# Modelling Food Loss & Waste in a CGE framework

GTAP seminar “Modelling Nutrition and Food Loss and Waste in a CGE Framework”

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# **Modelling FLW along global supply chains:** challenges & key steps forward

**METHODOLOGICAL CHALLENGES**

## CAPTURING PHYSICAL BIOMASS FLOWS IN ECONOMIC MODELS

1. Bridging economic and technical modelling of FLW by adding consistent tracing of biomass physical quantities along global FSC to a global GE model.

2. Assessing physical biomass competition (feed, seed, other use, food) through the global economy.

3. Tracing food quantities from farm to fork along global supply chains, identifying production, intermediate and final food use.

**tackling challenges**

**DATA CHALLENGES**

## QUANTIFYING FOOD LOSS AND WASTE

1. Capturing actual food intakes vs food supply based on FBS (omits retail & consumers waste which can be substantial).

2. New up-to-date global FLW database.

3. Identify physical magnitude and composition of FLW, outlining at which supply chain stages FLW occurs.

4. Identify in which region the FLW occurs to assess spatial scope for FLW.

# Data challenges: compiling a new global Food Loss and Waste database

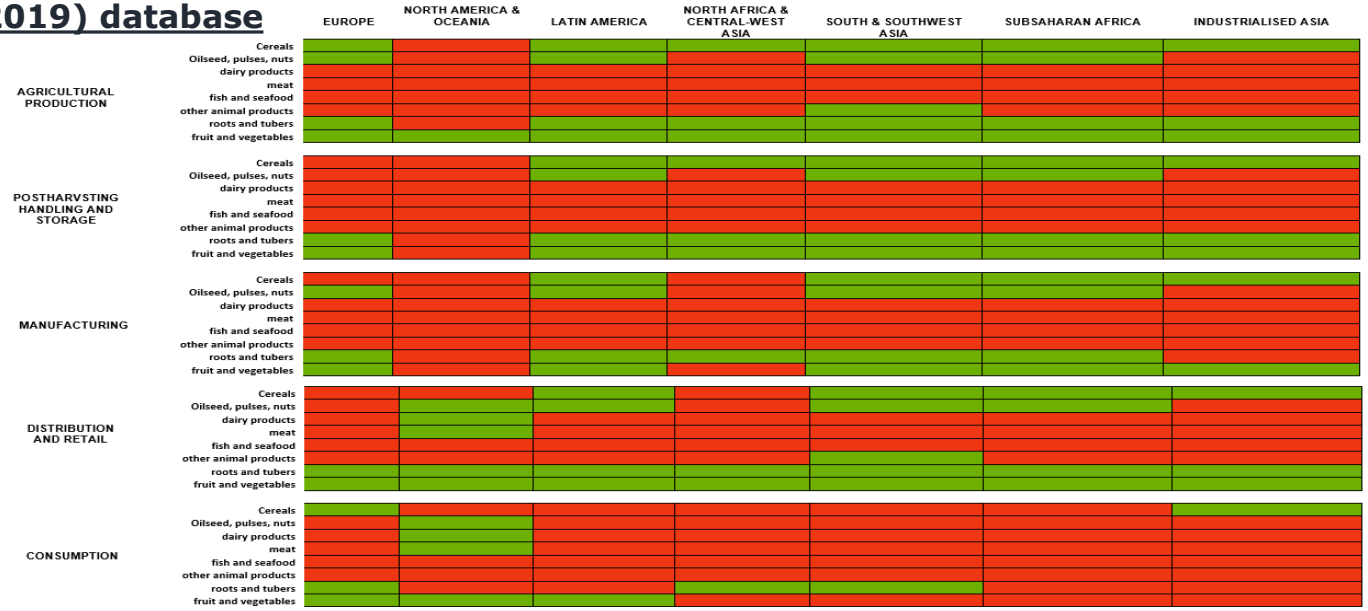
Up-to-date global estimates on percentages of loss/waste of total food weight along FSC (FAO-FLW 2019 data core).

Consistent FLW definition in line with SDG-12.3 and with FAO's FLI and FWI indicators (Fabi and English, 2018).

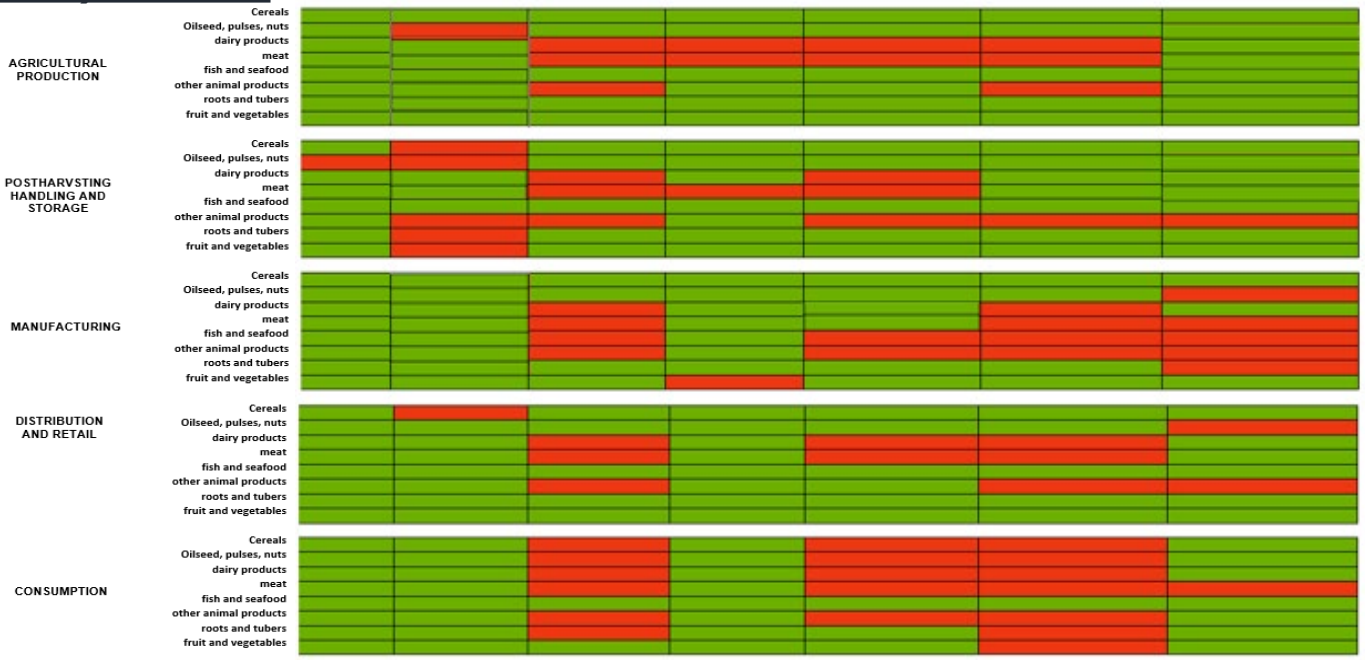
Expanding overall regional, commodity and supply chain coverage. Data focus on primary food commodities.

Expanding previous literature reviews of (Xue et al., 2017), (Porter et al., 2016), (Delgado et al., 2020) and OECD Food Waste database (2021) with an overall screening of more than 300 sources.

## FAO – FLW (2019) database




## Gatto et al. (2022) database



# Modelling physical (Mtons) flows along global food supply chains in a GE framework

**1.** Building on Kuiper (2022) to subtract monetary components (taxes, international margins, etc) from the value-based flows of the GTAP database, obtaining "dollar-based quantities".

→ We define a "balancing equation" kept as benchmark to test if model consistently holds balances in monetary (and physical) units.

**Total production = Intermediate demand (dom + imp) + final demand (dom + imp)**

**2**. From "balancing equation" we derive the Leontief Inverse matrix to obtain full overview of flows through the economy, including sector-to-sector international trade.

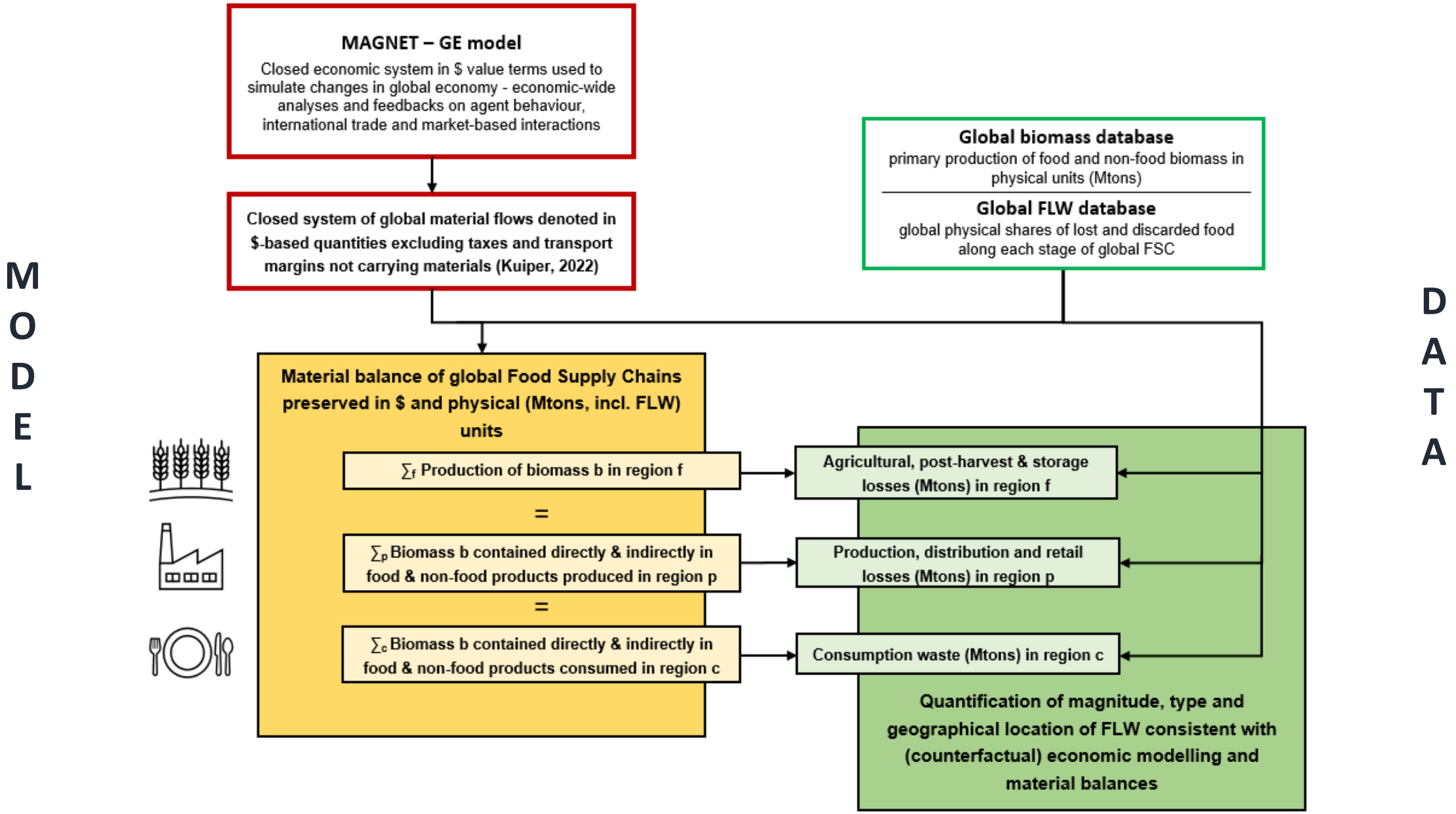
$$(1) \qquad QFD_{i,c}^{p,s,d} = LI_{i,c}^{p,s} * F_c^{s,d}$$

*( i ): Primary food product produced*
*( p ): Region of primary food production*
*( d ): Intermediate food demanding region*
*( s ): Final food demanding region*
*( c ): Final commodity demanded*

**3.** Dividing **(1)** by total production we obtain shares specifying how a single unit of output flows through the global economy.

**4.** Here we integrate physical (Mtons) biomass production data (FAO), defining physical food flows from "farm to fork" across the global economy and preserving material balances in monetary and physical units.

# Modelling food loss and waste: a potential framework



# Integrating information on food loss and waste along global supply chains

**1.** Definition of FLW coefficient from our database, reporting shares of FLW by region, commodity and supply chain stage.

$FLW_{a,g}^{p,s}$

*(p):* region where the loss is occurring
*(s):* stage of the supply chain at which the loss is occurring
*(a):* primary food commodity being lost/wasted
*(g)* represents a dummy variable that has value 1 when a specific commodity goes to manufacturing (processed food consumption) and 0 when it does not (fresh food consumption).

**2.** Integrating our FLW coefficient to the information retrieved from the Leontief inverse matrix to obtain an overview of FLW flows along global food supply chains.

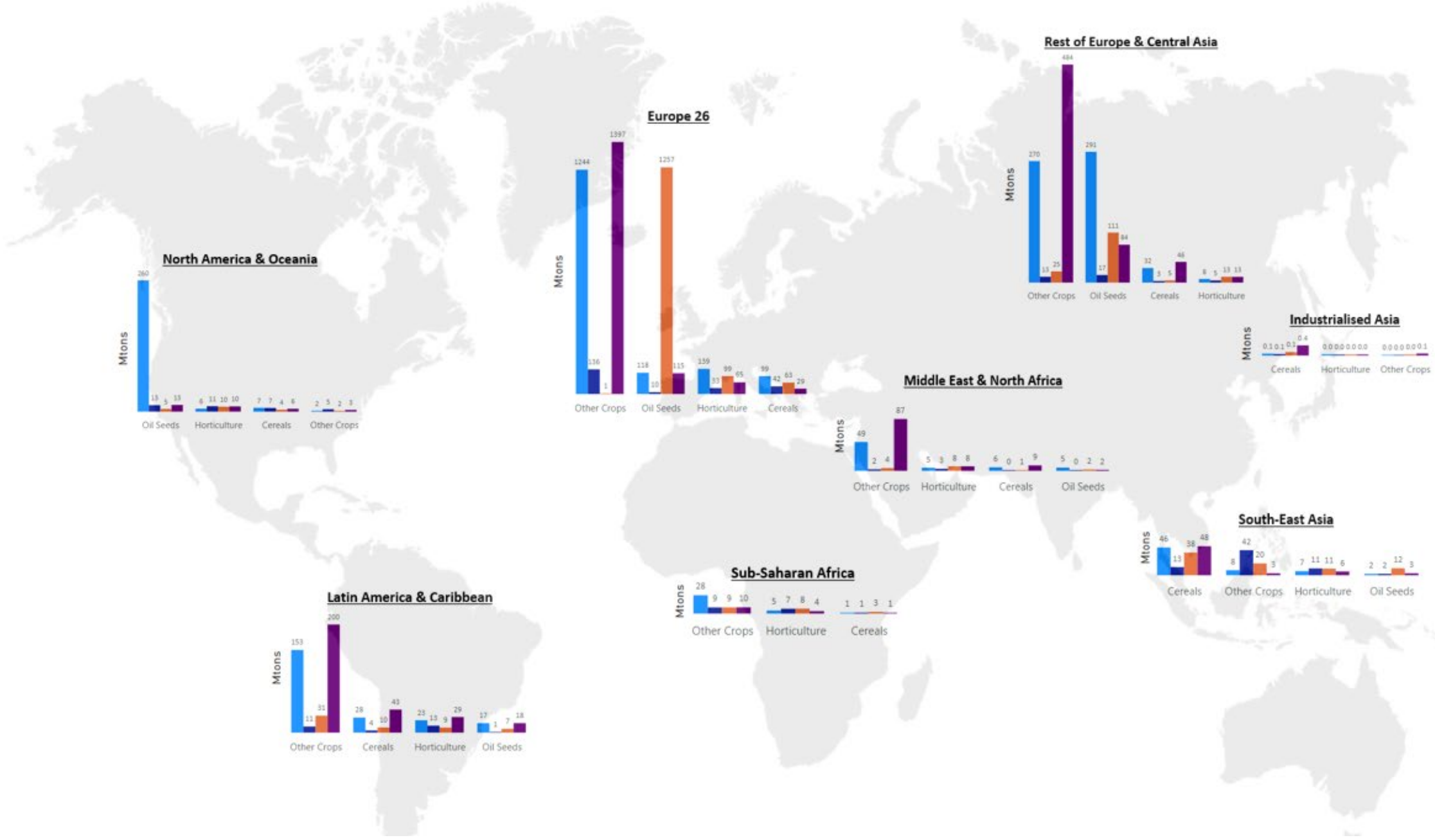
$$FLW\_FSC_{a,f,t}^{p,s,d} = \mathrm{FLW}_{f,g}^{p,s} * \ QFD\_mt_{a,f}^{p,s,d}$$

→ Mtons of FLW of product *(i)* at supply chain stage *(t)* generated by the consumption of commodity *(c)* produced in region *(p)* and demanded by an household in region *(d)* from region *(s)*

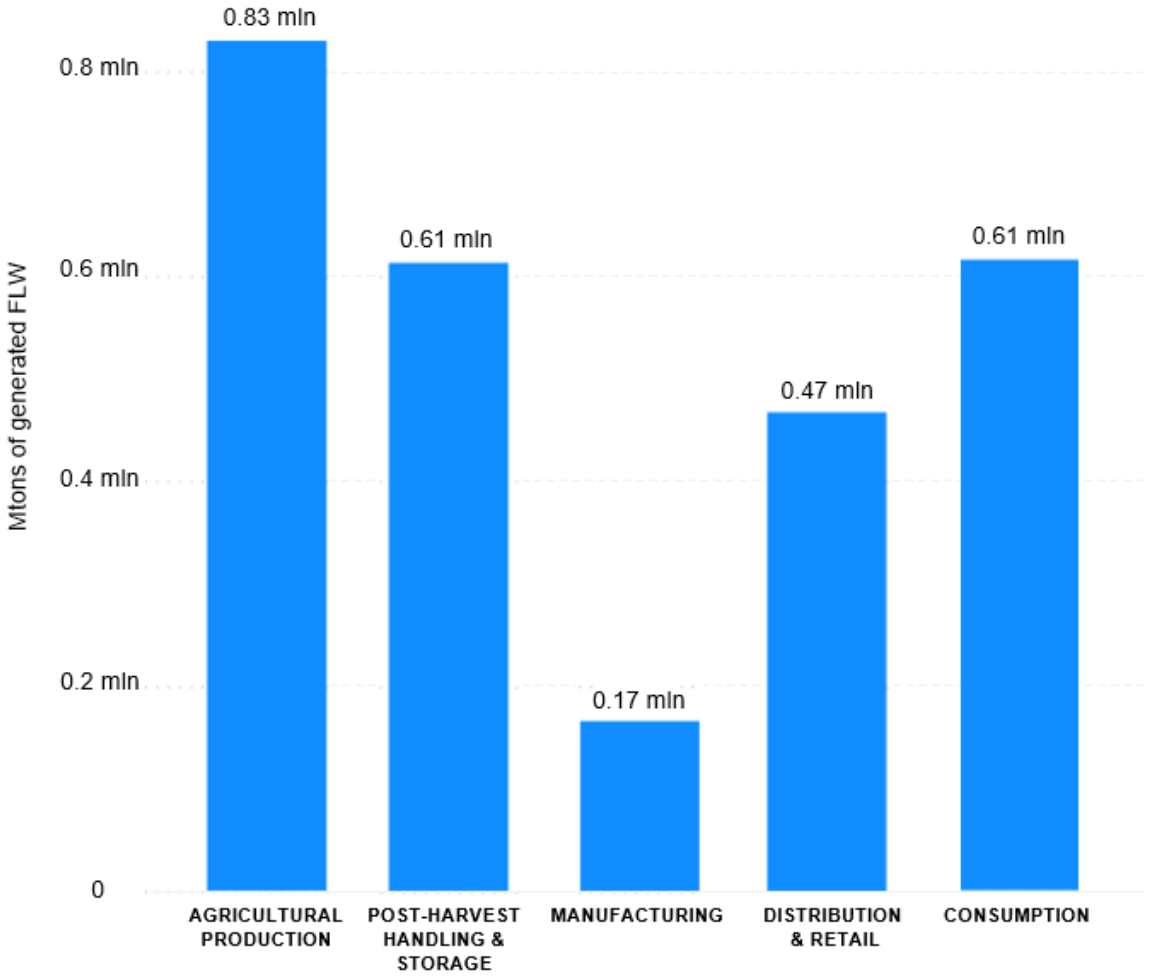
→ We merge $FLW_{a,g}^{p,s}$ with the idea that the physical supply of a food commodity decreases after each supply chain stage, entering the next stage net of losses occurred in previous stages.

# FLW generated along global supply chains by final consumption of processed vegetables in Europe (excl. consumption waste)

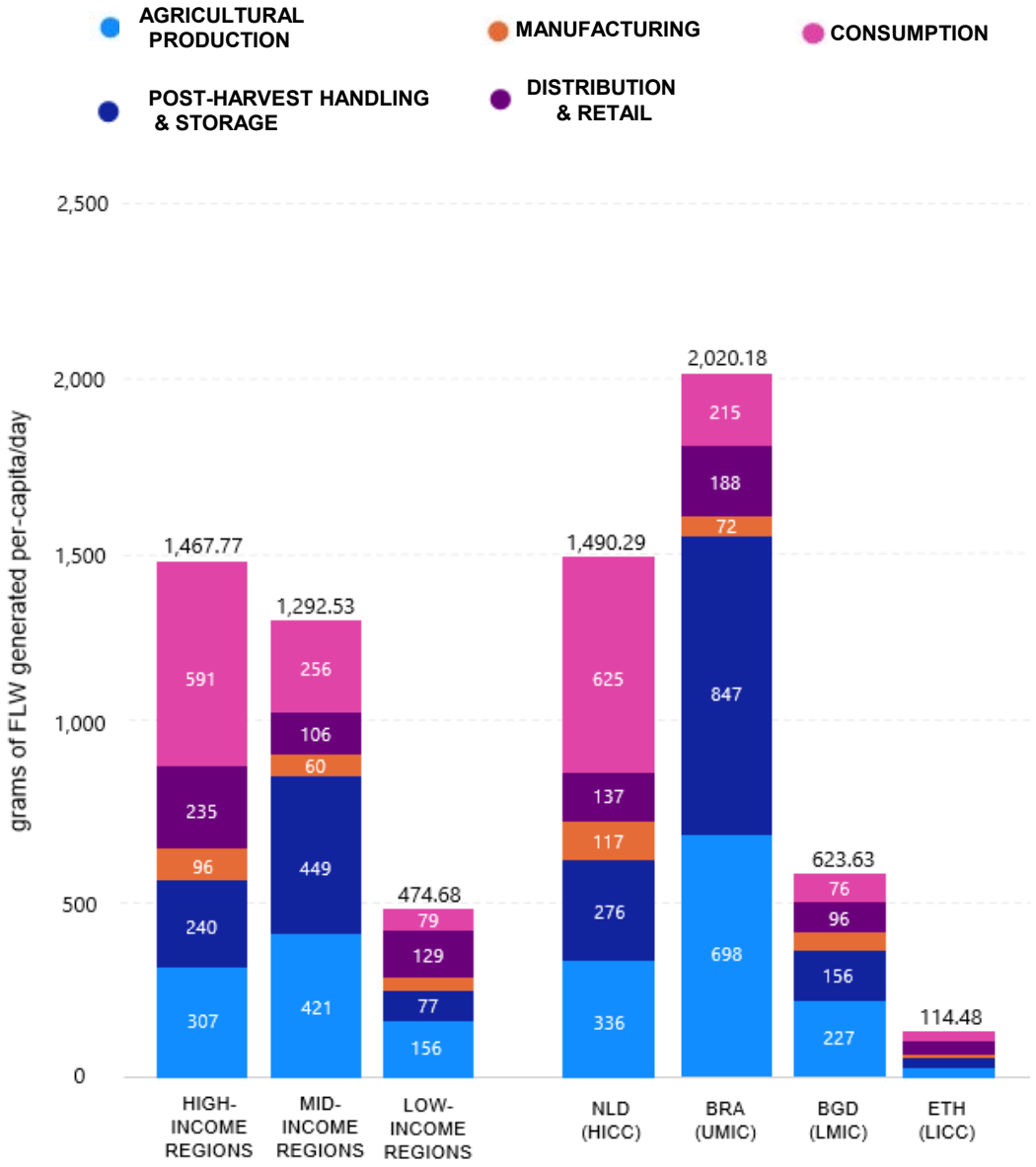
● AGRICULTURAL PRODUCTION ● DISTRIBUTION & RETAIL ● MANUFACTURING ● POST HARVEST & STORAGE



# Global Food loss and waste – an overview on magnitudes

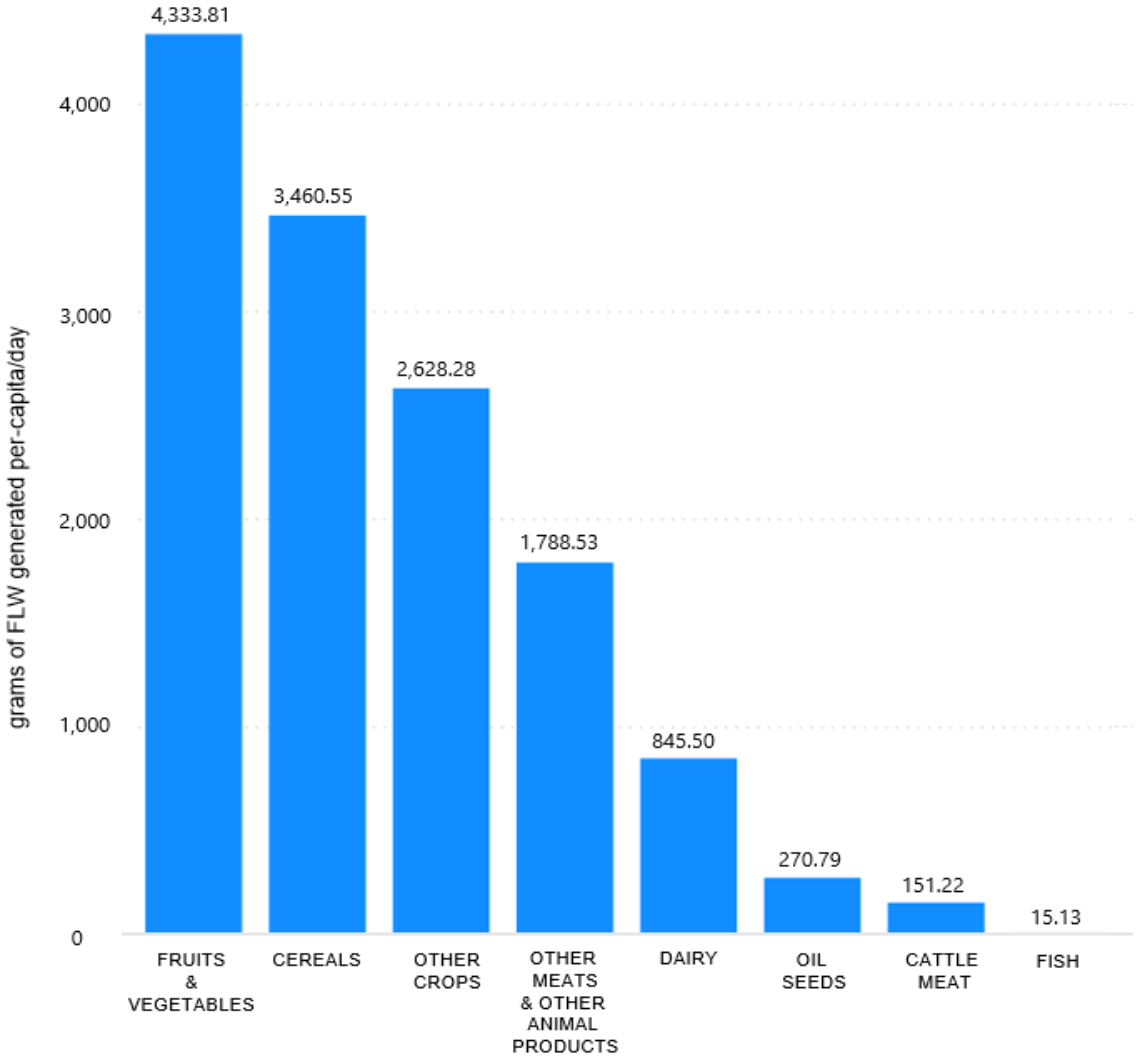



Total global FLW generation by supply chain stage
(SSP2 – 2030)

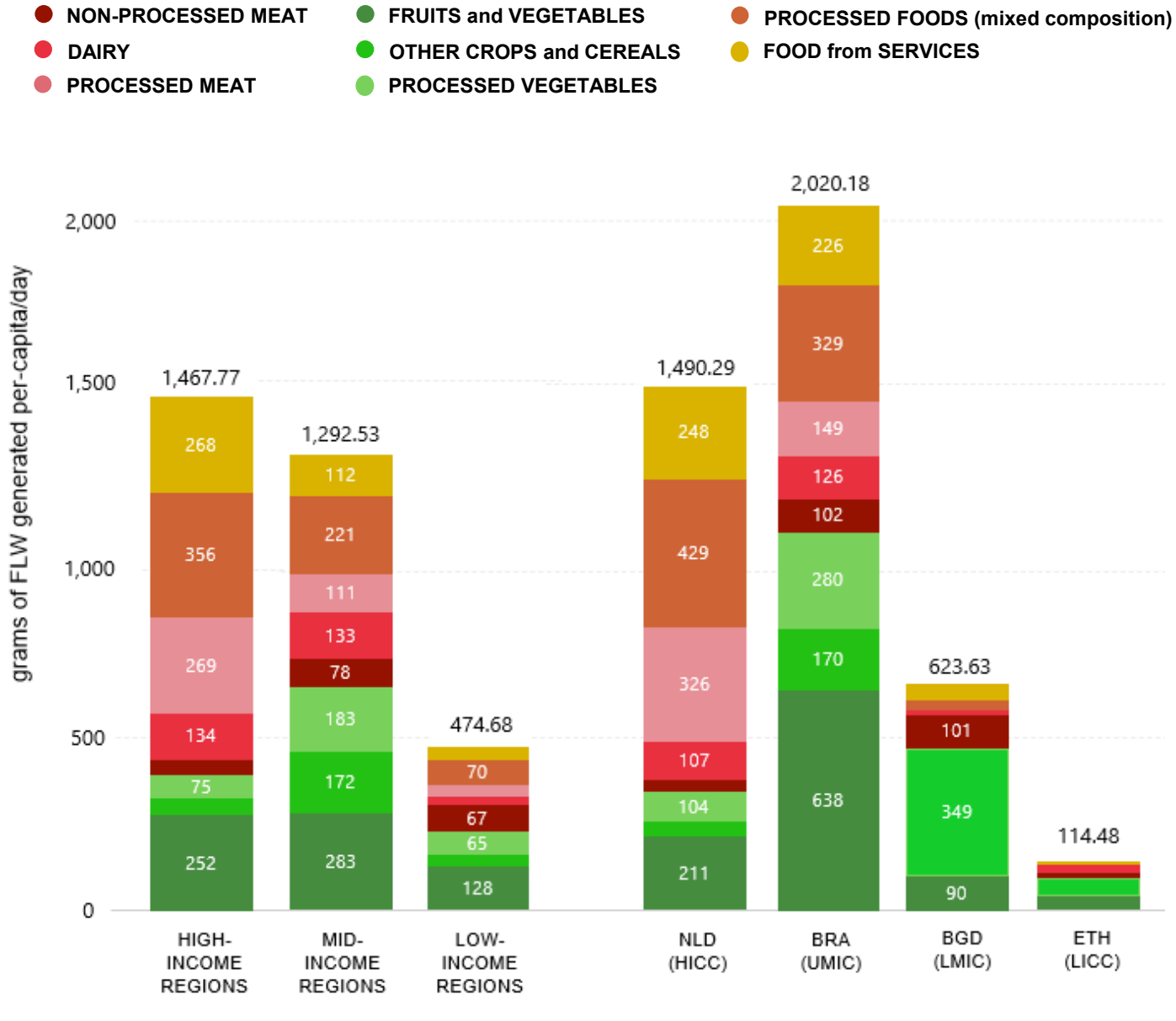



Per-capita FLW generation
(SSP2 – 2030)

# Global Food loss and waste – an overview on quality and composition

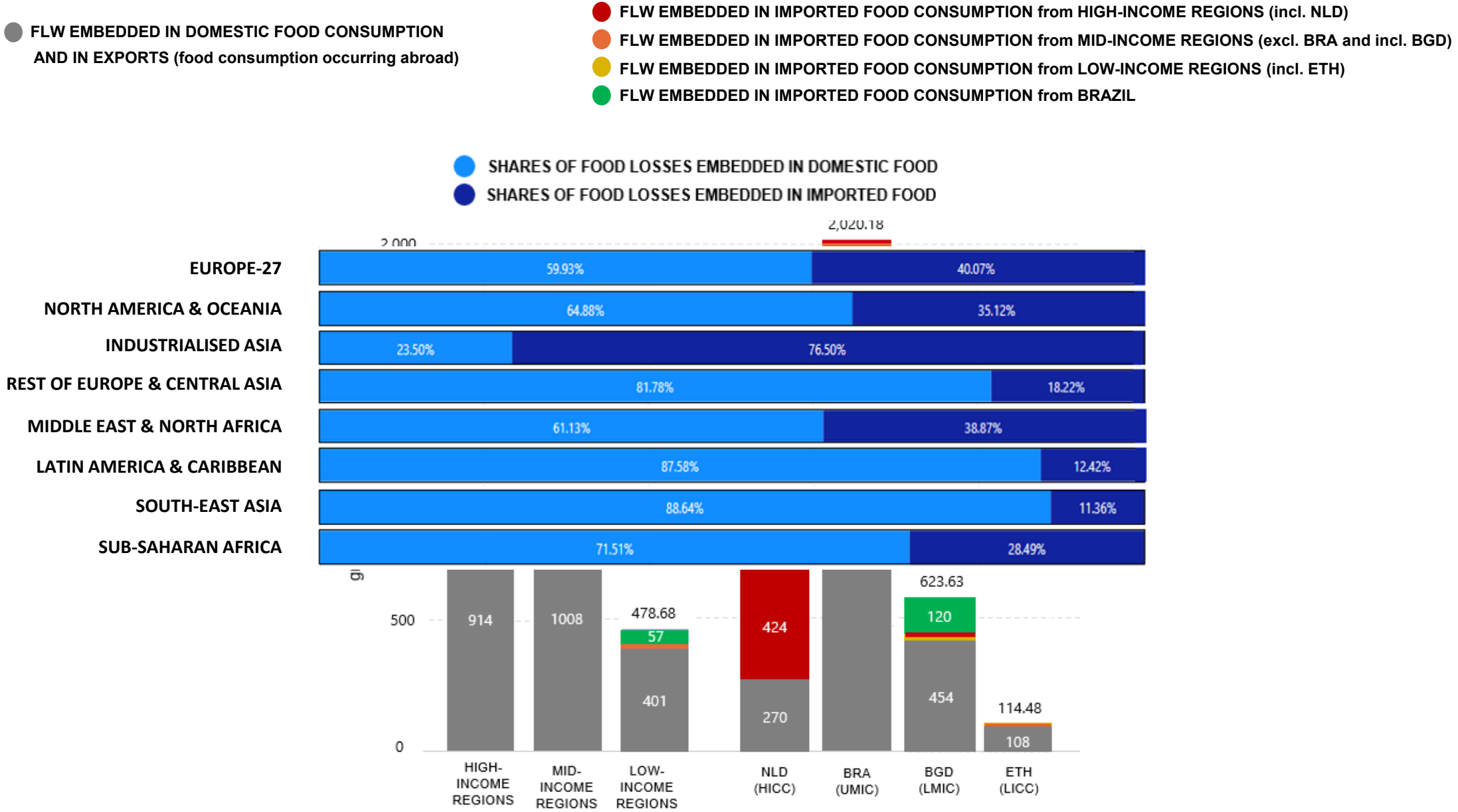



Total global FLW generation by commodity
(SSP2 – 2030)




Per-capita FLW generation by commodity
(SSP2 – 2030)

# Global Food loss and waste – an overview on geographical availability (location)




Location of per-capita FLW generation
(SSP2 – 2030)

# Limitation of current approach and further research

FLW data remains largely not available especially for later stages of the supply chain (i.e. consumption) in low-income regions.

Trade related FLW data is not available. Spatial factor related to trade not take into account in FLW generation.

Implementation of FLW accounting in a dynamic modelling framework (currently only ex-post) to allow more realistic policy scenarios for tackling FLW during simulations.

Development of FLW abatement cost curves.

Full integration of FLW tracing into GTAP 11 database with a special release (Gatto & Chepeliev).

Integrate findings in a circular economy framework (i.e. circular economy for livestock sectors based on FLW reuse as animal feed).

Application of method for tracing other martial flows through the economy (plastics, metals, minerals, etc.) key for circularity.

# Questions, comments, ideas?

**Thank you!**

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