A Food Loss and Waste Quantification Handbook for APEC Economies

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The Vision and Goal of "APEC Food Security Roadmap Towards 2020" (SOM3, Beijing, China, 20-21 August 2014):

APEC economies will strive to reduce food loss and waste by 10%* compared with the 2011-2012 levels by 2020 in the Asia-Pacific economies. (Para. 7)

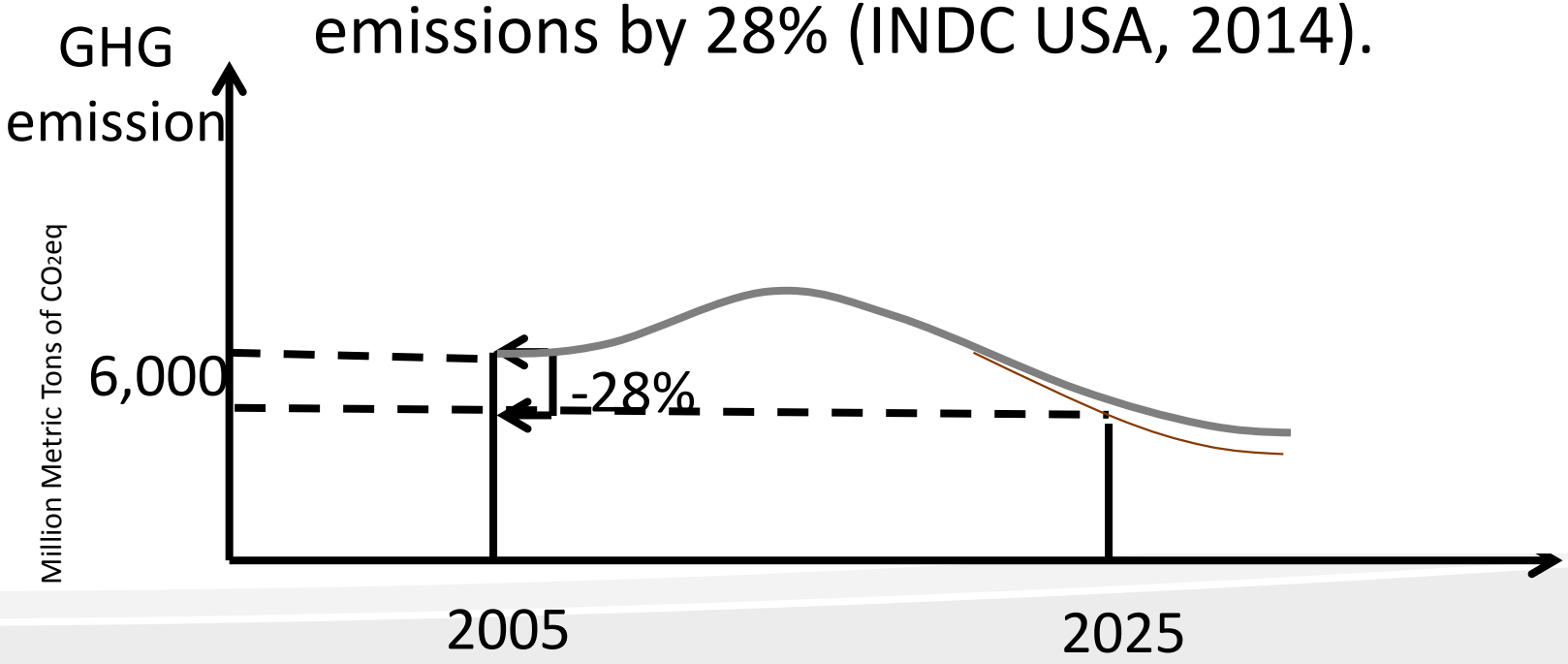
*** It is an average level for all economies. Specific indicator can be developed based on each economy's situation.**

“Compared to what?”

- Winston Churchill, when once asked, “How’s your wife?”

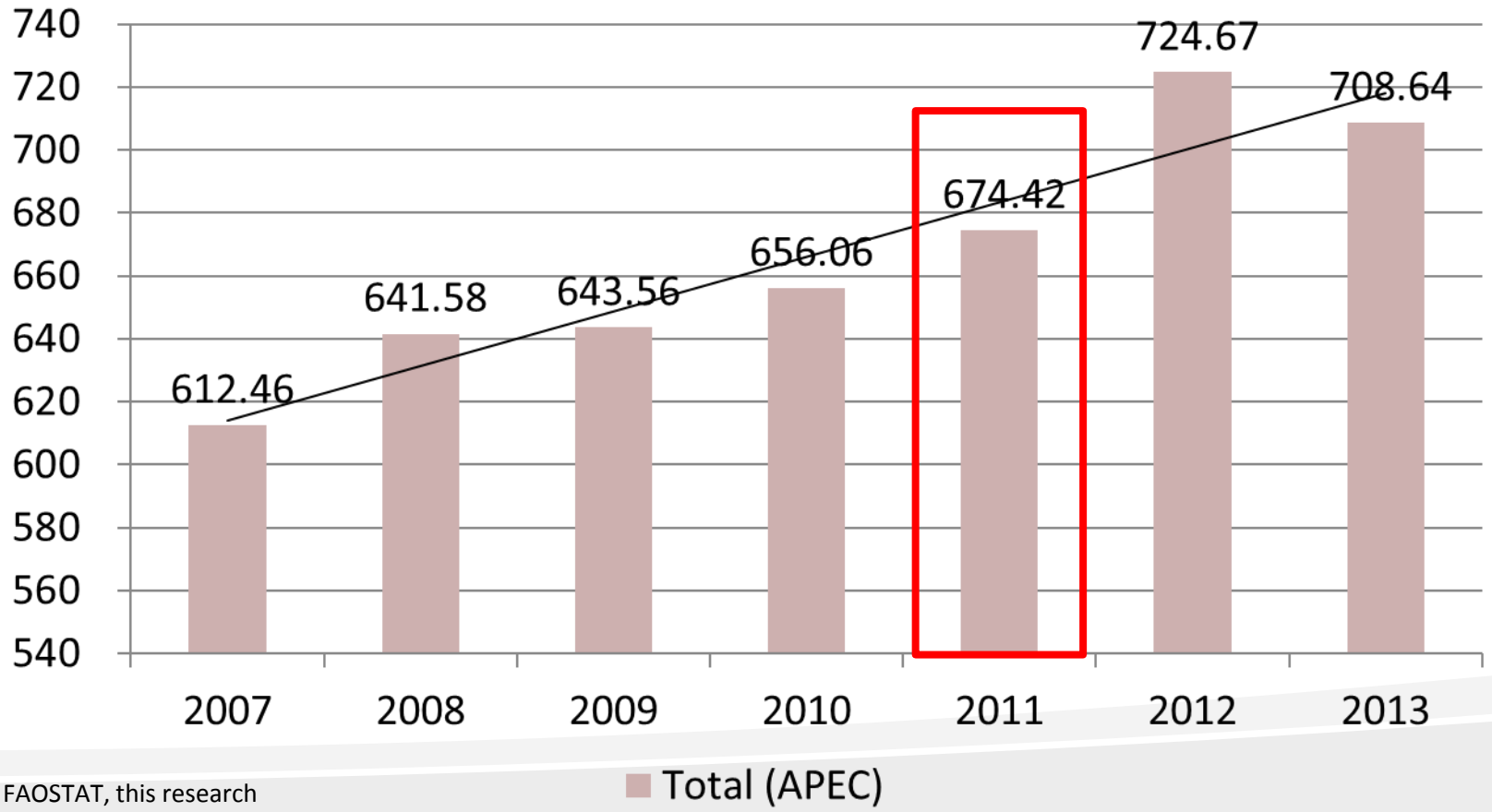
U.S. Target of GHG emission

For instance, the United States intends to achieve an economy-wide target of **reducing its greenhouse gas emissions by 26-28 per cent below its 2005 level in 2025** and to make best efforts to reduce its emissions by 28% (INDC USA, 2014).



APEC Food Losses and Waste

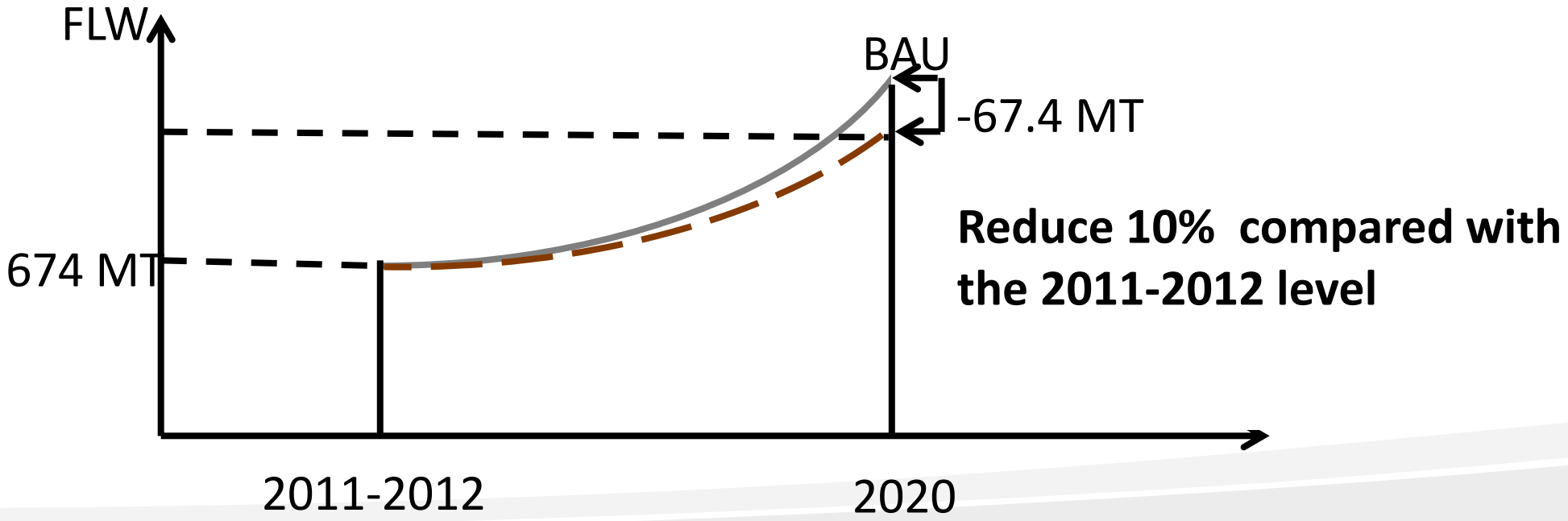
Unit: MT



Source: FAOSTAT, this research

Target of FLW Reduction for APEC Economies by 2020

"APEC economies will strive **to reduce food loss and waste by 10% compared with the 2011-2012 levels by 2020** in the Asia-Pacific economies ..."



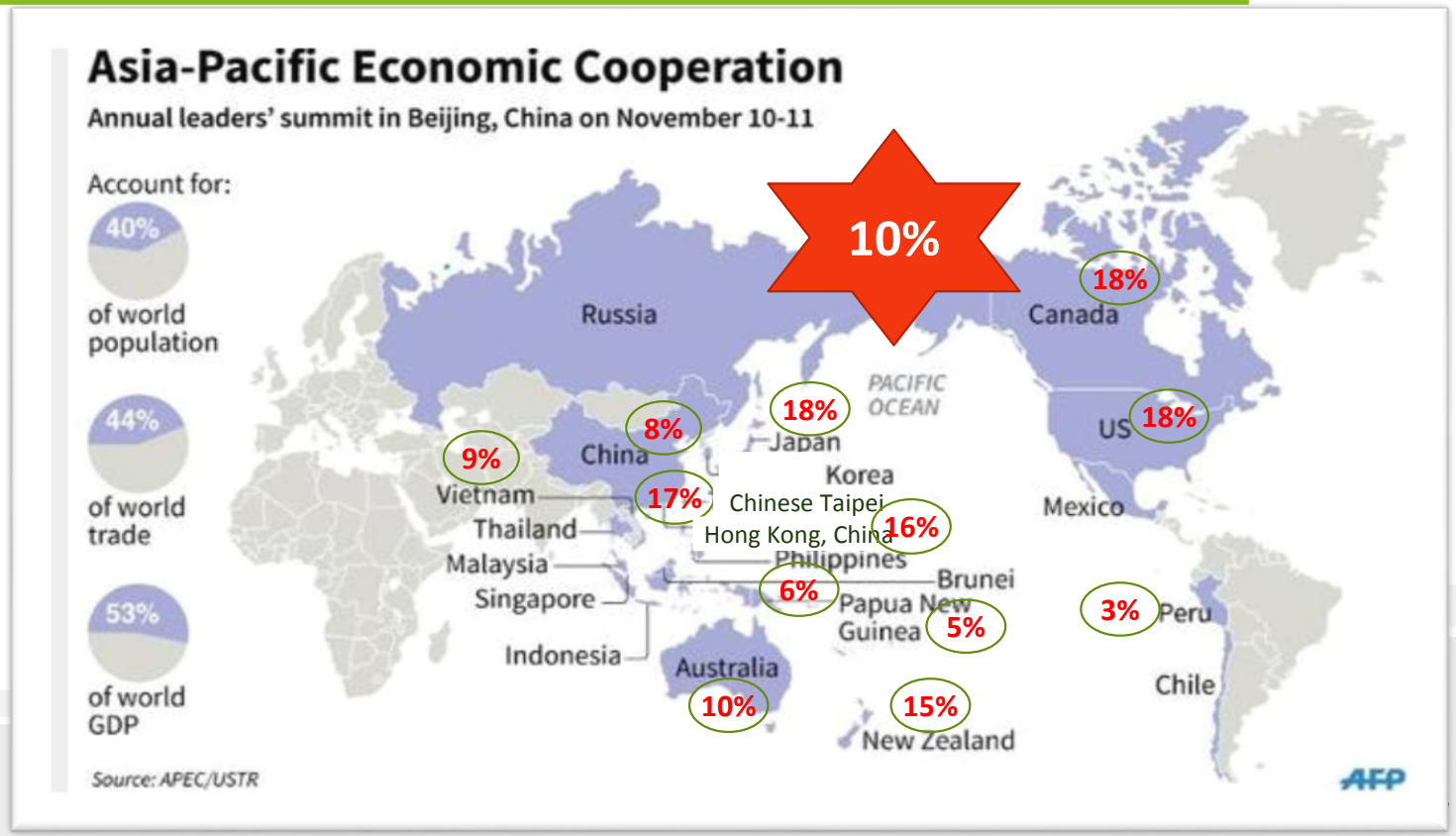
Source: APEC Food Security Roadmap Towards 2020 Third Senior Officials' Meeting, Beijing, China, 2014

What Does the 10% FLW Reduction Goal Mean?

"APEC economies will strive to reduce food loss and waste by 10% compared with the 2011-2012 levels by 2020 in the Asia-Pacific economies

"It is an average for all economies. Specific indicator can be developed based on each economy's situation."

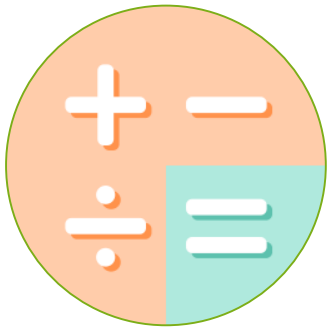
- ***Ranking***
- ***Aggregation***



In this Handbook

- **Chapter 1** provides an introduction of the background information, purpose of the Handbook and the guidance of this book.
- **Chapter 2** defines the key terms used in this Handbook.
- **Chapter 3** develops a general approach for quantifying, reporting and monitoring Food Loss and Waste (FLW) reduction progress at economy level in APEC.
- **Chapter 4** provides recommended approach and case study for sectors to establish quantification systems.
- **Chapter 5** presents the way forward.

Purpose of this Handbook



Developing a systematic yet flexible quantification method to estimate FLW at the ME and sectoral levels

Introducing how to report FLW quantification results for **self-improvement**

Recommendations for sectors to start quantifying FLW

How to use this Handbook?

- This Handbook provides a general framework which could be applied by any economy level authorities, statistical offices, and research institutes.
- This general approach could be developed further based on particular needs and could be used as a reference for users across industry sectors or by other third-party users concerned with FLW issues.
- The quantification methodologies developed in this Handbook are in harmony with the **World Resources Institute (WRI)'s** *Food Loss & Waste Protocol: Food Loss and Waste Accounting and Reporting Standard*, **FUSIONS's** *Food Waste Quantification Manual to Monitor Food Waste Amount and Progression*, and the **United Nations' Food and Agriculture Organization (FAO) FLW quantification methodology**.
- This APEC Handbook compiles information into one place for the reference of APEC MEs while also qualifying the above approaches to the needs of the APEC region.

Chapter 2 – A Review of FLW Definitions

Existing definitions

The four definitions are different from scope, and stage

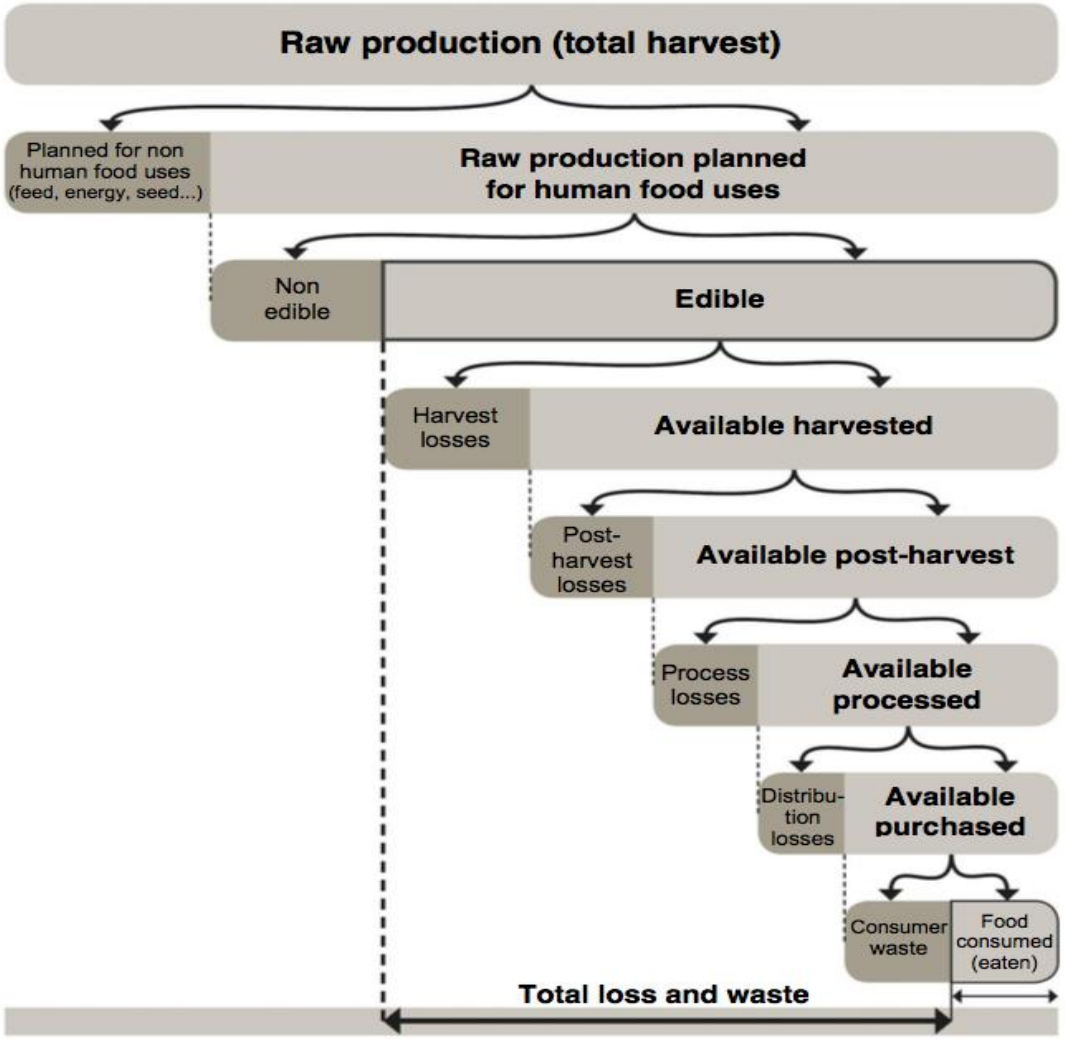
FAO and High Level Panel of Experts of United Nations	U.S Department of Agriculture (USDA), Economic Research Service (ERS)	U.S Environment Protection Agency (EPA)	Food Use for Social Innovation by Optimising Waste Prevention Strategies (FUSIONS)
- The decrease in edible food mass - Occur at all stages of the FSC - Emphasize the impact of FLW in three perspectives: systematic, sustainable, and food security perspectives.	- Amount of edible food, postharvest that is available for human consumption but is not consumed	- The amount of food going to landfills from residences, commercial establishments - Pre-consumer food generated is not included in EPA's food waste estimates	- Food and inedible parts of food removed from the supply chain

- We synthesize the existing definitions into two approaches:

Sustainability concern	Normally found in advanced economies where the food supply is secured, FLW represents **food and inedible parts** of food removed from all stages of the FSC.
Food security concern	• FLW includes **only edible food** (i.e. intended for human consumption), and does not include the inedible parts of food removed from all stages of the FSC.

- The FLW Quantification Handbook for APEC Economies adopts three perspectives: a food supply chain (i.e., systematic) perspective, a food security and nutrition perspective, and a sustainability perspective.

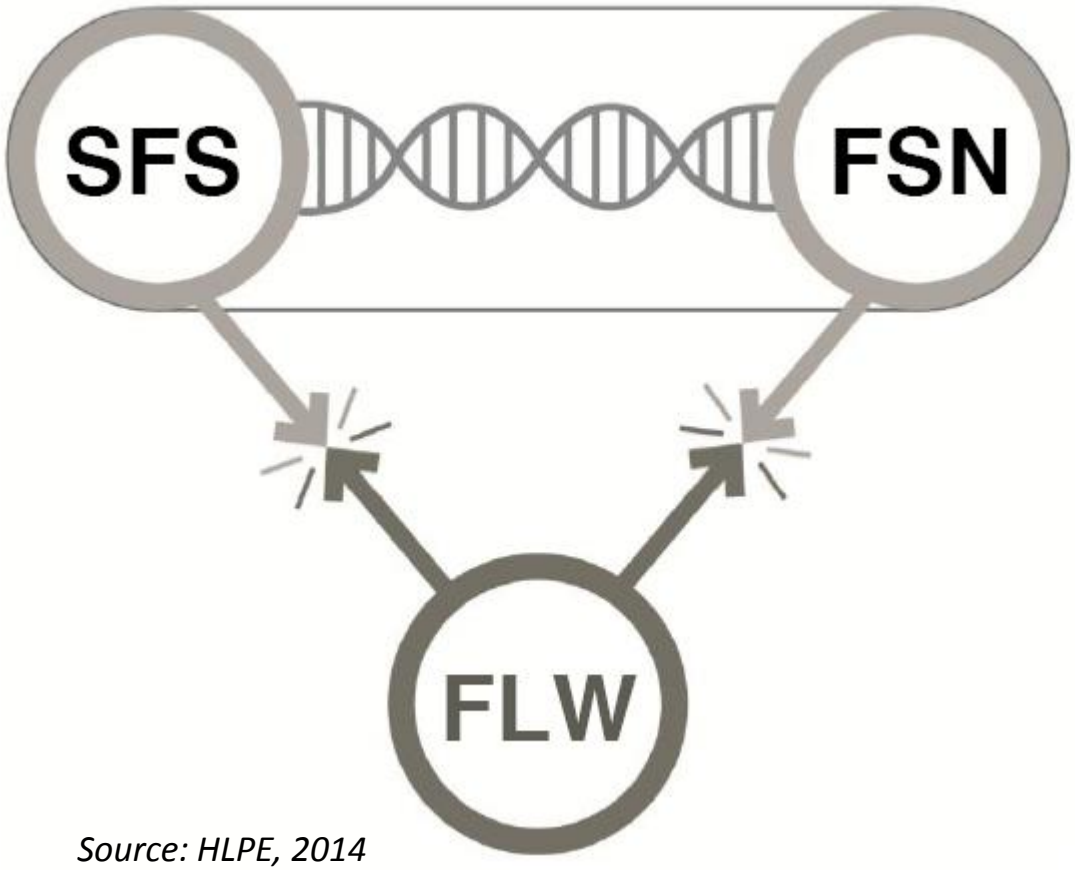
FLW in Systematic perspective



- FLW occurs along the food supply chain (FSC) from the production to the final uses of consumer.
- FLW is not an accident but it is an integral part of food system.
- There are five steps which are harvest, post-harvest, processing, distribution, and consumption. Total FLW is the sum at each step, of losses and waste of edible parts of food that is initially assigned for human consumption.

Source: HLPE, 2014

FLW in sustainability perspective



Source: HLPE, 2014

- A sustainable food system (SFS) ensures food security and nutrition (FSN) for all in which the economic, social and environmental bases for future generations' food security is not compromised.
- FLW go against the sustainability of food system (i.e., environmental, social and economic dimensions) and against food and nutrition security.

Food lost or wasted while people go hungry is first of all sign of a global food system that does not fulfil adequately its function (HLPE, 2014)

The impact of FLW in three perspectives – Food security and nutrition

- The availability of food is affected.
- FLW cause the higher food prices.
- Natural resources are not used sustainably, affecting food production conditions of future generations.

vs

Tuna eyeballs - Japan

- There is a highly diverse nature of APEC economies. The edible and inedible part of foods depend on culture and norm of each MEs.
- We encourage MEs define the scope of FLW by themselves and quantify FLW for self-improvement

A Two-Tiered Approach for Consideration

We propose a comprehensive yet flexible approach on FLW quantification to identify the volumes and causes of FLW within the food supply chain

Four-option framework for APEC members

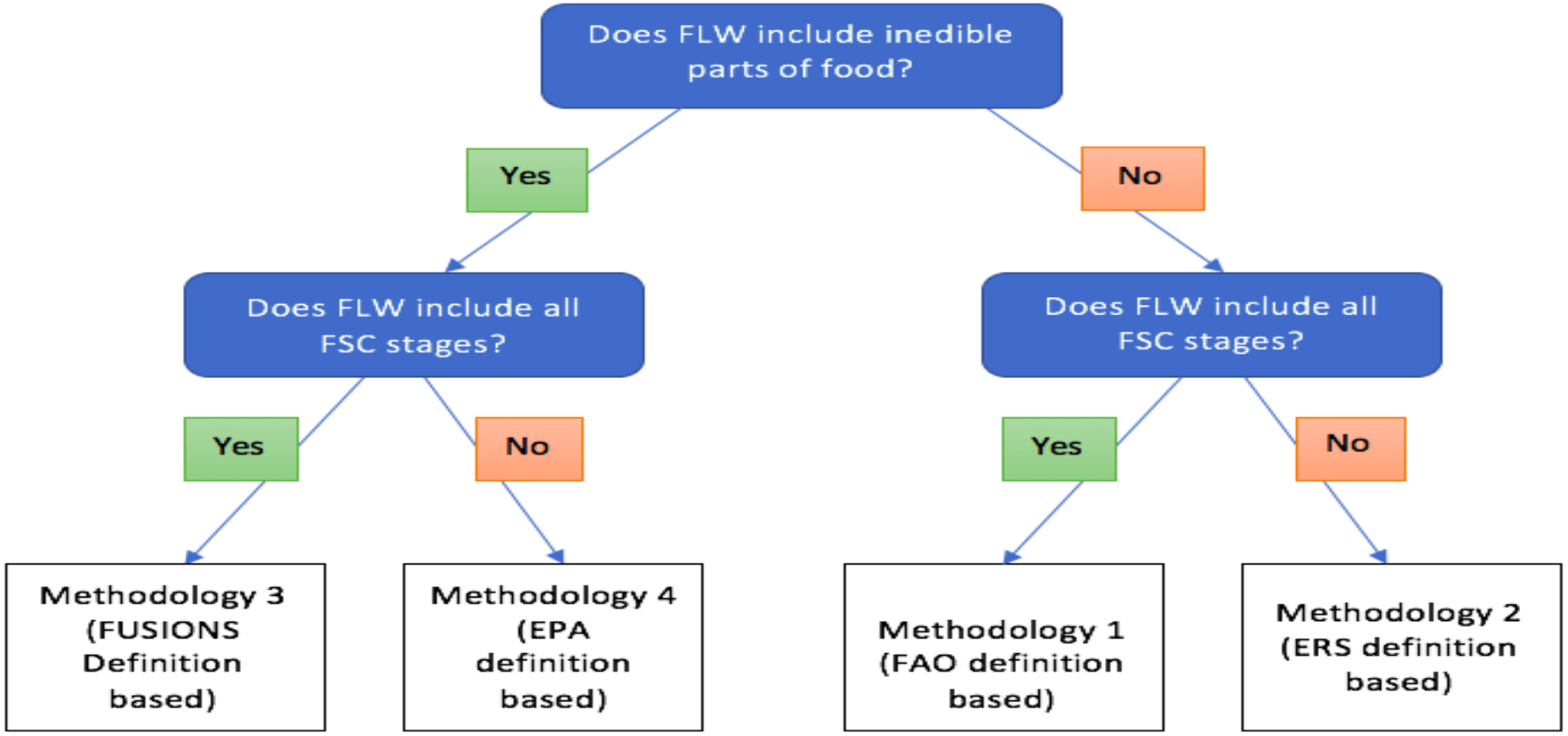
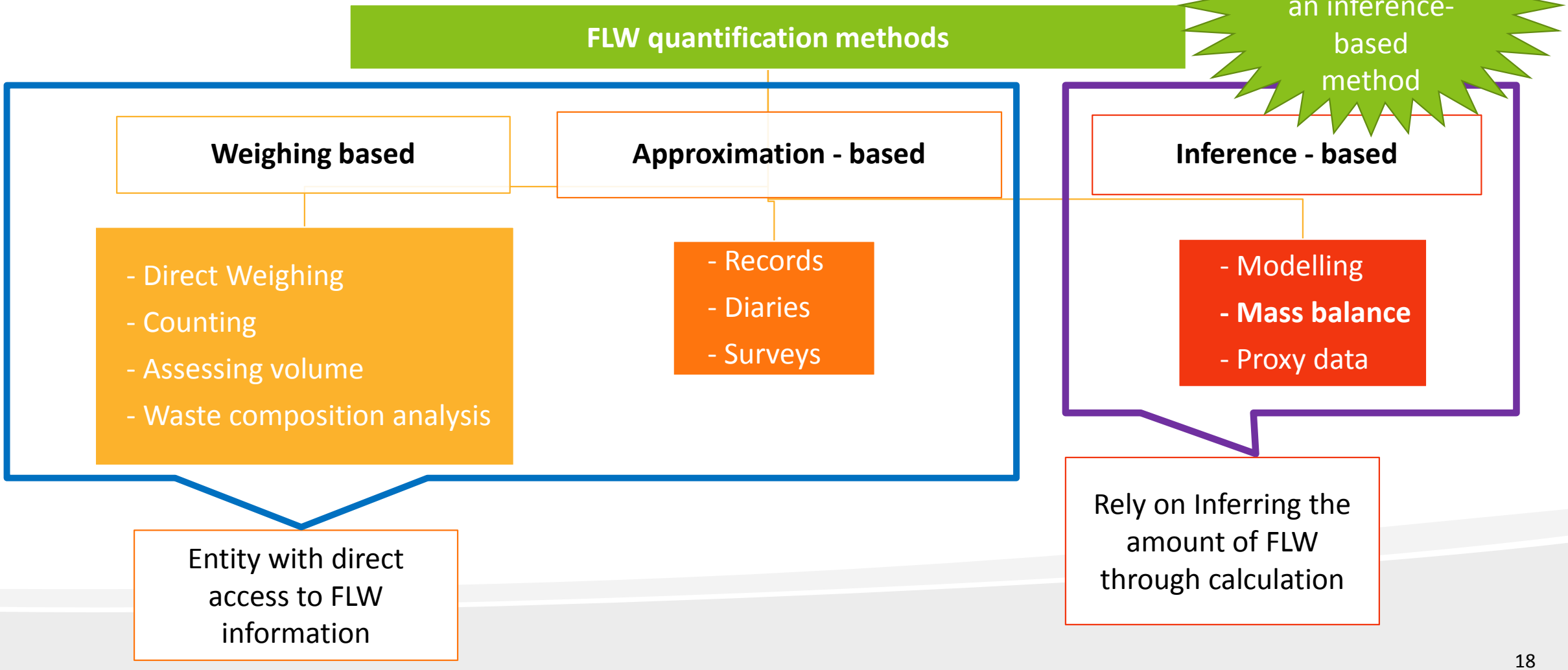


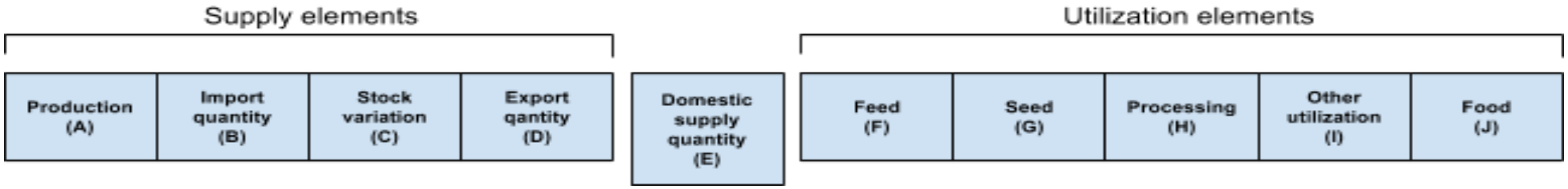
Figure 2.2 A two-tiered decision tree approach for consideration by APEC economies

Chapter 3 – FLW Quantification at the Economy Level

- Review of methodologies
  -The FLW Protocol proposed ten different quantification methods
  - EU FUSIONS follow closely the FLW Protocol



A Food Balance Sheet (FBS) presents a comprehensive picture of the pattern of an economy's food supply and utilization during a specified reference period



	Element	Interpretation
A	Production	Reported in primary crops for crops; carcass weight for meat; live weight equivalent for fish and total production leaving the manufacture for processed commodities.
B	Import quantity	All movements of the commodity in question into the n/region.
C	Stock variation	Changes in foremost government stocks.
D	Export quantity	All movements of the commodity in question out of the economy/region.
E	Domestic supply quantity	Sum of A, B, C, and D (of which D is negative).

	Element	Interpretation
F	Feed	The amounts of the commodity in question used to feed animals.
G	Seed	The amounts of the commodity in question used for reproductive purposes, e.g. seed, planting, eggs for hatching or fish for bait.
H	Processing	The amount of the commodity available for human consumption as part of mixed processed food products, containing different types of commodities.
I	Other utilization	The amounts of commodity lost during handling, storage and transport between production and distribution as well as amounts of the commodity used for non-food purposes, e.g. oil for oil production and wheat for bio-energy.
J	Food	All forms of the commodity available for human consumption, e.g. wheat flour, vegetable oils etc. (although not including H).

Taking the FBS data for a specific commodity, region and time, the data are then multiplied by the appropriate losses ratio and allocation factors, which are estimated by the SIK, based on FLW levels in comparable regions, commodity groups and steps of the FSC.

We encourage users to follow this format to build up their own FBS in a specified period as:

Commodity	Domestic supply					Domestic utilization				
	Production (A)	Import (B)	Stock variations (C)	Export (D)	Total (E)	Feed (F)	Seed (G)	Processing (H)	Other utilization (I)	Food (J)
Cereals										
Wheat										
Rice										
…										

ID	Loss/waste ratio
❶	Production
❷	Handling & Storage
❸	Processing & Packaging
❹	Distribution (Fresh)
❺	Distribution (Processed)
❻	Consumption (Fresh)
❼	Consumption (Processed)
K	Food (Fresh)
L	Food (Processed

The general steps for calculating the FLW at each stage using **Mass Flow Model**:

Production losses

- $FLW_1 = A * (❶ / (1 - ❶))$

PHL (FLW_2)

- $FLW_2 = A * ❷$

Processing losses

- $FLW_3 = (L+H) * ❸$

Distribution losses (FLW_4 & FLW_5)

- $FLW_4 = K * ❹$
- $FLW_5 = (L+H-LW_3) * ❺$

Consumption losses

- $FLW_6 = (K-FLW_4) * ❻$
- $FLW_7 = (L+H-FLW_3-FLW_5) * ❼$

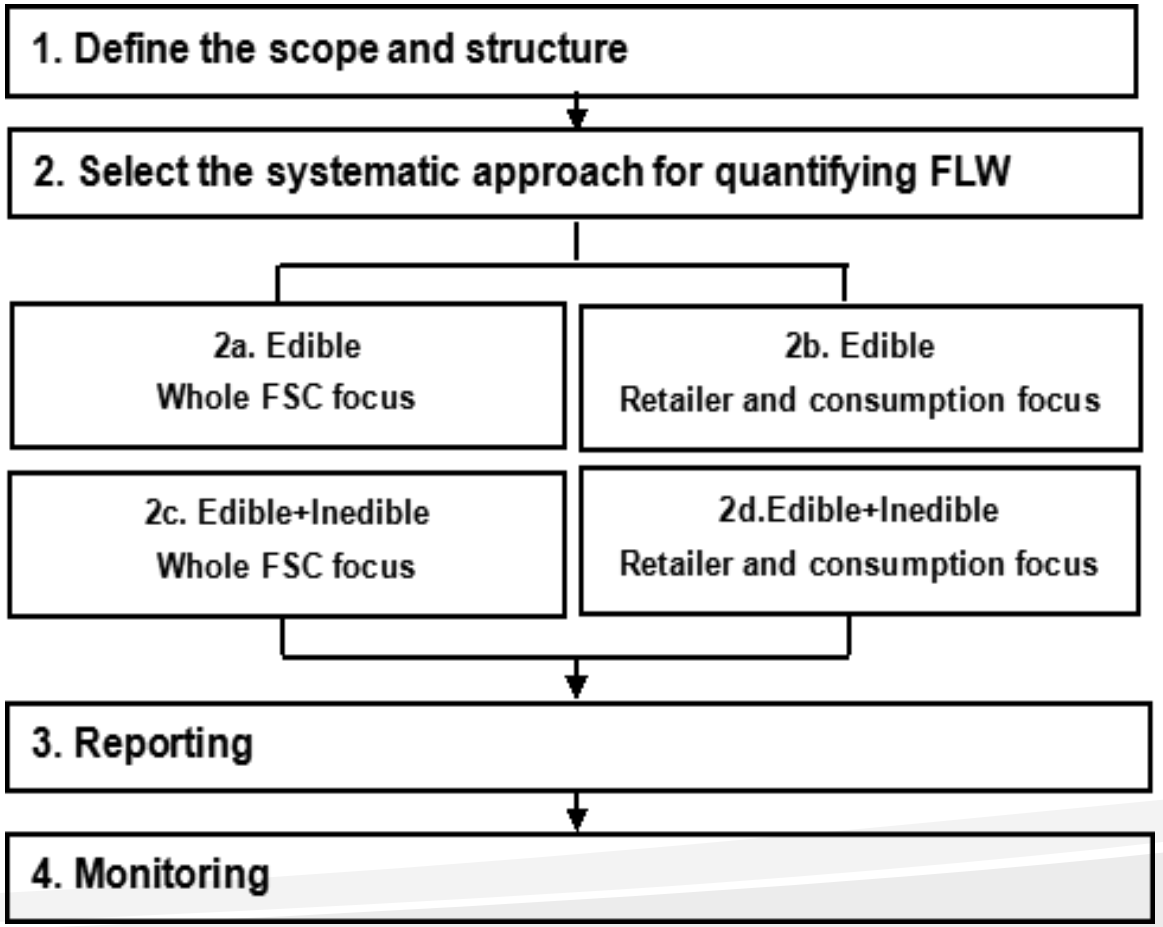
Chapter 3 – General approach for quantifying FLW at the economy level

Steps for quantifying FLW at economy level

- We adopt FAO quantification methodology for quantifying because of the following reasons:

- It has a clear and well-defined estimation procedure.

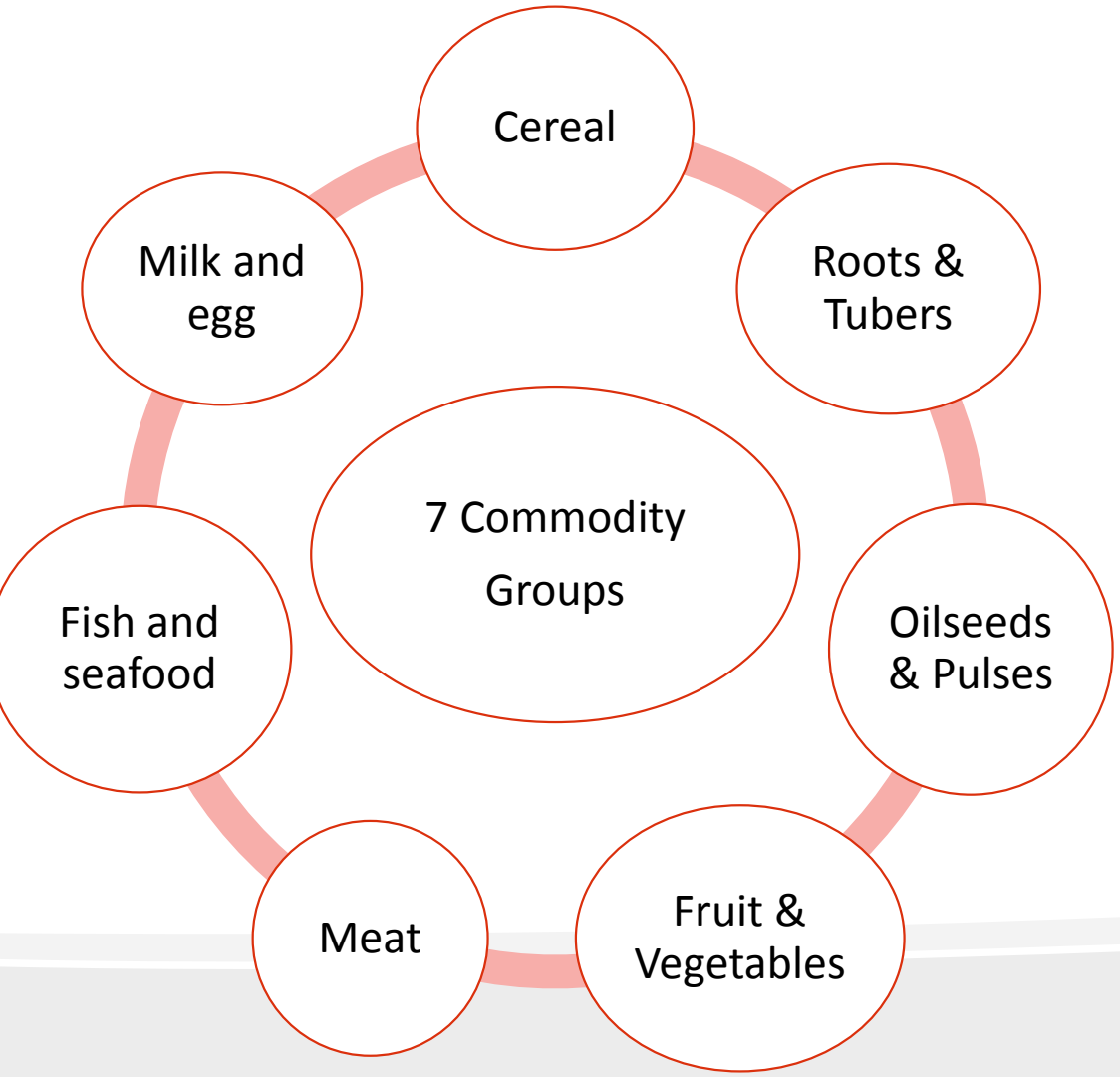
- It is also cost-effective methodology especially for those who do not have direct access to FLW data.



What's measured Improves
-Peter F. Drucker-

Step 1. Scope and Structure

Classification of commodity groups



- **Decide the stages included along the supply chain**

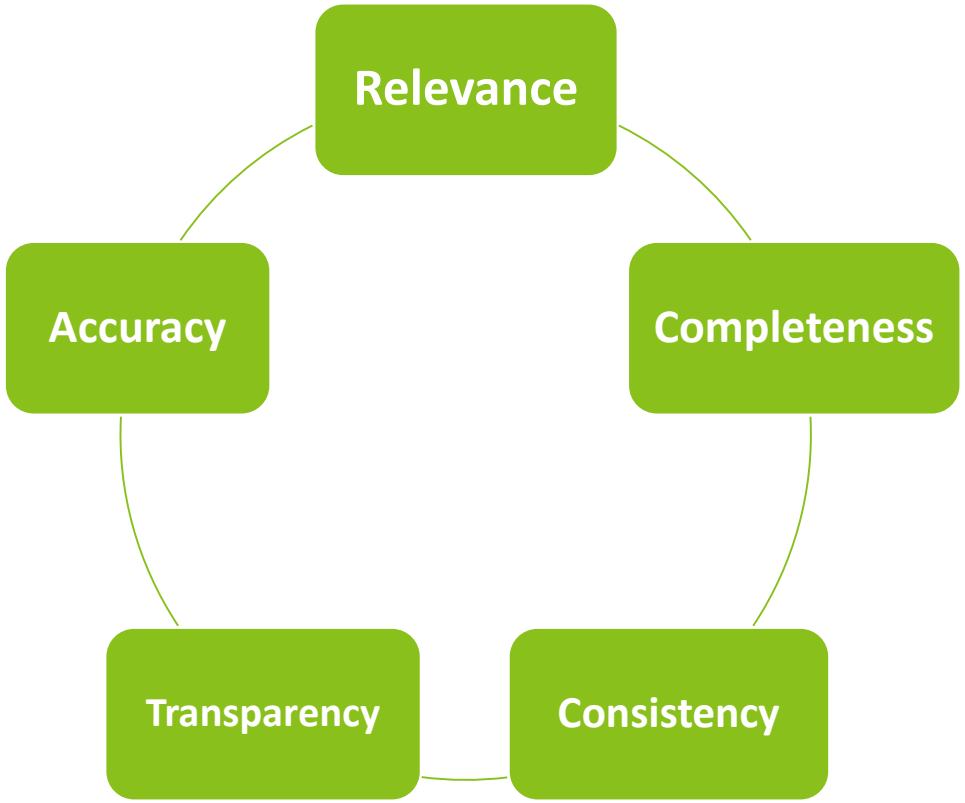
Agricultural Production	• losses due to mechanical damage and/or spillage during harvest operation, crops sorted out post-harvest
Post-harvest handling and storage	• losses due to spillage and degradation during handling, storage and transportation between farm and distribution
Processing	• spillage and degradation during industrial or domestic processing, e.g. juice production, canning and bread baking
Distribution	• Distribution refers to losses and waste in the market system, at e.g. wholesale markets, supermarkets, retailers and wet markets.
Consumption	• This includes losses and waste at the household level.

Step 2. Systematic Approach for Quantifications

	Edible	Edible + Inedible
The entire Food Supply Chain	**Methodology 1** **FLW**= $(FLW_1 + FLW_2 + FLW_3 + FLW_4 + FLW_5 + FLW_6 + FLW_7)$ x Conversion Factor $_{\text{corresponding FSC stage}}$	**Methodology 3** **FLW**= $(FLW_1 + FLW_2 + FLW_3 + FLW_4 + FLW_5 + FLW_6 + FLW_7)$
Retail and Consumption	**Methodology 2** **FLW**= $(FLW_4 + FLW_5 + FLW_6 + FLW_7)$ x Conversion Factor $_{\text{corresponding FSC stage}}$	**Methodology 4** **FLW**= $(FLW_4 + FLW_5 + FLW_6 + FLW_7)$

Step 3. Reporting

Reporting principles:



The FLW quantification report should include the following information:

General Information

- Name of the APEC economy
- Name of the coordinated organization
- Contact information
- Date published
- For subsequent report, a link to previous reports

Scope

- Commodities groups
- Food supply chain stages

Results

- Total amount of FLW expressed in a particular unit

Additional information (optional)

- Methodological details
- Uses of the FLW quantification report
- Setting targets and tracking changes

Step 4. Monitoring

Select a base year and set a target

- Target: absolute targets (specific amount) or relative targets (relative amount)
- Completion date: set in the same unit of time as the base year
- Level of ambition

Tracking performance over time

- Develop a monitoring plan
- Quantify frequently
- Ensure the consistency of scope
- Ensure the consistency of quantifying method

Recalculating FLW baseline

- The base year FLW should be recalculated if there is a significant change (member economy's authorities or scope change)

An example of calculating FLW of fruit using Chinese Taipei's food balance sheet 2011

Supply elements					Utilization elements				
Production (A) 2,646	Import quantity (B) 560	Stock variation © 0	Export qantity (D) 130	Domestic supply quantity (E) 3,076	Feed (F) 0	Seed (G) 0	Processing (H) 58	Other utilization (I) 188	Food (J) 2,828

ID	Description	Loss ratio (%)
❶	Production	10
❷	Handling & Storage	8
❸	Processing & Packaging	2
❹	Distribution (Fresh)	8
❺	Distribution (Processed)	4
❻	Consumption (Fresh)	15
❼	Consumption (Processed)	12

Production losses

- FLW_1=A*(❶/(1 - ❶)) = 2,646 * (0.1/(1-0.1))=**294**

PHL (FLW_2)

- FLW_2=A*❷ = 2,646 * 0.08=**212**

Processing losses (FLW_3)

- FLW_3=(L+H)*❸ = (141+58) * 0.02=**4**

Distribution losses (FLW_4 &FLW_5)

- FLW_4=K*❹ = 2,687 * 0.08=**215**
- FLW_5=(L+H-LW_3)*❺ = (141+58-4) * 0.04=**8**

Consumption losses

- FLW_6=(K- FLW_4)*❻ = (2,687-215) * 0.15=**371**
- FLW_7=(L+H- FLW_3-FLW_5)*❼ = (141+58-4-8) * 0.12=**22**

Results

Unit: 1,000 tons

	Edible	Edible + Inedible
The entire Food Supply Chain	Methodology 1 883	Methodology 3 1,126
Retail and Consumption	Methodology 2 491	Methodology 4 616

Detailed calculation can be found in the Handbook, p. 54

Chapter 4 – Sectoral level food loss and waste quantification

- Bottom-up Approach
- Through our APEC multi-year project, specialists and researchers presented FLW quantification methods, issues and concerns in the global and local food value chain, and recommendations and actions.
- This chapter is a compilation of information and data presented in these five years by our invited speakers and experts
- The chapter demonstrates FLW in five sectors, food donation, and sectoral initiative recommendations

Losses in the value chain of rice in APEC economies

Thailand: In the expert consultation on July 2015 in Taipei, data of losses in the value chain of rice were presented as below

(Source: Dr. Sarun Wattanutchariya)

Figure 4.1 Losses and Waste along the value chain of Rice in Thailand

The Philippines:

- In the expert consultation in July 2016 in Taipei the Philippine Center for Postharvest Development and Mechanization (PhilMech) presented some of its finding on food losses in the Philippines by Dr. Amelita R. Salvador
- An assessment by PhilMech published in 2012 reflected that paddy/rice losses in the postharvest stage accounts for **16.47%** of the total production, of which, **5.52%** is lost in the milling process. The main causes arise during harvesting, drying and threshing.

Losses in the value chain of fisheries products

Lessons from Korea

Fisheries generate large quantities of by-products which are not suitable for human consumption, e.g. bones and shells, but if further processed they may have high economic value.

Quantified fishery by-products in Korea using the food balance sheet and the following equation:

$$QFB = \sum_{i=1}^{n}((q_i + I_i + N_i - E_i - O_i - L_i - F_i - P_i) \times \beta_i)$$

where
QFB= Quantity of Fisheries By-products
q_i= total fisheries production
I_i= imports
N_i= carried in
E_i= exports
O_i= carried over
L_i= decrease
F_i= feed
P_i= processing

Quantification of Fisheries By-products in Korea Study (Cho, 2015)

unit: 1,000 ton

Categories	Production	Edible Supply	Non-edible (%)	By-products
Total	2,276.6	3,069	38.66	1,186
Fish	1383.3	1,850	39.16	724.6
Shellfish	893.3	1,218	37.91	461.9

Losses in the Livestock Sector in USA

- Milk, meat, and eggs are the main livestock products contributing to human food security.
- Buzby et al., 2014 uses data from ERS's Loss-Adjusted Food Availability (LAFA) data series which is ERS's data series, adjusted for spoilage, plate waste and other food losses.
- LAFA is from Food Availability data which is similar to Food Balance Sheet

FLW at the retailer and consumer level in the U.S. in 2010

Top three food groups in terms of amount			
1	Dairy Products	25 billion pounds	19%
2	Vegetables	25 billion pounds	19%
3	Grain Products	18.5 billion pounds	14%
Top three food groups in terms of value			
1	Meat, poultry, and fish	$48 billion	30%
2	Vegetables	$30 billion	19%
3	Dairy Products	$27 billion	17%

Eggs, meat, poultry, fish, and dairy products account for **48.6%** of the total value of food loss in the U.S.

Losses in the Service Industry

- Action **#14** of APEC Services Competitiveness Roadmap is **"the progressive facilitation of services to improve the regional food system to ensure access to safe, high quality food supplies across the Asia-Pacific".**
- Services competitiveness can be enhanced by improving the value chain through quantification of losses in the marketing chain, improving cool chain infrastructure, using innovative technology in marketing channels, all of which are also recommended to reduce FLW in APEC economies
- Previous audits in hospitality businesses found that **25-46%** of food waste occurs before food even reaches a plate. In fact, most of the hospitality sector lacks data and measurement of the waste which in turn makes waste management and reduction very unpractical.

Losses at the Household Level

- Under certain circumstances individuals or business organizations are unable to consume or sell all of the food items they have in their house/stores.
- The best use of food and one of the most preferable measures to reduce FLW is to feed hungry people.

→ Food banks play an important role for collecting, storing and distributing surplus food donated or shared.

The Food Rescue concept and its application in New Zealand

"The Immunity of Food Donors Act" was passed in 2014. This Act states that:

"A food donor is protected from civil and criminal liability that results from the consumption of food donated by the donor if-

a. *the food was safe and suitable when it left the possession or control of the donor; and*
b. *as applicable, the donor provided the recipient with the information reasonably necessary to maintain the safety and suitability of the food."*

Recommendations for APEC Sectoral Initiatives

- Stakeholder including processors, retailers, and final consumers often neglect the extend of FLW.
- This Handbook reviews the FLW Protocol of the WRI, the FAO Mass Flow Model, and the Food waste quantification manual to monitor food waste amounts and progression of the EU project FUSIONS.
- It is the decision of the member economy's authorities to choose one approach or the other, and depending on the scope, objectives, cultural background and available data, a sectoral approach may be taken.

Target of FLW Reduction for APEC Economies by 2020

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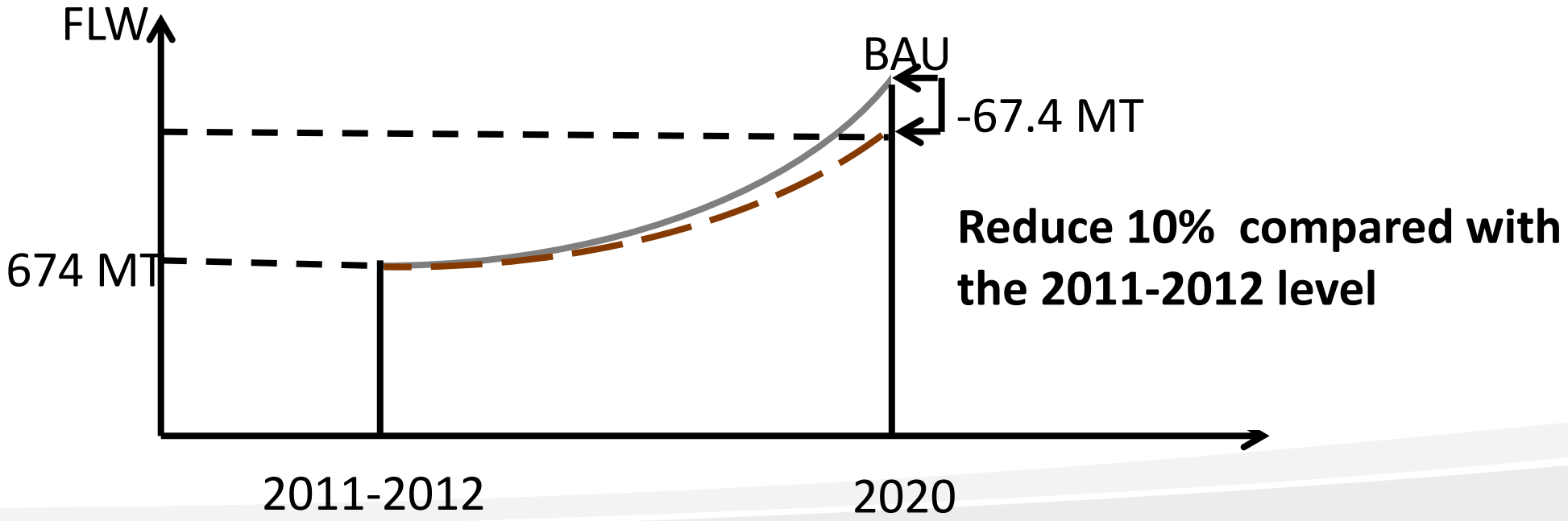

Source: APEC Food Security Roadmap Towards 2020 Third Senior Officials' Meeting, Beijing, China, 2014

Summary Results from Expert Consultation, Taipei, June 12-13, 2017

- Empirical results show that an achievable path for APEC to a 10% reduction of food loss and waste through 25 no-regret solutions. These solutions would divert 71 million tons from **landfills** and on-farm losses.
- Implementing these no-regret solutions is projected to generate 81 thousand **new jobs**, recover 9.8 billion meals per year of **food donations** to nonprofits, reduce 8.7 trillion gallons per year of **freshwater** use and avoid nearly 96 million tons of **greenhouse gas emissions** annually.
- These no-regret solutions will require a 9.5 billion investment per year which will yield an expected 55 billion in social economic value.

Thank you for your attention!