solutions to sell food (e.g., e-commerce that allows farm-to-consumer) were the most widely-used. There is still a need to popularize the use of technology for measuring FLW, especially to help monitor progress by 2025 as planned in the Roadmap.

In terms of food system resilience, the dimensions that had the highest weighted average scores were availability, utilization, and accessibility. The dimensions with the lowest scores were livelihood of agrifood actors and stability over time.

All APEC member economies have their GHG reduction targets by 2030. More respondents said their economies measure food waste, and its GHG equivalent, compared to food loss. But none of the APEC economies include any measurable targets for FLW as part of their GHG reduction plans. Most respondents say their economy includes FLW in their GHG reduction strategy. But in their official GHG reduction commitments/plans, most of the APEC member economies only mention waste in general among the sectors covered in their commitment or in their implementation plans. Only four APEC economies categorically include food waste in their GHG reduction commitment as part of the implementation plans.

3.2 APEC Project Evaluation Survey

After the workshop, we distributed the “APEC Project Evaluation Survey” to participants and received 80 responses from 13 economies. Table 5 shows the breakdown of the respondents according to economy. Most of the respondents are from Asia (90%), followed by North America (6%), and South America (4%).

Table 5 Respondents by Member Economy

Member Economy	Number	Member Economy	Number
Chile	2	The Philippines	11
China	1	Singapore	1
Indonesia	1	Chinese Taipei	49
Republic of Korea	1	Thailand	4
Malaysia	2	The United States	4
Mexico	1	Viet Nam	2
Peru	1		

Furthermore, most of the respondents are from the on-site participants (63 of 80 respondents, 78%), but most of the North American respondents are online participants (4 of 5 respondents, 80%). Table 6 shows the breakdown by continent and by participation mode.

Table 6 Respondents by continent and participation mode

	Physical	Online	Total
Asia	60	12	72
South America	2	1	3
North America	1	4	5
Total	63	17	80

Figure 13 shows the sessions which were deemed most helpful by the participants. Most of the respondents recognized that Session 1: Challenges on reducing FLW through digitalization and innovations along the food supply chain (75 respondents, 94%), and Session 3: Building Sustainable Food System (72 respondents, 90%) were the most helpful among all sessions. The least helpful according to the post-workshop survey was Session 6: Panel Discussion; only 56 respondents thought it is the most helpful (70%).

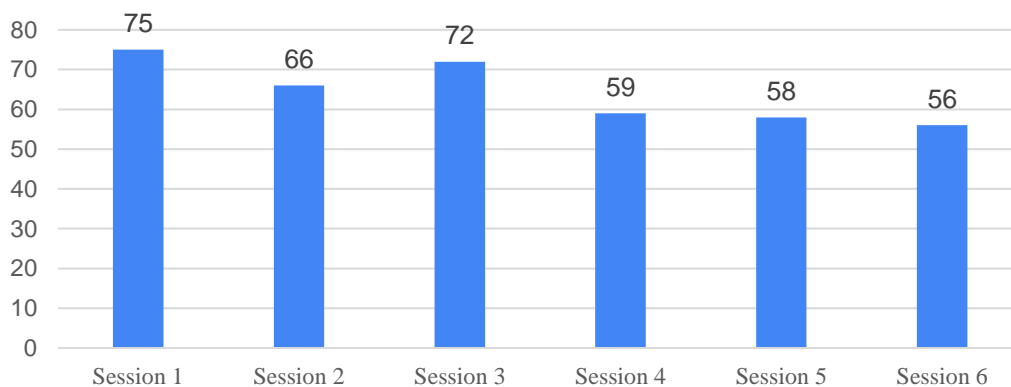


Figure 13 The session which most helpful

When asked whether this workshop met the expectations, about 74% of the participants strongly agreed (Figure 14). Furthermore, about 99% of the respondents agreed (70% of strongly agree) that their knowledge and skills about food loss and waste improved (Figure 15).

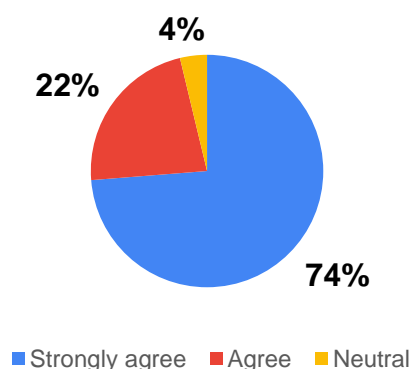


Figure 14 Expectations met

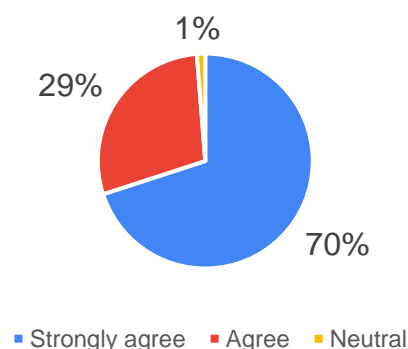


Figure 15 Knowledge of FLW improved

Moreover, we asked respondents to score the different dimensions about this workshop from 1 to 5 (with 1 being the lowest). The different dimensions include physical venue, food, time allotment, materials distributed, and overall organization of the workshop. Figure 16 below shows the average scores for each dimension, the highest scores were materials distributed (4.63) and overall organization of the workshop (4.63). The lowest average score were food and time allotment (4.59).⁵ In the detailed comments of the post-workshop survey, most respondents agree that the workshop was well-organized and that speakers were excellent. However, a respondent laments that time is insufficient for a deeper understanding of the concepts.



Figure 16 Average scores for each dimension of this workshop

Finally, this survey also asked the respondents what topics about food loss and waste they would be willing to know more about in subsequent APEC workshops. As Table 7 shows, most respondents are interested in best practices and actual case studies.

Table 7 Topics about FLW respondents want to learn more about

No	Response
1	Actual case study
2	Success story about Technology adoption especially among households, small- & large-scale farmers.
3	More discussion on the success stories and best practices on target-measure-act approaches in FLW Reduction.
4	Cultural, psychological, cognitive and behavioral economics aspects of FLW-associated behavior and practices
5	Solutions to reduce food waste at consumption stage
6	Use of technology in addressing food loss and waste
7	If it is possible to have some success mechanisms on PPP in terms of cold chain infrastructure establishments. Also, some initiative that works linking the small-scale producers to large scale processors to address food loss in the production and logistics stage.
8	Role of [overseas] organizations should be further discussed
9	Other Asian [economies'] participation level in reducing FLW
10	I think that an interesting topic to address would be: How public policy instruments (binding) can be promoted to safeguard the scope of the commitments regarding FLW
11	Urban approaches to food waste reduction, finance for food loss and waste

Overall, most respondents are satisfied with the implementation of this project. This project marks the importance of reducing FLW to build a sustainable food system and sharing best practices on digital and financial solutions to FLW reduction.

⁵ The slight difference in length on Figure 4 is due to rounding off to the second decimal place.

4. Agenda

Day 1: July 20, 2023 (Thursday)	
08:30 – 09:00	Arrival and Check-in
09:00 – 09:10	Welcome and Opening Remarks 1. Vincent LIN , Council of Agriculture (Project Overseer) 2. Su-San CHANG , Lead Shepherd, ATCWG, APEC 3. Teddy PAVON , Program Director, APEC Secretariat Group Photo
09:10 – 10:30	Session 1 – <u>Challenges on reducing FLW through digitalization and innovations along the food supply chain</u> 1. Global challenges and the need to strengthen evidence gathering and capacity development in reducing FLW. - Maximo TORERO , FAO 2. Challenges on digital solutions and implementation to foster collaboration among stakeholders to reduce FLW in the US - Dana GUNDERS , ReFED 3. The role of food loss and waste reduction in sustainable food systems - Brian LIPINSKI , WRI Chair: Su-San CHANG , Lead Shepherd, ATCWG, APEC
10:30 – 10:40	Coffee/Tea Break
10:40 – 12:00	Session 2 – <u>Digital and financial solutions to FLW reduction</u> 1. Innovative digital solutions MaSS – An Inclusive mobility solution for on-demand food services and social resilience - Samuel HOU , Feng-Chia University 2. Role of infrastructure/skill investment and enabling environment to speed up digital adoption/integration - Kanjana KWANMUANG , National Agricultural Big Data Center 3. Role of inclusive financial solutions and the growing use of ESG/CSR - Sophia CHENG , Cathay Financial Holding Co. Chair: Ching-Cheng CHANG , Academia Sinica
12:00 – 13:30	Lunch Break
13:30 – 15:30	Session 3 – <u>Building a sustainable food system</u> 1. Best practices sharing on sustainable food upcycling and waste valorization from Singapore - Matthew TAN , Assentoft Aqua Asia Pte Ltd. 2. Food waste policies and management system in Korea - Kwang-Yim KIM , Korea Zero Waste Movement Network 3. Advancing food waste prevention: Monitoring and benchmarking hospitality performance in Asia Pacific - Rubina SRIKUREJA , Lightblue Environmental Consulting Chair: Ching-Cheng CHANG , Academia Sinica
15:30 – 15:50	Coffee/Tea Break

15:50 – 17:00	<p>Session 4 – <u>Member economy and survey report on progress and challenges in the food system during/post COVID-19 pandemic</u></p> <p>1. Chile 2. Indonesia 3. Malaysia 4. The Philippines 5. Chinese Taipei</p> <p>6. Thailand 7. Viet Nam 8. APEC survey report - Kenneth DY, Academia Sinica</p> <p>Chair: Ching-Cheng CHANG, Academia Sinica</p>
17:00 – 17:20	<p>Closing Remarks - Ching-Cheng CHANG, Academia Sinica</p>
Day 2: July 21, 2023 (Friday)	
08:30 – 09:00	Arrival and Check-in
09:00 – 10:30	<p>Session 5 - <u>Target-Measure-Act with the aid of technology</u></p> <p>ReFED Insight Engine: An interactive digital learning tools to monitor food waste, identify solutions, calculate impacts, and plan out funding strategies - Asch HARWOOD, ReFED</p> <p>Chair: Kenneth DY, Academia Sinica</p>
10:30 – 10:40	Coffee/Tea Break
10:40 – 11:40	<p>Session 6 - <u>Panel discussion</u></p> <p>1. Key challenges and opportunities associated with capacity development and implementation for governments, NGO/NPO, domestic and cross-border supply chain stakeholders</p> <p>2. Strategic planning associated with inclusivity, gender equity, public-private partnerships, financing gap, e-certificates, infrastructure investment, coordination in data accountability/security and more</p> <p>3. Role of digital transformation for reducing FLW and target-measure-act cooperation under the APEC Food Security Roadmap Towards 2030</p> <p>Panelists: Brian LIPINSKI Matthew TAN Kanjana KWANMUANG</p> <p>Kwang-Yim KIM Shih-Hsun Tony HSU</p> <p>Moderator: Su-San CHANG, ATCWG, APEC</p>
11:40 – 12:00	<p>Closing Session</p> <p>1. Wrap up and Discussion on next step from workshop participants - Ching-Cheng CHANG, Academia Sinica</p> <p>2. Closing remarks - Vincent LIN, Council of Agriculture (Project Overseer)</p>
12:00 – 14:00	Lunch Break
14:00 – 17:00	Exhibition & Field Trip on reducing food loss and waste

5. Survey Questionnaire

Economy	
Sector	<input type="radio"/> Government <input type="radio"/> Academic <input type="radio"/> Private or Non-government organizations
Respondent's Information	Name:
	Gender: <input type="radio"/> Male <input type="radio"/> Female
	Agency:
	Position:
	Please rank your level of knowledge regarding FLW from 0 to 5, five being the highest: <input type="radio"/> 0 <input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
	Email:

The survey is part of the APEC project #ATC-01-2022: “Reducing Food Loss and Waste by Strengthening the Resilience of APEC Food System and Enhancing Digitalization and Innovative Technologies.” Our goal is to gather information regarding the role of digital and related innovative technologies in building an open, productive, sustainable, and resilient APEC food system including ways of measuring FLW. This survey follows up on a survey done two years ago in the APEC region. The summary of previous survey results can be downloaded from the APEC-FLOWS website: <https://apec-flows.ntu.edu.tw/publication.aspx>.

This *survey* has four parts:

- Q1:** Post-COVID-19 situation of FLW along the food supply chain
- Q2:** Digitalization or innovative technologies used to manage FLW
- Q3:** Strengthening food system resilience
- Q4:** Inclusion of FLW targets in greenhouse gas (GHG) emission reduction goals

All personal details will be treated as strictly confidential. The summary of responses herein will be shared during the workshop in Chinese Taipei on **20–21 July 2023**.

If you require any assistance, please email

Dr. Kenneth Bicol Dy at: [email removed for this APEC report]

Mr. Jun-song Yew at: [email removed for this APEC report]

Thank you for your support and cooperation.

Q1. Post-COVID-19 Food Loss and Waste (FLW) along the food supply chain

In May 2023, WHO declared that COVID-19 is no longer a global health emergency. However, for purposes of this survey, post-Covid-19 period is understood to mean after an economy has allowed fully vaccinated cross-border non-business travelers to enter without hotel quarantine. This is different per economy, so we will not specify an exact cut-off month or year.

1.1 How would you assess the change in FLW situation of the following commodity groups after the pandemic?

	Worsened a lot	Worsened	No change	Improved	Improved a lot	No idea
1. Cereals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Roots and tubers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Oilseeds and Pulses	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Fruits and vegetables	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Meat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Dairy products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Eggs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Fish and seafood	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

1.2 If possible, please expound on your answer in 1.1.

1.3 How did the FLW situation change along the following stages after the pandemic?

	Worsened a lot	Worsened	No change	Improved	Improved a lot	No idea
1. Production stage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Post-harvest handling and storage stage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Processing and packaging stage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Distribution and marketing stage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Consumption stage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

1.4 If possible, please expound on your answer in 1.3.

1.5 APEC Food Security Roadmap towards 2030 17e: “Provide capacity building and best practice sharing workshops to support member economies’ individual and collective efforts to align with the UN Sustainable Development Goals 12.3 ‘by 2030, halve per capita global food

waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses,' with specific indicators based on each economy's respective situation such as measured by the UN/FAO Food Waste Index (FWI) or other appropriate index. And promote public-private investment in infrastructure and cold chain to reduce the current levels of food loss and waste and review progress in this area by 2025.”

With regard to the APEC Food Security Roadmap goal, have you become more positive or negative about FLW situation in your economy after the pandemic? (Please choose one.)

- Significantly more positive
- Slightly more positive
- No change
- Slightly more negative
- Significantly more negative
- No idea

1.6 If possible, please expound on your answer in 1.5.

Q2. Digitalization or innovative technologies for managing FLW

2.1 Are you aware whether any of the following digital technologies or innovative solutions are being used in your economy for minimizing FLW. Please check the corresponding box. (Multiple choices. If none of them apply, kindly check the appropriate box at the end.)

1. Agricultural production stage

- AI or IoT in farming that help reduce food loss
- Robots for harvesting

2. Post-harvest handling and storage stage

- Storage technologies or practices that help preserve food (e.g., packaging innovations, dehydration technology, edible coating that prevents food loss, water-resistant and air-tight containers, small-scale drying machines)
- Investment in more cold storage facilities and training courses

3. Processing and packaging stage

- Circular model of food production (e.g., recovery for energy production or other means of using unavoidable organic by-product)
- Companies that sell or upcycle “imperfect” food

4. Distribution and marketing stage

- AI or IoT that provides real time food quality assessment along the supply chain (e.g., shelf-life prediction food scanners, digital monitoring or tracing systems along the supply chain)

- Digital solutions to sell food (e.g., e-commerce that allows farm-to-consumer)
 - Technology that helps in dynamic pricing of perishable products
 - Technology that encourages consumers to buy products about to expire
 - Electronic phytosanitary or veterinary certificates for cross-border trade
- 5. Consumption stage**
- Phone app that help consumers waste less
 - Phone app for consumer food sharing, recovery and redistribution operations
 - Promotion of urban farming or waste composting by consumers
- 6. Food waste measurement and management**
- AI or IoT to estimate food waste in food service providers
 - Smart bins that can help measure household food waste
 - FLW treatment facilities (e.g., waste-to-energy plants after consumption stage)
- 7. None or not aware**
- None
 - No idea

2.2 If possible, please give us other digital technologies or innovative solutions for minimizing FLW in your economy not listed above. Kindly describe them briefly and provide a link, if available.

Q3. Strengthening food system resilience

Please follow the definitions from the [FAO 2021 State of Food and Agriculture](#):
Agrifood systems' resilience – The capacity over time of agrifood systems, in the face of any disruption, to sustainably ensure availability of and access to sufficient, safe, and nutritious food for all, and sustain the livelihoods of agrifood systems' actors.

3.1 How would you rank the different dimensions of agrifood system resilience in your economy from one to five, with five being the most resilient?

- | | | | | | | |
|-------------------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------------|
| 1. Stability over time | <input type="radio"/> 1 | <input type="radio"/> 2 | <input type="radio"/> 3 | <input type="radio"/> 4 | <input type="radio"/> 5 | <input type="radio"/> No idea |
| 2. Sustainability | <input type="radio"/> 1 | <input type="radio"/> 2 | <input type="radio"/> 3 | <input type="radio"/> 4 | <input type="radio"/> 5 | <input type="radio"/> No idea |
| 3. Availability | <input type="radio"/> 1 | <input type="radio"/> 2 | <input type="radio"/> 3 | <input type="radio"/> 4 | <input type="radio"/> 5 | <input type="radio"/> No idea |
| 4. Accessibility | <input type="radio"/> 1 | <input type="radio"/> 2 | <input type="radio"/> 3 | <input type="radio"/> 4 | <input type="radio"/> 5 | <input type="radio"/> No idea |
| 5. Sufficient, safe, and nutritious | <input type="radio"/> 1 | <input type="radio"/> 2 | <input type="radio"/> 3 | <input type="radio"/> 4 | <input type="radio"/> 5 | <input type="radio"/> No idea |
| 6. (food security) for all | <input type="radio"/> 1 | <input type="radio"/> 2 | <input type="radio"/> 3 | <input type="radio"/> 4 | <input type="radio"/> 5 | <input type="radio"/> No idea |
| 7. Livelihood of agrifood actors | <input type="radio"/> 1 | <input type="radio"/> 2 | <input type="radio"/> 3 | <input type="radio"/> 4 | <input type="radio"/> 5 | <input type="radio"/> No idea |

3.2 If possible, please expound on your answer in 3.1.

Q4. Including FLW targets as part of the GHG emission reduction goals

4.1 Does your economy have GHG emission reduction goals?

Yes No No idea

4.2 Is your economy actively measuring FLW to monitor progress?

Food loss: Yes No No idea

Food waste: Yes No No idea

4.3 If yes, does your economy try to estimate the GHG equivalent of the estimated FLW?

Food loss: Yes No No idea Not applicable (4.2 was a 'No')

Food waste: Yes No No idea Not applicable (4.2 was a 'No')

4.4 Is FLW reduction targets part of your economy's strategy to meet the GHG emission reduction goals?

Food loss: Yes No No idea

Food waste: Yes No No idea

4.5 If not, does your economy intend to include FLW targets under the GHG emission reduction goals?

Food loss: Yes No No idea Not applicable (4.4 was a 'Yes')

Food waste: Yes No No idea Not applicable (4.4 was a 'Yes')

References

- Asia-Pacific Economic Cooperation. 2022. Reducing Food Loss and Waste along the Food Value Chain in APEC during and post-COVID-19 Pandemic. APEC. <https://www.apec.org/publications/2022/03/reducing-food-loss-and-waste-along-the-food-value-chain-in-apec-during-and-post-covid-19-pandemic>
- Dy, K.B., Chang, C-C., Hsu, S-H., Yew, J-S. APEC. 2021. APEC Minimizing Food Loss and Waste Survey (Full Survey Report). <https://apec-flows.ntu.edu.tw/publication.aspx>
- Food and Agriculture Organization. 2019. *The State of Food and Agriculture 2019. Moving forward on food loss and waste reduction*. FAO. <https://doi.org/10.4060/CA6030EN>
- Food and Agriculture Organization. 2021. *State of Food and Agriculture: Making Agrifood Systems More Resilient to Shocks and Stresses*. FAO. <https://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/1457191/>
- Food and Agriculture Organization. 2023. State of Food Security and Nutrition in the World. FAO. <https://www.fao.org/documents/card/en/c/cc0639en>
- Pacific Coast Collaborative. 2022. *Case Study: Using Artificial Intelligence to Reduce Food Waste in Grocery Retail*. <https://pacificcoastcollaborative.org/food-waste/>
- Tendall, D.M., Joerin, J., Kopainsky, B., Edwards, P., Shreck, A., Le, Q.B., Kruetli, P., Grant, M. & Six, J. 2015. Food system resilience: Defining the concept. *Global Food Security*, 6:17–23.
- United Nations Environment Programme. (2021). *Food Waste Index Report 2021*. <https://www.unep.org/resources/report/unep-food-waste-index-report-2021>