“DRAFT: NOT FOR PUBLICATION”

Main

Food loss and waste (FLW) generated along global food supply chains (FSC) contribute substantially to climate change and natural resources depletion (Porter et al., 2016). Lost or discarded foods endanger economic stability (Parry et al., 2015), undermine social welfare and threaten our path towards global food security (Foley et al., 2011, Lipinski et al., 2013). Transitioning to a more sustainable food system lies at the core of the Sustainable Development Agenda (U.N., 2019). Available studies often focus on synergies between nutritional (SDG2) and environmental (SDG13) challenges (for example Davis et al., 2016; Springmann et al., 2016, 2018), neglecting potential trade-offs with FLW targets (SDG12.3). To date, the interaction between sustainable diets and FLW generation has received little attention (Helander et al., 2021).

A healthier and more sustainable plant-based diet (Willett et al., 2019) increases the availability of high quality plant based biomass along global FSC (HLPE, 2014) suitable as production input. Rising demands for plant-based food may also intensify competition in global markets. This could stimulate FLW reuse in regions where FLW-based inputs improve market competitiveness, unless the geographical concentration of FLW is in locations where possibilities for reuse are limited or not competitive. If not coupled with reusing strategies, growing consumption of plant-based food may generate increasing magnitudes of FLW (Delgado et al., 2021), and increase air and soil pollution (Porter et al., 2016) thus reducing the positive impact of a more sustainable diet.

Assessing trade-offs between global dietary changes and FLW requires quantifying lost or discarded food along FSC while simultaneously addressing actors’ behaviour across the economic system. Currently, no reliable global measurement of FLW is available (Kuiper & Cui, 2021). In the absence of a common FLW definition data vary in the inclusion/exclusion of inedible food parts in FLW flows (Delgado et al., 2021), and in the (non-)consideration of food flows diverted to other uses (e.g. animal feed) as FLW (Corrado et al., 2019). Different specifications of supply chain stages and different scales of analysis (Delgado et al., 2021), result in further inconsistent estimates and databases (Xue et al., 2017), rendering contents of studies relative to scopes (Corrado et al., 2019).

On top of data limitations current methodological approaches face limitations in coverage of global FSC and/or accounting for agents’ behaviour. Technical studies (van Hal et al., 2019, Van Zanten et al., 2019, Kummu et al., 2012, Liu et al., 2013) rely on detailed FLW data but have limited coverage of FSC (i.e. focus on primary agricultural sectors or livestock sectors) and tend to disregard agent’s behaviour and their interactions (Chaboud & Daviron 2017). Partial equilibrium (PE) economic models (Lopez Barrera & Hertel, 2020; Springmann et al., 2018) include agents’ behaviour but are limited to primary agricultural sectors, ignoring changes in processing and service parts of FSC, and interactions with non-food sectors. Global general equilibrium (GE) models provide economy-wide coverage allowing multi-country and multi-sectoral market-based analyses of FLW along global FSC (Britz et al., 2019; Okawa, 2015; Campoy-Muñoz et al., 2021). Adjustments in GE models are based on economic agents changing their behaviour based on price signals. Through economywide coverage GE models capture interactions among producers in global FSC, interactions with non-food producers, and consumer responses to changing prices (food and non-food) and incomes. GE models, however, are limited in being fully defined only in monetary values, lacking data on the underlying physical flows needed for FLW assessments. Previous studies have extended global GE models with physical data on selected flows (Britz & van der Mensbrugghe, 2018; Chepeliev, 2021), but none explicitly addresses biophysical flows of FLW along global FSCs. A second limitation of existing physical extensions of economic models is that material balances may be violated thus misrepresenting material flows and hampering the connection to technical studies required to tackle FLW with new technologies.

This study aims to provide a bridge between economic and technical modelling of FLW by adding consistent tracing of FLW in physical quantities along global FSC to a global GE model capturing behavioural responses of economic actors along food and non-food supply chains. Building on an approach to integrate physical biomass data in a monetary value-based GE model that respects material balances, we quantify changes in FLW along FSC. To compute FLW amounts we compile a new global database, quantifying lost or discarded food by region, commodity, and supply chain stage. With this extended global GE model we investigate how a global transition towards a more sustainable EAT-Lancet dietary scenario (Willett et al, 2019) influences FLW quantities and location in global FSC up to 2030. Our scenario results clarify how magnitude, quality, location and reuse potential of FLW may evolve with a healthier and more sustainable food consumption compared to business-as-usual diet developments captured by a SSP2[1] scenario.

Results

The impact of a healthy and sustainable diet on global FLW magnitude. Substitution effects within global biomass flows directly impact FLW. In our baseline scenario, expanding food consumption in 2030 increases global FLW (11.6%), reaching 2.6 billion tons. In low-income regions, domestic demand responses to higher per-capita incomes coupled with expanding export rates stimulate primary food production, increasing losses at early stages of the FSC. Agricultural Production losses increase by 15%, on average, cumulatively constituting the largest share (60%) of global FLW. Moreover, inadequate transportation facilities in the context increasing trade, enlarge wastes in Distribution & Retail (10.7%). Growing global demand enlarges Post-Harvest Handling & Storage losses in mid-income regions, where increasing plant-based food exports result in an average loss increase of 14.9%. In contrast FLW in high-income regions mainly expand at the final stages of the FSC. Shifts towards processed foods intensify industrial food production, increasing Manufacturing losses (13.3%) and enlarging Distribution & Retail and Consumption waste (average 14.3%).

Moving to the EAT-Lancet diet decreases average global food demand, reducing FLW to 2.3 billion tons (-11.5%) (Fig. 2). Globally, as the EAT-Lancet diet shifts consumption from processed foods to healthier fresh plant-based products, it partially transfers losses from Manufacturing to Post-Harvest Handling & Storage, i.e. from food industries to farms. In low-income regions, despite FLW decrease at Agricultural Production (-21.3%), Post-Harvest Handling & Storage (-15.8%) and Distribution & Retail (-13.5%), primary agri-food production remains a global hotspot for FLW generation as in the baseline. Lower food intake decreases agri-food production and exports of mid-income regions, reducing Post-Harvest Handling & Storage losses by 18.9% on average. In high-income regions, changing trends towards cheaper imported foods decrease domestic losses at Agricultural Production (-8.1%). As observable from figure 2, while FLW decreases globally, exceptions are represented by large primary food trading regions such as the Netherlands and Brazil. More trade in fresh plant-based foods increases losses at Agricultural Production (9.9%), Post-Harvest Handling & Storage (14.9%) and Distribution & Retail (8.1%), reflecting the trade-oriented horticultural sectors of these countries.

[1] Shared Socioeconomic Pathways (SSPs) are scenarios of projected socioeconomic global changes up to 2100. The SSP2 (Business-as-Usual) reflects a global path in which social, economic, and technological trends do not shift markedly from historical patterns.

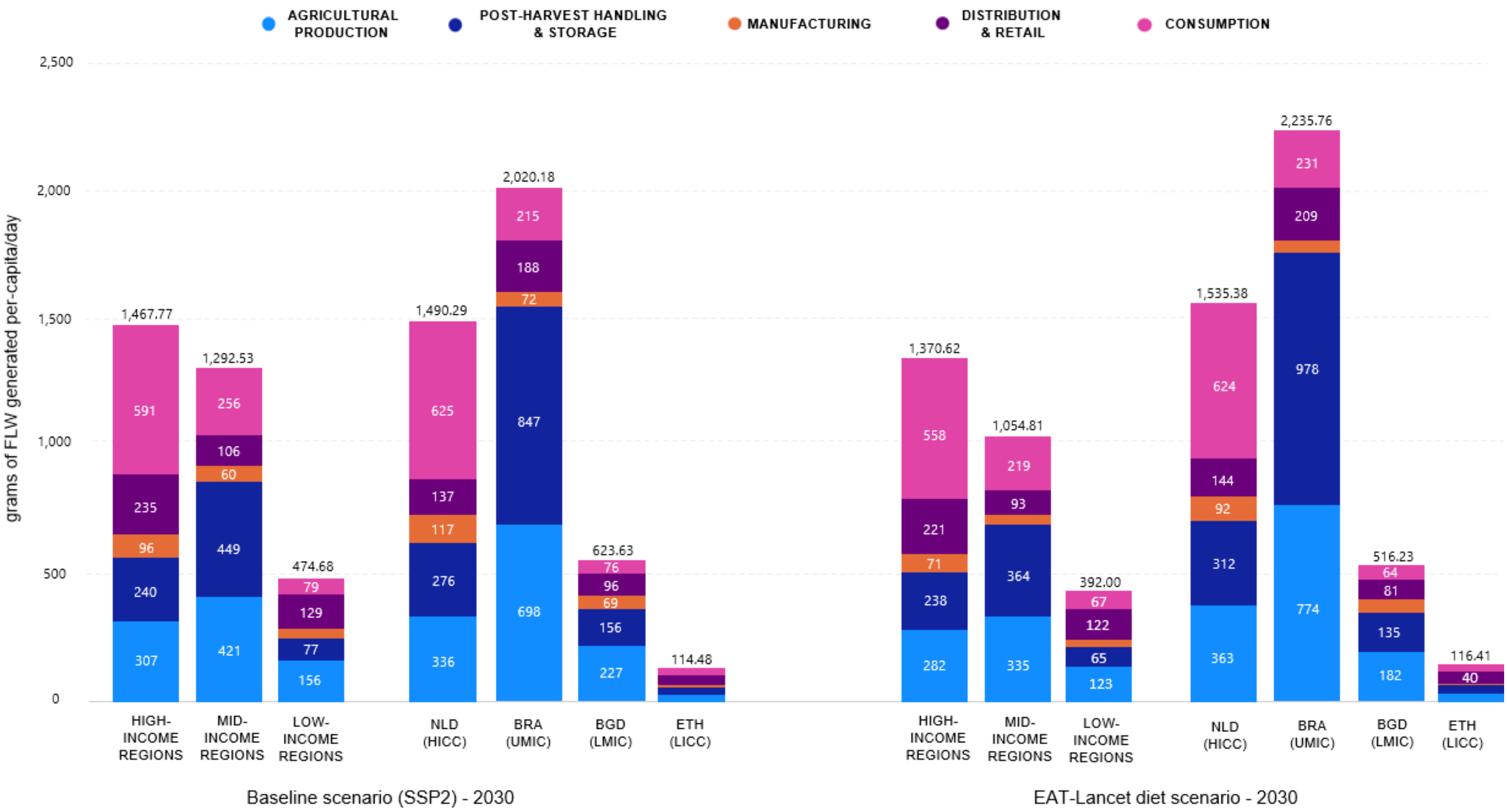

Figure 2. Grams of FLW generated per-capita/day along FSC stages in different regions (2030, by scenario). FLW amounts refer to total final consumption of food excluding biomass losses in non-food biomass use, including both domestic and FLW embedded in imported food. Note we attribute FLW in imports to the location of final consumption but depending on the FSC where FLW occurs this FLW may not be physically present in the location of final consumption. The income aggregation hides regional variations within income categories. For example, as the Netherlands increases imports from regions that have high rates of FLW at farm level, its overall FLW generation results higher in the EAT-Lancet diet scenario, contrasting the average decreasing trend for high-income regions. Additional figures are reported in the Supplementary Information.

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Supplementary Information for

Healthier but Wasteful? Changes in food loss and waste along global supply chains with healthier diets

A. Gatto, M. Kuiper & H. van Meijl

Contents

Model definition

We used the Modular Applied General Equilibrium Tool (MAGNET) for our analysis. MAGNET is a multi-regional, multi-sectoral applied computable general equilibrium (CGE) model based on a combination of macro- and microeconomic theories. As a GE model, MAGNET solves through an equilibrium price vector that simultaneously clears all factor, goods, and service markets. MAGNET is a more advanced recursive dynamic version of the Global Trade Analysis Project (GTAP) model (Corong et al. 2017). A distinguishing feature of the model is its modular structure, which allows the model to be easily tailored to specific research questions, regions, and products of interest. This flexibility allows to adjust the complexity of the model to the questions at hand, providing a focus around specific actors of the global economy. While covering the global economy, MAGNET principally focuses on agriculture. In this regard, its detailed endogenous land markets and segmented agricultural/non-agricultural labour markets and specific representation of the bioeconomy and the food system, proficiently serve the aim of this study to investigate FLW associated to global food biomass flows. Additionally, the exhaustive details on global biomass flows and representation of food sectors at different production and consumption levels, with many agricultural sectors, food-processing sectors and food services, allows to grasp the effects of policy changes on food biomass flows through the economy, rendering MAGNET preferred over other GE models.

The different regions and sectors of the model are connected through international trade flows subject to several theoretical assumptions. The Armington (elasticity) assumption and varying transportation costs, define substitution mechanisms between products supplied by different regions, allowing a detailed modelling of international market competition. As the model encompasses agricultural, industrial, and service sectors, its framework allows to detect different types of biomass flows (i.e. feed, seed, food and other industrial uses) through the sectors of the economy, providing a clear picture of how biobased commodities are traded between different regions.

The model aggregation adopted for this study involves 12 regions (Table S1), each comprising 39 production sectors (Table S2). Sectors demanding and supplying biomass are represented as explicitly as possible given the data provided by the GTAP 10 database (Aguiar et al. 2019). The food system is represented by 11 agricultural sectors including livestock and crops production, 8 food processing sectors producing meat, dairies, processed vegetables, and processed foods, and 5 food services. To ease model running time and interpretation of results, we aggregate the remaining sectors (industries and other services) into two categories, namely “other industries” and “other services”, in line with the focus of our study on biomass.

Table S1 - Regional model aggregation

Region	Description	Countries	Aggregation used for figures in main text
NLD	Netherlands (High-income country)	Netherlands	NLD (HICC)
BRA	Brazil (Upper mid-income country)	Brazil	BRA (UMIC)
BGD	Bangladesh (Lower mid-income country)	Bangladesh	BGD (LMIC)
ETH	Ethiopia (Low-income country)	Ethiopia	ETH (LICC)
EU26	Europe 26 (excl. Netherlands)	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden	High-income regions
NAMO	North America and Oceania	Australia, New Zealand, Rest of Oceania, Canada, United States of America, Rest of North America, Rest of the World	High-income regions
INDA	Industrialised Asia	Hong Kong, Japan, South Korea, Taiwan, Singapore	High-income regions
LAC	Latin America and Caribbean	Mexico, Argentina, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Rest of South America, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Belize, Dominican Republic, Jamaica, Puerto Rico, Trinidad and Tobago, Caribbean	Mid-Income regions
MENA	North Africa and Middle East	Bahrain, Iran, Israel, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Turkey, United Arab Emirates, Iraq, Lebanon, Occupied Palestinian Territory, Syrian Arab Republic (Syria), Yemen, Egypt, Morocco, Tunisia, Algeria, Libya, Western Sahara	Mid-Income regions
REUCA	Rest of Europe and Central Asia	United Kingdom, Switzerland, Norway, Iceland, Liechtenstein, Albania, Belarus, Russian Federation, Ukraine, Moldova, Andorra, Bosnia and Herzegovina, Faroe Islands, Gibraltar, Guernsey, Holy See (Vatican City State), Isle of Man, Jersey, Macedonia, Republic of, Monaco, Montenegro, San Marino, Serbia, Kazakhstan, Kyrgyzstan, Tajikistan, Tajikistan, Turkmenistan, Uzbekistan, Armenia, Azerbaijan, Georgia	Mid-Income regions
SEA	South East Asia	China, Mongolia, Democratic People's Republic of Korea, Macao, Brunei Darussalam, Cambodia, Indonesia, People's Democratic Republic of Lao, Malaysia, Philippines, Thailand, Viet Nam, India, Nepal, Pakistan, Sri Lanka, Myanmar, Timor-Leste, Afghanistan, Bhutan, Maldives	Low-Income regions
SSA	Sub Saharan Africa	Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Ghana, Guinea, Nigeria, Senegal, Togo, Cape Verde, Gambia, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Saint Helena, Sierra Leone, Central African Republic, Chad, Congo, Equatorial Guinea, Gabon, Sao Tome and Principe, South Central Africa, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe, Angola, Congo, Democratic Republic of the, Botswana, Namibia, South Africa, Burundi, Comoros, Djibouti, Eritrea, Mayotte, Seychelles, Somalia, Sudan, Lesotho, Swaziland	Low-Income regions

Table S2 - Sectoral model aggregation

MAGNET aggregate	Description	GTAP sectors	Aggregation used for figures in main text
pdr	Paddy rice	pdr	Other Crops and Cereals
wht	Wheat	wht	Other Crops and Cereals
gro	Cereal grains	gro	Other Crops and Cereals
hort	Vegetables, fruit, nuts	v_f	Fruits & Vegetables
osd	Oil seeds	osd	Other Crops and Cereals
c_b	Sugar cane, sugar beet	c_b	Other Crops and Cereals
pfb	Plant-based fibers	pfb	-
ocrops	Other Crops	ocr	Other Crops and Cereals
ctl	Bovine cattle, sheep and goats	ctl	Non-processed Meat
oap	Animal products	oap	Non-processed Meat
rmk	Raw milk	rmk	Dairy
wol	Wool, silk-worm cocoons	wol	-
frs	Forestry	frs	-
fsh	Fishing	fsh	Non-processed Meat
coa	Coal	coa	-
c_oil	Crude Oil	oil	-
gas	Gas	gas	-
othind	Other Industry	oxt, tex, wap, lea, lum, ppp, bph, rpp, nmm, i_s, nfm, fmp, ele, eeq, ome, mvh, otn, omf, gdt, wtr, cns	-
cmt	Bovine meat products	cmt	Processed Meat
omt	Meat products	omt	Processed Meat
vol	Vegetable oils and fats	vol	Processed Vegetables
mil	Dairy products	mil	Dairy
pcr	Processed rice	pcr	Processed Vegetables
sugar	Refined Sugar	sgr	Processed Vegetables
ofd	Processed Food	ofd	Processed Foods
b_t	Beverages and tobacco products	b_t	Processed Foods
petro	Petroleum, coal products	p_c	-
chem	Chemical products	chm	-
ely	Electricity	ely	-
gas_dist	Gas manufacture, distribution	n.a.*	-
othsvcs	Other services	cmn, ofi, ins, rsa, obs, dwe	-
trd	Trade	trd	-
afs	Accommodation, Food, and service	afs	Food Services
trans	Transportation, Water transport, Air transport	opt, wtp, atp	-
whs	Warehousing and support activities	whs	-
ros	Recreational and other service	ros	Food Services
osg	Public Administration and defence	osg	Food Services
edu	Education	edu	Food Services
hht	Human health and social work	hht	Food Services

* sectors reported under "n.a." are not available in the standard GTAP database and refer to MAGNET specific sectors. For a detailed description of the GTAP sectors see https://www.gtap.agecon.purdue.edu/databases/contribute/detailedsector.asp

Supplementary Methods

The following section provides an analytical description of the methodology adopted for tracing FLW along global FSC. Building on the adjusted GTAP 10 database (Aguiar et al., 2019) available from (Kuiper, 2022), we derive the quantity-based amount (defined in "dollar-based quantities") of production included (directly and indirectly) in final demand. This is defined as

$$QFD_{i,c}^{p,s,d} = LI_{i,c}^{p,s} * F_{c}^{s,d} \tag{1}$$

Where $QFD_{i,c}^{p,s,d}$ represents the production of primary commodity *i,* in region *p,* produced to satisfy final demand of commodity *c*, that is demanded by region *d* from region *s*. The first term on the right-hand side of the equation represents the Leontief inverse matrix which specifies the amount of production of commodity *i* from region *p* needed for final demand of commodity *c* in region ***s.*** The second term represents final demand and reports for region ***d,*** how much final product *c* is demanded from region *s*. Equation (1) provides the full matrix of how production of *i* in region *p* flows to final consumers in region *d*. Based on the Leontief inverse it reports all direct and indirect flows of all commodities within the global economy. To ensure consistency, we check that the summing of all commodities *c*, in all regions *s* and *d* equals the production of commodity *i* in region *p*, preserving monetary balances such that (direct and indirect) demand equals total production.

To integrate physical material flows, we divide equation (1) by total production, specifying how a single unit of output flows through the global economy as

$$SH_{QFD}{}_{i,c}^{p,s,d} = \frac{QFD_{i,c}^{p,s,d}}{Q_{i}^{p}} \tag{2}$$

where the numerator is given by equation (1) while the denominator Q_{i}^{p} represents total production of commodity *i* in region *p,* reported in dollar-based quantities. We extend (Kuiper, 2022) by linking a coefficient representing physical production of global biomass (Mtons), defined as $Q\_mt_{i}^{p}$, where *i* represents the biomass commodity produced and *p* the region of production. $Q\_mt_{i}^{p}$ reports only primary biomass production, as all flows of non-primary and processed biomass along the supply chain will be successively computed. As our analysis circumscribes to FLW, we separate food and non-food biomass flows, defining $Q\_mt_{i}^{p}$ and $SH\_QFD_{i,c}^{p,s,d}$ over a subset of produced commodities *i*, comprehending only primary food commodities, and over a subset of consumed commodities *c* including only food commodities supplied to final consumers as primary, processed or via food services. Such split allows to isolate food biomass flows, understanding which product flows may potentially generate FLW. By multiplying equation (2) with total food biomass production, we obtain the full matrix previously derived in equation (1) in physical units, defined as

$$QFD\_mt_{i,c(food)}^{p,s,d} = Q\_mt_{i(food)}^{p} * SH\_QFD_{i,c(food)}^{p,s,d} \tag{3}$$

For consistency, as done for equation (1), we check that material balances are preserved in physical units and remain always preserved in monetary units as part of a GE framework. Equation (3) represents the total flows of food biomass through global supply chains. It provides a first glance on different stages of global FSC, illustrating how food consumption is linked to primary food production. Moreover, it captures international trade dynamics between food sectors, outlining food location and composition in different global regions.

To integrate information on FLW, we define a coefficient reporting physical shares of FLW, specified as $FLW_{i,g}^{p,s}$, where *p* represents the region where the loss is occurring, *s* represents the stage of the supply chain at which the loss is occurring, *i* represents the primary food commodity causing the loss and *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). As FLW data is mainly available in primary equivalents, we apply $FLW_{i,g}^{p,s}$, only to primary food commodities successively flowing to consumed (primary, processed and food service) commodities. With this we avoid a potential double counting of losses when a processed commodity is employed in the production of another processed commodity or food service along the supply chain. We merge $FLW_{i,g}^{p,s}$, 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. For primary products freshly consumed by final consumers (e.g. oranges) losses occurring at manufacturing stages are not applied. Moreover, a special treatment regards commodities consumed through food services (i.e. food from restaurants, hotels, etc). As commodities flow into food services both as processed and non-processed (e.g. an orange can be consumed from a restaurant both as an orange or as an orange juice), we split the food supply from food services in two different flows, assuming that a share of supply enters manufacturing stage (i.e. consumed from food services as processed thus reporting manufacturing losses), while the remaining share goes directly to distribution and retail (i.e. consumed from food services as fresh therefore not incurring manufacturing losses).

To quantify physical flows of FLW, we multiply our FLW coefficient with the physical food flows derived from equation (3), tracing FLW along global food supply chains as

$$FLW\_FSC_{i,c,t}^{p,s,d} = \mathrm{FLW}_{c,g}^{p,s} * \ QFD\_mt_{i,c(food)}^{p,s,d} \tag{4}$$

where *p* represents the region where primary commodity *i* is produced, hence where losses from Agricultural Production up to Distribution & Retail occur, *d* represents the region where final consumption occurs hence where Consumption waste is generated, *s* represents the region through which food flows are linked from *p* to *d*, *c* represents the commodity consumed by final consumers in region *d* and to which primary food flows *i* are flowing to and *t* represents the stage of the supply chain at which losses are occurring. The five stages of the food supply chain obtained from our FLW database, are consistently aligned with the information obtained from the Leontief Inverse (equation 3). Agricultural Production and Post-Harvest Handling & Storage stage are associated with primary production ($Q\_mt_{i(food)}^{p}$), while Manufacturing and Consumption stage are linked to intermediate/final production and final demand ($QFD\_mt_{i,c(food)}^{p,s,d}$), respectively. As a Distribution & Retail stage is not explicitly available from the material flows of equation (3) we assume that Distribution & Retail losses cover food flowing from Manufacturing to Consumption stage. In the case of $p \neq s, d$ we further attribute trade losses by assigning Distribution & Retail FLW rates to traded food flows, assuming that from a production region to a consumption region some food is lost during transportation. We attribute trade losses to importing regions, hypothesising that if food gets spoiled or damaged during transportation, it will be physically available and potentially treated within the importing region. Finally, equation (4) allows to quantify, for each stage of the supply chain, how much FLW is generated in a region when a product is consumed domestically or abroad.

Data

Biomass data

To quantify total physical flows of biomass through the global economy, we use primary production data (Mtons) from FAOSTAT (FAO, 2020). We integrate additional data from the FAO–Food Balance Sheets (FAO, 2020), including primary production of food not covered in standard FAO production data. As food production data is only required for primary agricultural products, non-primary commodities available from the FAO database have been purposely excluded. Table S3 reports the regional mappings between FAO countries and our MAGNET regions, while Table S4 reports the commodity mappings between FAO commodities and MAGNET sectors. We further report in Table S5 the commodities that have been purposely excluded from the data merging as reported by FAO as non-primary food commodities.

Table S3 – Region mappings between FAO countries and MAGNET regions

FAO country code	FAO country description	FBS country description	GTAP country	MAGNET aggregate
AFG	Afghanistan	Afghanistan	xsa	SEA
AGO	Angola	Angola	xac	SSA
ALB	Albania	Albania	alb	REUCA
ARE	United Arab Emirates	United Arab Emirates	are	MENA
ARG	Argentina	Argentina	arg	LAC
ARM	Armenia	Armenia	arm	REUCA
ATG	Antigua and Barbuda	Antigua and Barbuda	xcb	LAC
AUS	Australia	Australia	aus	NAMO
AUT	Austria	Austria	aut	EU26
AZE	Azerbaijan	Azerbaijan	aze	REUCA
BDI	Burundi	N.A.	xec	SSA
BEL	Belgium	Belgium	bel	EU26
BEN	Benin	Benin	ben	SSA
BFA	Burkina Faso	Burkina Faso	bfa	SSA
BGD	Bangladesh	Bangladesh	bgd	BGD
BGR	Bulgaria	Bulgaria	bgr	EU26
BHR	Bahrain	N.A.	bhr	MENA
BHS	Bahamas	Bahamas	xcb	LAC
BIH	Bosnia and Herzegovina	Bosnia and Herzegovina	xer	REUCA
BLR	Belarus	Belarus	blr	REUCA
BLZ	Belize	Belize	xca	LAC
BOL	Bolivia, Plurinational State of	Bolivia, Plurinational State of	bol	LAC
BRA	Brazil	Brazil	bra	BRA
BRB	Barbados	Barbados	xcb	LAC
BRN	Brunei Darussalam	N.A.	brn	SEA
BTN	Bhutan	N.A.	xsa	SEA
BWA	Botswana	Botswana	bwa	SSA
CAF	Central African Republic	Central African Republic	xcf	SSA
CAN	Canada	Canada	can	NAMO
CHE	Switzerland	Switzerland	che	REUCA
CHL	Chile	Chile	chl	LAC
CHN	China	China	chn	SEA
CIV	Côte d'Ivoire	Côte d'Ivoire	civ	SSA
CMR	Cameroon	Cameroon	cmr	SSA
COD	Congo, the Democratic Republic of the	N.A.	xac	SSA
COG	Congo	Congo	xcf	SSA
COK	Cook Islands	N.A.	xoc	NAMO
COL	Colombia	Colombia	col	LAC
COM	Comoros	Comoros	xec	SSA
CPV	Cape Verde	Cape Verde	xwf	SSA
CRI	Costa Rica	Costa Rica	cri	LAC
CUB	Cuba	Cuba	xcb	LAC
CYP	Cyprus	Cyprus	cyp	EU26
CZE	Czech Republic	Czech Republic	cze	EU26
DEU	Germany	Germany	deu	EU26
DJI	Djibouti	Djibouti	xec	SSA
DMA	Dominica	Dominica	xcb	LAC
DNK	Denmark	Denmark	dnk	EU26
DOM	Dominican Republic	Dominican Republic	dom	LAC
DZA	Algeria	Algeria	xnf	MENA
ECU	Ecuador	Ecuador	ecu	LAC
EGY	Egypt	Egypt	egy	MENA
ERI	Eritrea	N.A.	xec	SSA
ESP	Spain	Spain	esp	EU26

EST	Estonia	Estonia	est	EU26
ETH	Ethiopia	Ethiopia	eth	ETH
FIN	Finland	Finland	fin	EU26
FJI	Fiji	Fiji	xoc	NAMO
FRA	France	France	fra	EU26
FRO	Faroe Islands	N.A.	xer	REUCA
FSM	Micronesia, Federated States of	N.A.	xoc	NAMO
GAB	Gabon	Gabon	xcf	SSA
GBR	United Kingdom	United Kingdom	gbr	REUCA
GEO	Georgia	Georgia	geo	REUCA
GHA	Ghana	Ghana	gha	SSA
GIN	Guinea	Guinea	gin	SSA
GMB	Gambia	Gambia	xwf	SSA
GNB	Guinea-Bissau	Guinea-Bissau	xwf	SSA
GNQ	Equatorial Guinea	N.A.	xcf	SSA
GRC	Greece	Greece	grc	EU26
GRD	Grenada	Grenada	xcb	LAC
GTM	Guatemala	Guatemala	gtm	LAC
GUY	Guyana	Guyana	xsm	LAC
HKG	Hong Kong	Hong Kong	hkg	INDA
HND	Honduras	Honduras	hnd	LAC
HRV	Croatia	Croatia	hrv	EU26
HTI	Haiti	Haiti	xcb	LAC
HUN	Hungary	Hungary	hun	EU26
IDN	Indonesia	Indonesia	idn	SEA
IND	India	India	ind	SEA
IRL	Ireland	Ireland	irl	EU26
IRN	Iran, Islamic Republic of	Iran, Islamic Republic of	irn	MENA
IRQ	Iraq	Iraq	xws	MENA
ISL	Iceland	Iceland	xef	REUCA
ISR	Israel	Israel	isr	MENA
ITA	Italy	Italy	ita	EU26
JAM	Jamaica	Jamaica	jam	LAC
JOR	Jordan	Jordan	jor	MENA
JPN	Japan	Japan	jpn	INDA
KAZ	Kazakhstan	Kazakhstan	kaz	REUCA
KEN	Kenya	Kenya	ken	SSA
KGZ	Kyrgyzstan	Kyrgyzstan	kgz	REUCA
KHM	Cambodia	Cambodia	khm	SEA
KIR	Kiribati	Kiribati	xoc	NAMO
KNA	Saint Kitts and Nevis	Saint Kitts and Nevis	xcb	LAC
KOR	Korea, Republic of	Korea, Republic of	kor	INDA
KWT	Kuwait	Kuwait	kwt	MENA
LAO	Lao People's Democratic Republic	Lao People's Democratic Republic	lao	SEA
LBN	Lebanon	Lebanon	xws	MENA
LBR	Liberia	Liberia	xwf	SSA
LBY	Libyan Arab Jamahiriya	N.A.	xnf	MENA
LCA	Saint Lucia	Saint Lucia	xcb	LAC
LKA	Sri Lanka	Sri Lanka	lka	SEA
LSO	Lesotho	Lesotho	xsc	SSA
LTU	Lithuania	Lithuania	ltu	EU26
LUX	Luxembourg	N.A.	lux	EU26
LVA	Latvia	Latvia	lva	EU26
MAC	Macao	Macao	xea	SEA
MAR	Morocco	Morocco	mar	MENA
MDA	Moldova, Republic of	Moldova, Republic of	xee	REUCA
MDG	Madagascar	Madagascar	mdg	SSA
MDV	Maldives	Maldives	xsa	SEA
MEX	Mexico	Mexico	mex	LAC
MHL	Marshall Islands	N.A.	xoc	NAMO
MKD	Macedonia, the former Yugoslav Republic of	Macedonia, the former Yugoslav Republic of	xer	REUCA
MLI	Mali	Mali	xwf	SSA
MLT	Malta	Malta	mlt	EU26
MMR	Myanmar	Myanmar	xse	SEA
MNE	Montenegro	Montenegro	xer	REUCA
MNG	Mongolia	Mongolia	mng	SEA
MOZ	Mozambique	Mozambique	moz	SSA
MRT	Mauritania	Mauritania	xwf	SSA
MUS	Mauritius	Mauritius	mus	SSA
MWI	Malawi	Malawi	mwi	SSA
MYS	Malaysia	Malaysia	mys	SEA
NAM	Namibia	Namibia	nam	SSA
NCL	New Caledonia	New Caledonia	xoc	NAMO
NER	Niger	Niger	xwf	SSA
NGA	Nigeria	Nigeria	nga	SSA
NIC	Nicaragua	Nicaragua	nic	LAC
NIU	Niue	N.A.	xoc	NAMO
NLD	Netherlands	Netherlands	nld	NLD
NOR	Norway	Norway	nor	REUCA
NPL	Nepal	Nepal	npl	SEA
NRU	Nauru	N.A.	xoc	NAMO

NZL	New Zealand	New Zealand	nzl	NAMO
OMN	Oman	Oman	omn	MENA
PAK	Pakistan	Pakistan	pak	SEA
PAN	Panama	Panama	pan	LAC
PER	Peru	Peru	per	LAC
PHL	Philippines	Philippines	phl	SEA
PNG	Papua New Guinea	Papua New Guinea	xoc	NAMO
POL	Poland	Poland	pol	EU26
PRI	Puerto Rico	N.A.	pri	LAC
PRK	Korea, Democratic People's Republic of	Korea, Democratic People's Republic of	xea	SEA
PRT	Portugal	Portugal	prt	EU26
PRY	Paraguay	Paraguay	pry	LAC
PSE	Palestinian Territory, Occupied	N.A	xws	MENA
PYF	French Polynesia	French Polynesia	xoc	NAMO
QAT	Qatar	N.A	qat	MENA
ROU	Romania	Romania	rou	EU26
RUS	Russian Federation	Russian Federation	rus	REUCA
RWA	Rwanda	Rwanda	rwa	SSA
SAU	Saudi Arabia	Saudi Arabia	sau	MENA
SDN	Sudan	Sudan	xec	SSA
SEN	Senegal	Senegal	sen	SSA
SGP	Singapore	N.A	sgp	INDA
SLB	Solomon Islands	Solomon Islands	xoc	NAMO
SLE	Sierra Leone	Sierra Leone	xwf	SSA
SLV	El Salvador	El Salvador	slv	LAC
SOM	Somalia	N.A	xec	SSA
SRB	Serbia	Serbia	xer	REUCA
SSD	South Sudan	N.A	xec	SSA
STP	Sao Tome and Principe	Sao Tome and Principe	xcf	SSA
SUR	Suriname	Suriname	xsm	LAC
SVK	Slovakia	Slovakia	svk	EU26
SVN	Slovenia	Slovenia	svn	EU26
SWE	Sweden	Sweden	swe	EU26
SWZ	Swaziland	Swaziland	xsc	SSA
SYC	Seychelles	Seychelles	xec	SSA
SYR	Syrian Arab Republic	N.A	xws	MENA
TCD	Chad	Chad	xcf	SSA
TGO	Togo	Togo	tgo	SSA
THA	Thailand	Thailand	tha	SEA
TJK	Tajikistan	Tajikistan	tjk	REUCA
TKL	Tokelau	N.A	xoc	NAMO
TKM	Turkmenistan	Turkmenistan	xsu	REUCA
TLS	Timor-Leste	Timor-Leste	xse	SEA
TON	Tonga	N.A	xoc	NAMO
TTO	Trinidad and Tobago	Trinidad and Tobago	tto	LAC
TUN	Tunisia	Tunisia	tun	MENA
TUR	Turkey	Turkey	tur	MENA
TUV	Tuvalu	N.A	xoc	NAMO
TWN	Taiwan, Province of China	Taiwan, Province of China	twn	INDA
TZA	Tanzania, United Republic of	Tanzania, United Republic of	tza	SSA
UGA	Uganda	Uganda	uga	SSA
UKR	Ukraine	Ukraine	ukr	REUCA
URY	Uruguay	Uruguay	ury	LAC
USA	United States	United States	usa	NAMO
UZB	Uzbekistan	Uzbekistan	xsu	REUCA
VCT	Saint Vincent and the Grenadines	Saint Vincent and the Grenadines	xcb	LAC
VEN	Venezuela, Bolivarian Republic of	Venezuela, Bolivarian Republic of	ven	LAC
VNM	Viet Nam	Viet Nam	vnm	SEA
VUT	Vanuatu	Vanuatu	xoc	NAMO
WSM	Samoa	Samoa	xoc	NAMO
YEM	Yemen	Yemen	xws	MENA
ZAF	South Africa	South Africa	zaf	SSA
ZMB	Zambia	Zambia	zmb	SSA
ZWE	Zimbabwe	Zimbabwe	zwe	SSA

Table S4 – Commodity mappings between FAO commodities and MAGNET sectors

FAO commodity code (CPC code)	FAO commodity description	GTAP sector	MAGNET aggregate
101	Canary seed	osd	osd
1017	Meat, goat	ctl	ctl
1018	Offals, edible, goats	ctl	ctl
1019	Fat, goats	ctl	ctl
1020	Milk, whole fresh goat	rmk	rmk
1025	Skins, goat, fresh	ctl	ctl
103	Grain, mixed	gro	gro
1035	Meat, pig	oap	oap
1036	Offals, pigs, edible	oap	oap
1037	Fat, pigs	oap	oap
1058	Meat, chicken	oap	oap
1062	Eggs, hen, in shell	oap	oap
1067	Eggs, hen, in shell (number)	oap	oap
1069	Meat, duck	oap	oap
1073	Meat, goose, and guinea fowl	oap	oap
108	Cereals nes	gro	gro
1080	Meat, turkey	oap	oap
1089	Meat, bird nes	oap	oap
1091	Eggs, other bird, in shell	oap	oap
1092	Eggs, other bird, in shell (number)	oap	oap
1097	Meat, horse	ctl	ctl
1098	Offals, horses	ctl	ctl
1108	Meat, ass	ctl	ctl
1111	Meat, mule	ctl	ctl
1127	Meat, camel	ctl	ctl
1128	Offals, edible, camels	ctl	ctl
1129	Fat, camels	ctl	ctl
1130	Milk, whole fresh camel	rmk	rmk
1141	Meat, rabbit	oap	oap
1151	Meat, other rodents	oap	oap
1158	Meat, other camelids	ctl	ctl
116	Potatoes	v_f	hort
1163	Meat, game	ctl	ctl
1166	Meat nes	oap	oap
1176	Snails, not sea	oap	oap
1182	Honey, natural	oap	oap
1183	Beeswax	oap	oap
1185	Silk-worm cocoons, reelable	wol	wol
122	Sweet potatoes	v_f	hort
125	Cassava	v_f	hort
135	Yautia (cocoyam)	v_f	hort
136	Taro (cocoyam)	v_f	hort
137	Yams	v_f	hort
149	Roots and tubers nes	v_f	hort
15	Wheat	wht	wht
156	Sugar cane	c_b	c_b
157	Sugar beet	c_b	c_b
161	Sugar crops nes	c_b	c_b
176	Beans, dry	v_f	hort
181	Broad beans, horse beans, dry	v_f	hort
187	Peas, dry	v_f	hort
191	Chick peas	v_f	hort
195	Cow peas, dry	v_f	hort
197	Pigeon peas	v_f	hort
201	Lentils	v_f	hort
203	Bambara beans	v_f	hort
205	Vetches	v_f	hort
210	Lupins	v_f	hort
211	Pulses nes	v_f	hort
216	Brazil nuts, with shell	v_f	hort
217	Cashew nuts, with shell	v_f	hort
220	Chestnut	v_f	hort
221	Almonds, with shell	v_f	hort
222	Walnuts, with shell	v_f	hort
223	Pistachios	v_f	hort
224	Kola nuts	v_f	hort
225	Hazelnuts, with shell	v_f	hort
226	Areca nuts	v_f	hort
234	Nuts nes	v_f	hort
236	Soybeans	v_f	hort
242	Groundnuts, with shell	v_f	hort
249	Coconuts	v_f	hort
260	Olives	v_f	hort
263	Karite nuts (sheanuts)	v_f	hort
265	Castor oil seed	osd	osd
267	Sunflower seed	osd	osd
27	Rice, paddy	pdr	pdr
270	Rapeseed	osd	osd
275	Tung nuts	v_f	hort

277	Jojoba seed	osd	osd
280	Safflower seed	osd	osd
289	Sesame seed	osd	osd
292	Mustard seed	osd	osd
296	Poppy seed	osd	osd
299	Melonseed	osd	osd
30	Rice, paddy (rice milled equivalent)	pdr	pdr
305	Tallowtree seed	osd	osd
310	Kapok fruit	v_f	hort
328	Seed cotton	osd	osd
333	Linseed	osd	osd
336	Hempseed	osd	osd
339	Oilseeds nes	osd	osd
358	Cabbages and other brassicas	v_f	hort
366	Artichokes	v_f	hort
367	Asparagus	v_f	hort
372	Lettuce and chicory	v_f	hort
373	Spinach	v_f	hort
378	Cassava leaves	v_f	hort
388	Tomatoes	v_f	hort
393	Cauliflowers and broccoli	v_f	hort
394	Pumpkins, squash, and gourds	v_f	hort
397	Cucumbers and gherkins	v_f	hort
399	Eggplants (aubergines)	v_f	hort
401	Chillies and peppers, green	v_f	hort
402	Onions, shallots, green	v_f	hort
403	Onions, dry	v_f	hort
406	Garlic	v_f	hort
407	Leeks, other alliaceous vegetables	v_f	hort
414	Beans, green	v_f	hort
417	Peas, green	v_f	hort
420	Vegetables, leguminous nes	v_f	hort
423	String beans	v_f	hort
426	Carrots and turnips	v_f	hort
430	Okra	v_f	hort
44	Barley	gro	gro
446	Maize, green	gro	gro
449	Mushrooms and truffles	v_f	hort
459	Chicory roots	v_f	hort
461	Carobs	v_f	hort
463	Vegetables, fresh nes	v_f	hort
486	Bananas	v_f	hort
489	Plantains and others	v_f	hort
490	Oranges	v_f	hort
495	Tangerines, mandarins, clementines, satsumas	v_f	hort
497	Lemons and limes	v_f	hort
507	Grapefruit (inc. pomelos)	v_f	hort
512	Fruit, citrus nes	v_f	hort
515	Apples	v_f	hort
521	Pears	v_f	hort
523	Quinces	v_f	hort
526	Apricots	v_f	hort
530	Cherries, sour	v_f	hort
531	Cherries	v_f	hort
534	Peaches and nectarines	v_f	hort
536	Plums and sloes	v_f	hort
541	Fruit, stone nes	v_f	hort
542	Fruit, pome nes	v_f	hort
544	Strawberries	v_f	hort
547	Raspberries	v_f	hort
549	Gooseberries	v_f	hort
550	Currants	v_f	hort
552	Blueberries	v_f	hort
554	Cranberries	v_f	hort
558	Berries nes	v_f	hort
56	Maize	gro	gro
560	Grapes	v_f	hort
567	Watermelons	v_f	hort
568	Melons, other (inc.cantaloupes)	v_f	hort
569	Figs	v_f	hort
571	Mangoes, mangosteens, guavas	v_f	hort
572	Avocados	v_f	hort
574	Pineapples	v_f	hort
577	Dates	v_f	hort
587	Persimmons	v_f	hort
591	Cashewapple	v_f	hort
592	Kiwi fruit	v_f	hort
600	Papayas	v_f	hort
603	Fruit, tropical fresh nes	v_f	hort
619	Fruit, fresh nes	v_f	hort
656	Coffee, green	ocr	ocrops

661	Cocoa, beans	ocr	ocrops
667	Tea	ocr	ocrops
671	Maté	ocr	ocrops
677	Hops	ocr	ocrops
687	Pepper (piper spp.)	ocr	ocrops
689	Chillies and peppers, dry	ocr	ocrops
692	Vanilla	ocr	ocrops
693	Cinnamon (cannella)	ocr	ocrops
698	Cloves	ocr	ocrops
702	Nutmeg, mace and cardamoms	ocr	ocrops
71	Rye	gro	gro
711	Anise, badian, fennel, coriander	ocr	ocrops
720	Ginger	ocr	ocrops
723	Spices nes	ocr	ocrops
748	Peppermint	ocr	ocrops
75	Oats	gro	gro
754	Pyrethrum, dried	ocr	ocrops
767	Cotton lint	pfb	pfb
773	Flax fibre and tow	pfb	pfb
777	Hemp tow waste	pfb	pfb
780	Jute	pfb	pfb
782	Bastfibres, other	pfb	pfb
788	Ramie	pfb	pfb
789	Sisal	pfb	pfb
79	Millet	gro	gro
800	Agave fibres nes	pfb	pfb
809	Manila fibre (abaca)	pfb	pfb
813	Coir	pfb	pfb
821	Fibre crops nes	pfb	pfb
826	Tobacco, unmanufactured	ocr	ocrops
83	Sorghum	gro	gro
836	Rubber, natural	ocr	ocrops
867	Meat, cattle	ctl	ctl
868	Offals, edible, cattle	ctl	ctl
869	Fat, cattle	ctl	ctl
882	Milk, whole fresh cow	rmk	rmk
89	Buckwheat	gro	gro
919	Hides, cattle, fresh	ctl	ctl
92	Quinoa	gro	gro
94	Fonio	gro	gro
947	Meat, buffalo	ctl	ctl
948	Offals, edible, buffaloes	ctl	ctl
949	Fat, buffaloes	ctl	ctl
951	Milk, whole fresh buffalo	rmk	rmk
957	Hides, buffalo, fresh	ctl	ctl
97	Triticale	gro	gro
977	Meat, sheep	ctl	ctl
978	Offals, sheep,edible	ctl	ctl
979	Fat, sheep	ctl	ctl
982	Milk, whole fresh sheep	rmk	rmk
987	Wool, greasy	wol	wol
995	Skins, sheep, fresh	ctl	ctl

FBS commodity code (CPC code)	FBS commodity description	GTAP sector	MAGNET aggregate
2761	Freshwater Fish	fsh	fsh
2762	Demersal Fish	fsh	fsh
2763	Pelagic Fish	fsh	fsh
2764	Marine Fish, Other	fsh	fsh
2765	Crustaceans	fsh	fsh
2766	Cephalopods	fsh	fsh
2767	Molluscs, Other	fsh	fsh

Table S5 – FAO commodities excluded as reported as non-primary commodities

FAO commodity code (CPC code)	FAO commodity description	FAO commodity code (CPC code)	FAO commodity description
237	Oil, soybean	271	Oil, rapeseed
252	Oil, coconut (copra)	281	Oil, safflower
254	Oil palm fruit	290	Oil, sesame
258	Oil, palm kernel	331	Oil, cottonseed
261	Oil, olive, virgin	334	Oil, linseed
268	Oil, sunflower	60	Oil, maize
244	Oil, groundnut		

Food Loss and Waste data

Definitions

We define FLW as "*food (including inedible parts) lost or discarded along the food supply chain, comprising pre-harvest losses, and excluding food diverted to animal feed, seed or to other non-food material uses such as bio-based products"*. With this classification, we align with SDG12.3 considering only food produced for human consumption, including all food types, disposal routes and stages of the FSC. We consider the entirety of food products, as (un)edible foods shares, thus (un)avoidable FLW, often vary according to countries or cultures. By doing so, we overcome a broadly debated (Delgado et al., 2021) methodological limitation of Gustavsson et al. (FAO, 2011). Moreover, we exclude from FLW food produced for other purposes outside human consumption, as such allocation rather prevents biomass from becoming waste. Finally, we report data on percentage losses of total food weight as percentage estimates result more stable across years (Fabi and English, 2018).

Database

The core of our FLW database is represented by the FAO–FLW database (FAO, 2019). Within the FAO–FLW database we assume a standard data computation method based on the methodology adopted by (FAO, 2019). Here, the FAO–FLW database is utilised for calibrating indicators[2] built explicitly on edible and inedible shares of commodities, excluding other non-food biomass flows (i.e. feed, seed, etc.) from FLW. Accordingly, we adopt this method as reference methodology for our final FLW database, remaining consistent with our FLW definition. We group FAO data in seven global regions, defining seven commodity groups produced along five macro-stages of the FSC. Such aggregation procedure influences final estimates but is here necessary due to large unavailability of data at single country/commodity level.

The FAO–FLW database mainly covers low-income regions. Data is mostly available for sub-Saharan Africa, South-East Asia and North Africa & Middle East, while for high-income regions such as Europe and North America & Oceania observations are relatively limited. This geographical focus influences overall data availability for commodities and supply chain stages. Most reported losses occur in fact at early stages of the supply chain, i.e. Agriculture Production and Post-Harvest Handling & Storage and involve horticultural commodities and cereals, usually prevailing in low-income regions' diets. Data is largely not available for animal-sourced products, particularly in the final stages of the supply chain such as Distribution & Retail and Consumption. Despite the broad temporal coverage of the database (1945-2021), observations are mostly concentrated between 2000 and 2017, with peaks between 2009 and 2011. On the coverage limitations of the FAO-FLW database we perform a literature review, building on previous investigations (Xue et al., 2017; Porter et al., 2016; Affognon et al., 2015; OECD, 2021). We only collect data computed consistently with our FLW definition, enhancing data availability mainly for Europe, North America & Oceania and North Africa & Middle East. To achieve a global data coverage, we complete our database replacing non-available data with a consistent gap-filling methodology based on FLW in comparable regions, commodities, and stages of the FSC. Such finalization procedure recommends a careful utilization and interpretation of final estimates as data assumptions and aggregations may influence the magnitude of estimates hereby reported. Moreover, as we aggregate data through physical mass, our methodology does not allow a direct assessment of SDG12.3, for which an indicator based on economic weights (Fabi and English, 2018) is adopted as measurement methodology. Estimates on percentage losses and waste of total food weight, and respective sources, are reported in Tables A-G.

[2] SDG12.3 - Food Loss Index (FLI) and Food Waste Index (FWI) – see Fabi and English, 2018. For an integral explanation see FAO, 2019, p. 32-34.

Tab. A – Europe	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
Cereals	8.6[1]	1.4 – 1.5[2,3]	3.2[2]	2.2[2]	28.0[1]
Oilseed, Pulses and Nuts (incl. sugar)	11.1[1]	2.5 – 3[2,3]	6.0[1]	0.3[2]	4.0 – 4.8[2,10]
Roots and Tubers	3.5[1]	4.0[1]	11.2[1]	1.1[1]	28.0[1]
Fruits and Vegetables	12.8[1]	6.4[1]	10.6[1]	4.1[1]	12.2[1]
Dairy products	0.3[2,3]	0.1 – 0.3[2,4,5]	0.7[2]	0.2 – 0.8[2,7,8]	3.2 – 12.1[2,7,10,11]
Meat	0.8[2,3]	0.1[4,5]	4.7[2]	2.7 – 3.8[2,9]	8.0 – 50.3[2,7,10,11]
Fish and Seafood	0.0 –0.7[2,3]	0.1[4,5]	37.8[2]	2.4 – 3.6[2,7]	9.7 – 22.3[2,7,10]
Other animal products	3.6 – .8[2,3,4]	1.0[4,5]	1.6[2]	1.4 – 1.6[2,7]	22.6 – 36[2,7,10]

[1] FAO, 2019. Food Loss and Waste Database. Food Agric. Organ. U. N. URL http://www.fao.org/platform-food-loss-waste/flw-data/en/ (accessed 1.12.21).

[2] calculated from Caldeira, C., De Laurentiis, V., Corrado, S., van Holsteijn, F., Sala, S., 2019. Quantification of food waste per product group along the food supply chain in the European Union: a mass flow analysis. Resour. Conserv. Recycl. 149, 479–488. https://doi.org/10.1016/j.resconrec.2019.06.011

[3] Hartikainen, H., Mogensen, L., Svanes, E., Franke, U., 2018. Food waste quantification in primary production – The Nordic countries as a case study. Waste Management. 71, 502–511. https://doi.org/10.1016/j.wasman.2017.10.026

[4] Koester, U., Empen, J., Holm, T. 2013. Food Losses and Waste in Europe and Central Asia. Draft synthesis report. FAO – Regional Office for Europe and Central Asia. http://www.fao.org/3/a-au843e.pdf

[5] Themen, D. 2014. Reducing of Food Losses and Waste in Europe and Central Asia for Improved Food Security and Agrifood Chain Efficiency. FAO – Regional Office for Europe and Central Asia. http://www.fao.org/3/a-au844e.pdf

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[10] WRAP, 2014. Household Food and Drink Waste: a Product Focus. The Waste and Resources Action Programme, UK.

[11] Vanham, D., Bouraoui, F., Leip, A., Grizzetti, B., Bidoglio, G., 2015. Lost water and nitrogen resources due to EU consumer food waste. Environ. Res. Lett. 10, 084008. https://doi.org/10.1088/1748-9326/10/8/084008

Tab. B – North America & Oceania	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
Cereals	7.2[2]	4[4]	3.2[13]	15.0[7]	18.5[6] – 23.8[7]
Oilseed, Pulses and Nuts (incl. sugar)	12.0[10]	3.0[12]	6.0[13]	11.0[1]	18.0[1]
Roots and Tubers	20.0[11]	7.1[4]	1.4 – 2.6[8] or 11.2[12]	13.9[1]	17.6[4]
Fruits and Vegetables	8.8[1]	19.8[4]	14.2 – 14.8[8]	12.9[1]	17.0[1]
Dairy products	3.5[11]	0.4[4]	0.7[13]	12.0[1]	18.0[1]
Meat	3.5[11]	1.0[11]	4.7[13]	4.0[1]	37.0[1]
Fish and Seafood	2.0[11]	0.5[11]	37.8[13]	2.7[5] - 8.0[6]	31.6[6]
Other animal products	4.0[3]	1.0[13]	1.6[13]	9.0[6]	20.9[9]

[1] FAO, 2019. Food Loss and Waste Database. Food Agric. Organ. U. N. URL http://www.fao.org/platform-food-loss-waste/flw-data/en/ (accessed 1.12.21).

[2] Clarke, J.M. 1989. Drying rate and harvest losses of windrowed versus direct combined barley. Canadian Journal of Plant Science 1989; 69(3):713-20.

[3] Aerni V., Brinkhof, M.W.G., Wechsler, B., Oester, H., Fröhlich, E. 2005. Productivity and mortality of laying hens in aviaries: A systematic review. World's Poultry Science Journal 2005; 61(01):13

[4] calculated from USDA ERS - food availability (per capita) data system; Available from: http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system/.aspx. (calculated on whole commodity, including inedible food parts)

[5] Gooch, M., Felfel, A., Marenick, N. 2010. Food Waste in Canada; Value Chain Management Centre: Oakville, ON, Canada, 2010. https://vcm-international.com/wp-content/uploads/2013/04/Food-Waste-in-Canada-112410.pdf

[6] Canadian Statistical Bureau. 2010. https://www.statcan.gc.ca/eng/start

[7] calculated from Buzby, J.C., Farah-Wells, H., Hyman, J., 2014. The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States. SSRN Electron. J.https://doi.org/10.2139/ssrn.2501659 (calculated on whole commodity, including inedible food parts)

[8] World Wide Fund for Nature. 2018. Maximizing farm resources and edible food rescue. Specialty Crop Loss Report. https://c402277.ssl.cf1.rackcdn.com/publications/1243/files/original/WWF_Farm_Loss_Technical_Report_Redacted_0619.pdf?1560175295

[9] OECD (2021), "Waste: Food Waste", OECD Environment Statistics (database), https://doi.org/10.1787/ba9da2b7-en (accessed on 1 December 2021).

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[11] FAO (Food and Agriculture Organization of the United Nations). 2011. Global Food Losses and Food Waste. Extent, Causes and Prevention. Rome: FAO.

[12] Assumption made by taking the higher boundry of the interval reported for Europe.

[13] Assumption based on values for Europe.

Tab. C – Industrialized Asia	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
Cereals	5.6[1]	7.9[1]	2.7[1]	1.1[1]	13.8[1]
Oilseed, Pulses and Nuts (incl. sugar)	6.0[5]	2.5[6]	6.0[7]	0.3[7]	16.55[4]
Roots and Tubers	2.2[1]	11.0[1]	1.4 – 2.6[8] or 11.2[7]	2.0[1]	7.1[4]
Fruits and Vegetables	10.7[1]	22.0[1]	15.9[1]	8.2[1]	17.2[2]
Dairy products	3.5[5]	0.1[6]	4.7[7]	0.2[6]	2.6[4]
Meat	8.7[2]	2.0 - 3.6[2]	1.3[2]	3.5[2]	16.3[2]
Fish and Seafood	3.6[2]	7.3[2]	37.8[7]	5.8[2]	26.1[2]
Other animal products	6.0[3]	1.0[7]	1.6[7]	1.4[6]	13.5[2]

[1] FAO, 2019. Food Loss and Waste Database. Food Agric. Organ. U. N. URL http://www.fao.org/platform-food-loss-waste/flw-data/en/ (accessed 1.12.21).

[2] calculated from Liu, G., 2014. Food Losses and Food Waste in China: A First Estimate. https://doi.org/10.1787/5jz5sq5173lq-en (calculated on whole commodity, including inedible food parts)

[3] Aerni V., Brinkhof, M.W.G., Wechsler, B., Oester, H., Fröhlich, E. 2005. Productivity and mortality of laying hens in aviaries: A systematic review. World's Poultry Science Journal 2005; 61(01):13

[4] calculated from Song, G., Li, M., Semakula, H.M., Zhang, S. 2015. Food consumption and waste and the embedded carbon, water and ecological footprints of households in China. Sci Total Environ 2015, Oct 1; 529:191-7. http://dx.doi.org/10.1016/j.scitotenv.2015.05.068

[5] FAO (Food and Agriculture Organization of the United Nations). 2011. Global Food Losses and Food Waste. Extent, Causes end Prevention. Rome: FAO.

[6] Assumption made by taking the lower boundry of the interval reported for Europe.

[7] Assumption based on values for Europe.

[8] Assumption based on values for North America & Oceania.

Tab. D – North Africa & Middle East	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
Cereals	14.0[1]	18.3[1]	2.0[2]	1.0[2]	5.0[2]
Oilseed, Pulses and Nuts ilncl. sugar)	15.0[2,3]	5[2]	7.0[2]	1.0[2]	4.0[2]
Roots and Tubers	14.8[1]	8.3[1]	4.0[1]	5.3[1]	10.0[1]
Fruits and Vegetables	9.3[1]	6.2[1]	10.0[2]	10.7[1]	34.1 – 35.4[3]
Dairy products	10.0[2]	1.0[2]	1.5[2]	6.0[2]	5.5[3]
Meat	10.0[2]	0.2[2]	5.0[2]	0.5[2]	7.4[3]
Fish and Seafood	10.0[2]	0.05[2]	0.05[2]	0.1[2]	4.8[3]
Other animal products	6.0[2]	1.0[2]	2.0[2]	1.0[2]	2.0[3]

[1] FAO, 2019. Food Loss and Waste Database. Food Agric. Organ. U. N. URL http://www.fao.org/platform-food-loss-waste/flw-data/en/ (accessed 1.12.21).

[2] Koester, U., Empen, J., Holm, T. 2013. Food Losses and Waste in Europe and Central Asia. Draft synthesis report. FAO – Regional Office for Europe and Central Asia. http://www.fao.org/3/a-au843e.pdf

[3] OECD (2021), "Waste: Food Waste", OECD Environment Statistics (database), https://doi.org/10.1787/ba9da2b7-en (accessed on 1 December 2021).

Tab. E – Latin America & Caribbean	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
Cereals	8.7[1]	15.2[1]	3.3[1]	1.2[1]	5.0[3]
Oilseed, Pulses and Nuts (incl. sugar)	14.8[1]	15.3[1]	6.6[1]	0.8[1]	4.0[3]
Roots and Tubers	6.3[1]	26.4[1]	3.6[1]	4.0[1]	10.0[3]
Fruits and Vegetables	13.3[1]	10.4[1]	4.0[1]	10.9[1]	3.4[1]
Dairy products	3.5[2]	1.0[3]	1.5[3]	6.0[3]	5.5[3]
Meat	5.6[2]	1.1[2]	5.0[3]	0.5[3]	7.4[3]
Fish and Seafood	5.7[2]	5.0[2]	0.05[3]	0.1[3]	4.8[3]
Other animal products	6.0[2,3]	1.0[3]	2.0[3]	1.0[3]	2.0[3]

[1] FAO, 2019. Food Loss and Waste Database. Food Agric. Organ. U. N. URL http://www.fao.org/platform-food-loss-waste/flw-data/en/ (accessed 1.12.21).

[2] FAO (Food and Agriculture Organization of the United Nations). 2011. Global Food Losses and Food Waste. Extent, Causes and Prevention. Rome: FAO.

[3] Assumption based on values for North Africa & Middle East.

Tab. F – South-East Asia	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
Cereals	3.7[1]	4.6[1]	3.2[1]	1.5[1]	4.0[3]
Oilseed, Pulses and Nuts (incl. sugar)	0.8[1]	1.2[1]	7.8[1]	1.0[1]	4.0[7]
Roots and Tubers	3.2[1]	4.5[1]	3.2[1]	3.5[1]	4.0[7]
Fruits and Vegetables	4.0[1]	4.2[1]	14.2[1]	8.5[1]	3.4[1]
Dairy products	3.5[4]	3.4[5]	1.5[6]	6.0[6]	5.5[6]
Meat	5.6[4]	0.3[4]	5.0[6]	0.5[6]	7.4[6]
Fish and Seafood	8.2[4]	6.0[4]	0.05[6]	12.3[2]	4.8[6]
Other animal products	34.7[1]	1.0[6]	2.0[6]	7.4[1]	2.0[6]

[1] FAO, 2019. Food Loss and Waste Database. Food Agric. Organ. U. N. URL http://www.fao.org/platform-food-loss-waste/flw-data/en/ (accessed 1.12.21).

[2] Hossain, M.M., Rahman, M., Hassan, M.N., Nowsad, A.A. 2013. Post-harvest loss of farm raised Indian and Chinese major carps in the distribution channel from Mymensingh to Rangpur of Bangladesh. Pak J Biol Sci 2013, Jun 15; 16(12):564-9.

[3] Hossain, A., Miah, M. (2009). Post-harvest losses and technical efficiency of potato storage systems in Bangladesh. *Final Report CF # 2/08* Bangladesh Agricultural Research Institute.

[4] FAO (Food and Agriculture Organization of the United Nations). 2011. Global Food Losses and Food Waste. Extent, Causes and Prevention. Rome: FAO.

[5] Assumption based on FAOSTAT, 2020 and on values for North Africa & Middle East.

[6] Assumption based on values for North Africa & Middle East.

[7] Assumption based on Cereals.

Tab. G – Sub-Saharan Africa	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
Cereals	3.3[1]	3.25[1]	3.7[1]	1.8[1]	4.0[7]
Oilseed, Pulses and Nuts (incl. sugar)	7.7[1]	17.0[1]	8.0[1]	24.1[1]	4.0[8]
Roots and Tubers	12.8[1]	25.5[1]	4.1[1]	16.5[1]	4.0[8]
Fruits and Vegetables	18.1[1]	3.3[1]	8.7[1]	17.0[1]	3.4[7]
Dairy products	6.0[4]	8.2[2]	1.5[5]	13.8[3]	5.5[5]
Meat	19.0[4]	3.0[2]	5.0[5]	0.5[5]	7.4[5]
Fish and Seafood	5.7[4]	14.3 - 27.3[2]	9.0[6]	12.3[7]	4.8[5]
Other animal products	6.0[5]	1.0[5]	2.0[5]	7.4[7]	2.0[5]

[1] FAO, 2019. Food Loss and Waste Database. Food Agric. Organ. U. N. URL http://www.fao.org/platform-food-loss-waste/flw-data/en/ (accessed 1.12.21).

[2] Affognon, H., Mutungi, C., Sanginga, P., Borgemeister, C. 2015. Unpacking postharvest losses in sub-Saharan Africa: A meta-analysis. World Development 2015, Feb; 66:49-68. http://dx.doi.org/10.1016/j.worlddev.2014.08.002

[3] Wesana, J., Gellynck, X., Dora, M.K., Pearce, D., De Steur, H., 2019. Measuring food and nutritional losses through value stream mapping along the dairy value chain in Uganda. Resour. Conserv. Recycl. 150, 104416. https://doi.org/10.1016/j.resconrec.2019.104416

[4] FAO (Food and Agriculture Organization of the United Nations). 2011. Global Food Losses and Food Waste. Extent, Causes and Prevention. Rome: FAO.

[5] Assumption based on values for North Africa & Central-West Asia.

[6] Davies, R. M., Davies, O.A. 2009. "Traditional and Improved Fish Processing Technologies in Bayelsa State, Nigeria." European Journal of Scientific Research 26: 539-548.

[7] Assumption based on values for South & South-East Asia.

[8] Assumption based on Cereals.

FLW data into the MAGNET model

To integrate our FLW data into MAGNET we map FLW estimates to primary food commodities of MAGNET. From Table S6 to S17 we report the FLW (%) estimates applied to commodities across the global regions included in our model.

Tab.S6 – NLD	**Agricultural Production**	**Post-Harvest Handling & Storage**	**Manufacturing**	**Distribution & Retailing**	**Consumption**
pdr	0.042	0.014	0.032	0.022	0.28
wht	0.094	0.014	0.032	0.022	0.137
gro	0.042	0.014	0.032	0.022	0.137
hort	0.121	0.063	0.104	0.037	0.154
osd	0.025	0.025	0.282	0.003	0.048
c_b	0.026	0.03	0.03	0.003	0.013
ocrops	0.04	0.01	0.03	0.022	0.13
ctl	0.008	0.001	0.047	0.032	0.292
oap	0.042	0.01	0.016	0.015	0.293
rmk	0.003	0.002	0.007	0.005	0.076
fsh	0.004	0.001	0.378	0.03	0.16

Tab. S7 – BRA	**Agricultural Production**	**Post-Harvest Handling & Storage**	**Manufacturing**	**Distribution & Retailing**	**Consumption**
pdr	0.036	0.076	0.034	0.012	0.05
wht	0.03	0.099	0.03	0.012	0.05
gro	0.122	0.182	0.034	0.012	0.05
hort	0.112	0.166	0.043	0.074	0.034
osd	0.13	0.15	0.07	0.01	0.04
c_b	0.122	0.182	0.034	0.012	0.05
ocrops	0.122	0.182	0.034	0.012	0.05
ctl	0.056	0.011	0.04	0.005	0.074
oap	0.06	0.01	0.01	0.01	0.02
rmk	0.035	0.01	0.015	0.06	0.055
fsh	0.057	0.05	0.001	0.001	0.048

Tab.S8 – BGD	**Agricultural Production**	**Post-Harvest Handling & Storage**	**Manufacturing**	**Distribution & Retailing**	**Consumption**
pdr	0.038	0.041	0.033	0.011	0.02
wht	0.02	0.02	0.03	0.033	0.02
gro	0.024	0.041	0.03	0.01	0.04
hort	0.038	0.035	0.078	0.087	0.04
osd	0.009	0.013	0.05	0.01	0.04
c_b	0.012	0.004	0.03	0.067	0.04
ocrops	0.006	0.012	0.03	0.054	0.04
ctl	0.02	0.003	0.04	0.005	0.04
oap	0.247	0.01	0.01	0.075	0.02
rmk	0.035	0.034	0.015	0.05	0.04
fsh	0.03	0.06	0.001	0.123	0.048

Tab. S9 – ETH	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
pdr	0.01	0.012	0.045	0.018	0.02
wht	0.01	0.01	0.035	0.017	0.02
gro	0.01	0.01	0.035	0.019	0.02
hort	0.02	0.01	0.05	0.05	0.04
osd	0.02	0.012	0.035	0.05	0.02
c_b	0.03	0.01	0.01	0.01	0.02
ocrops	0.03	0.01	0.01	0.019	0.02
ctl	0.03	0.03	0.01	0.005	0.05
oap	0.06	0.01	0.02	0.075	0.02
rmk	0.06	0.082	0.015	0.138	0.055
fsh	0.057	0.03	0.03	0.05	0.048

Tab. S10 – EU26	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
pdr	0.042	0.014	0.032	0.022	0.28
wht	0.094	0.014	0.032	0.022	0.137
gro	0.042	0.014	0.032	0.022	0.137
hort	0.121	0.063	0.104	0.037	0.154
osd	0.025	0.025	0.282	0.003	0.048
c_b	0.026	0.03	0.03	0.003	0.013
ocrops	0.04	0.01	0.03	0.022	0.13
ctl	0.008	0.001	0.047	0.032	0.292
oap	0.042	0.01	0.016	0.015	0.293
rmk	0.003	0.002	0.007	0.005	0.076
fsh	0.004	0.001	0.378	0.03	0.16

Tab.S11 – SEA	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
pdr	0.038	0.041	0.033	0.011	0.02
wht	0.02	0.02	0.03	0.033	0.02
gro	0.024	0.041	0.03	0.01	0.04
hort	0.038	0.035	0.078	0.087	0.04
osd	0.009	0.013	0.05	0.01	0.04
c_b	0.012	0.004	0.03	0.067	0.04
ocrops	0.006	0.012	0.03	0.054	0.04
ctl	0.02	0.003	0.04	0.005	0.04
oap	0.247	0.01	0.01	0.075	0.02
rmk	0.035	0.034	0.015	0.05	0.04
fsh	0.03	0.06	0.001	0.123	0.048

Tab.S12 – INDA	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
pdr	0.01	0.076	0.027	0.011	0.04
wht	0.088	0.066	0.027	0.011	0.04
gro	0.126	0.04	0.027	0.011	0.111
hort	0.05	0.04	0.04	0.04	0.04
osd	0.06	0.025	0.06	0.003	0.048
c_b	0.01	0.04	0.02	0.011	0.04
ocrops	0.01	0.04	0.02	0.011	0.111
ctl	0.087	0.028	0.013	0.035	0.08
oap	0.02	0.01	0.016	0.014	0.03
rmk	0.01	0.001	0.047	0.002	0.01
fsh	0.036	0.073	0.378	0.058	0.1

Tab. S13 – NAMO	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
pdr	0.03	0.02	0.01	0.03	0.135
wht	0.03	0.02	0.01	0.03	0.135
gro	0.03	0.02	0.01	0.03	0.135
hort	0.04	0.1	0.102	0.13	0.17
osd	0.4	0.03	0.01	0.03	0.135
c_b	0.01	0.02	0.01	0.03	0.18
ocrops	0.03	0.02	0.01	0.03	0.135
ctl	0.035	0.01	0.047	0.04	0.25
oap	0.04	0.01	0.016	0.09	0.209
rmk	0.035	0.004	0.007	0.12	0.18
fsh	0.12	0.005	0.178	0.027	0.2

Tab.S14 – LAC	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
pdr	0.036	0.076	0.034	0.012	0.05
wht	0.03	0.099	0.03	0.012	0.05
gro	0.122	0.182	0.034	0.012	0.05
hort	0.112	0.166	0.043	0.074	0.034
osd	0.13	0.15	0.07	0.01	0.04
c_b	0.122	0.182	0.034	0.012	0.05
ocrops	0.122	0.182	0.034	0.012	0.05
ctl	0.056	0.011	0.04	0.005	0.074
oap	0.06	0.01	0.01	0.01	0.02
rmk	0.035	0.01	0.015	0.06	0.055
fsh	0.057	0.05	0.001	0.001	0.048

Tab. S15 – REUCA	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
pdr	0.14	0.293	0.02	0.01	0.05
wht	0.14	0.129	0.02	0.01	0.05
gro	0.14	0.293	0.02	0.01	0.05
hort	0.056	0.1	0.113	0.04	0.227
osd	0.15	0.05	0.07	0.01	0.04
c_b	0.14	0.293	0.02	0.01	0.05
ocrops	0.12	0.25	0.02	0.01	0.05
ctl	0.1	0.002	0.05	0.005	0.074
oap	0.06	0.01	0.02	0.01	0.02
rmk	0.1	0.01	0.015	0.06	0.055
fsh	0.1	0.0002	0.001	0.0003	0.048

Tab. S16 – MENA	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
pdr	0.14	0.293	0.02	0.01	0.05
wht	0.14	0.129	0.02	0.01	0.05
gro	0.14	0.293	0.02	0.01	0.05
hort	0.056	0.1	0.113	0.04	0.227
osd	0.15	0.05	0.07	0.01	0.04
c_b	0.14	0.293	0.02	0.01	0.05
ocrops	0.12	0.25	0.02	0.01	0.05
ctl	0.1	0.002	0.05	0.005	0.074
oap	0.06	0.01	0.02	0.01	0.02
rmk	0.1	0.01	0.015	0.06	0.055
fsh	0.1	0.0002	0.001	0.0003	0.048

Tab. S17 – SSA	Agricultural Production	Post-Harvest Handling & Storage	Manufacturing	Distribution & Retailing	Consumption
pdr	0.01	0.012	0.045	0.018	0.02
wht	0.01	0.01	0.035	0.017	0.02
gro	0.01	0.01	0.035	0.019	0.02
hort	0.02	0.01	0.05	0.05	0.04
osd	0.02	0.012	0.035	0.05	0.02
c_b	0.03	0.01	0.01	0.01	0.02
ocrops	0.03	0.01	0.01	0.019	0.02
ctl	0.03	0.03	0.01	0.005	0.05
oap	0.06	0.01	0.02	0.075	0.02
rmk	0.06	0.082	0.015	0.138	0.055
fsh	0.057	0.03	0.03	0.05	0.048

EAT-Lancet diet scenario

To simulate the transition to the EAT-Lancet dietary recommendations we target final food demand in our model. The magnitude of the shocks has been calculated by analysing per-capita private household consumption in our baseline scenario (SSP2) to 2030, successively calculating the percentage change required to meet the EAT-Lancet dietary targets. For processed foods and food services, not explicitly reported in the EAT-Lancet, we quantified the primary equivalents to proportionally compute a shock maintaining overall intakes within the EAT-Lancet nutritional targets. We increase/decrease consumption of specific commodities by region, directing household food demand towards the EAT-Lancet diet. The percentage change applied to the shocked variable in each region for each demanded commodity are reported in Table S18 below.

Table S18. Applied shock (% changes) to private per-capita household demand for each commodity in different global regions, simulating a global transition to the EAT-Lancet diet

QPC	NLD	BRA	BGD	ETH	EU26	SEA	INDA	NAMO	LAC	REUCA	MENA	SSA
pdr	0	1213.631	563.6906	183.7464	15258.04	-18.5	443.208	873.855	633.042	3553.163	147.875	-8.561
wht	33.654	468.007	400.0147	-7.7432	-40.456	5.88	331.883	47.043	68.845	-40.453	-37.649	-7.398
gro	591.91	40.056	63.015	-9.5506	8.597	0.739	328.018	86.937	-25.131	-11.317	-4.764	-41.709
hort	65.25	38.051	11.4961	10.6768	13.467	-10.069	51.9	42.985	18.637	-3.434	-1.208	-13.83
osd	1494.476	1853.704	94.5739	80.5672	151.877	0.895	32.581	431.803	407.776	87.811	47.733	-7.83
c_b	-6.419	227.473	-2.4358	-6.1198	-24.224	-16.74	40.582	9.314	-41.259	-40.842	-34.706	-40.045
pfb	0	0	0	0	0	0	0	0	0	0	0	0
ocrops	170.882	171.3	-5.1932	11.3884	276.939	346.135	360.648	195.227	594.073	393.895	447.408	549.037
ctl	610.148	-34.026	-5.4858	-6.927	310.701	21.497	131.741	606.699	-20.177	-30.156	-29.731	-30.62
oap	71.181	-38.722	2.7808	3.6424	-13.464	-38.362	-27.452	-38.136	-38.667	-40.023	-37.07	-20.973
rmk	38.864	-0.487	14.5439	1.7386	-9.327	15.859	165.975	46.083	115.632	-26.272	97.298	140.249
wol	0	0	0	0	0	0	0	0	0	0	0	0
frs	0	0	0	0	0	0	0	0	0	0	0	0
fsh	213.693	51.543	-8.4642	238.3914	53.56	-0.768	-1.94	249.444	80.984	206.107	39.829	68.8
cmt	-44.88	-45.883	10.4082	99.7158	-41.204	-29.979	-37.687	-43.508	-42.04	-44.047	-29.933	-27.638
omt	-40.352	-29.538	104.3855	733.4698	-38.926	5.679	-21.641	-35.143	-30.523	-2.148	30.906	38.358
vol	-21.545	-36.156	-8.3821	32.6976	-19.822	-24.064	-3.206	-2.982	-22.708	-10.307	-28.351	-3.356
mil	-40.887	-26.015	117.9416	566.7362	-35.186	59.033	6.836	-31.777	-17.683	-22.746	-13.29	75.493
pcr	556.325	-26.8	-12.2124	113.6298	306.738	-36.272	-27.683	155.314	0.544	554.313	5.49	-7.213
sugar	-46.028	-47.631	-11.9284	-8.073	-47.317	-44.644	-36.996	-45.888	-47.188	-46.746	-43.693	-43.774
ofd	-39.322	-37.271	-8.8279	30.1046	-37.469	-28.126	-37.63	-38.324	-33.328	-30.841	-32.747	-22.238
b_t	-21.428	-24.811	-9.4576	2.242	-22.37	13.974	-7.505	-2.145	-6.322	-5.135	-11.938	-31.19
trd	0	0	0	0	0	0	0	0	0	0	0	0
afs	-47.618	-46.79	13.8524	793.1944	-47.462	-46.271	-47.45	-44.491	-44.832	-45.643	-44.434	-30.817
ros	-38.895	-10.309	330.3192	-1.9012	-3.771	1.325	1.411	-46.672	-15.082	-22.023	-6.479	34.543
osg	-29.759	25.417	243.9939	0.6656	-15.039	89.383	5.271	-5.052	66.114	-25.698	0.41	138.062
edu	20.433	271.213	669.6829	21.7104	144.727	64.815	333.787	106.708	440.957	41.288	47.406	278.017
hht	-44.932	-32	312.3245	-0.8272	-36.974	12.948	-22.303	-40.925	-10.16	-39.704	-31.793	-2.048
whs	0	0	0	0	0	0	0	0	0	0	0	0
trans	0	0	0	0	0	0	0	0	0	0	0	0
coa	0	0	0	0	0	0	0	0	0	0	0	0
c_oil	0	0	0	0	0	0	0	0	0	0	0	0
gas	0	0	0	0	0	0	0	0	0	0	0	0
petro	0	0	0	0	0	0	0	0	0	0	0	0
chem	0	0	0	0	0	0	0	0	0	0	0	0
ely	0	0	0	0	0	0	0	0	0	0	0	0
othind	0	0	0	0	0	0	0	0	0	0	0	0
othsvcs	0	0	0	0	0	0	0	0	0	0	0	0

Supplementary figures

As figures reported in the main text hide regional variations due to a higher aggregation level, figures hereby reported expand the results provided in the main text, illustrating our findings at a regional level. The numeration of figures coincides with the numeration adopted in the main text. Additionally, we report supplementary figures (marked as "additional") related to our findings to allow for a better interpretation of our results.

1. **The impact of a healthy and sustainable diet on global FLW magnitude.**

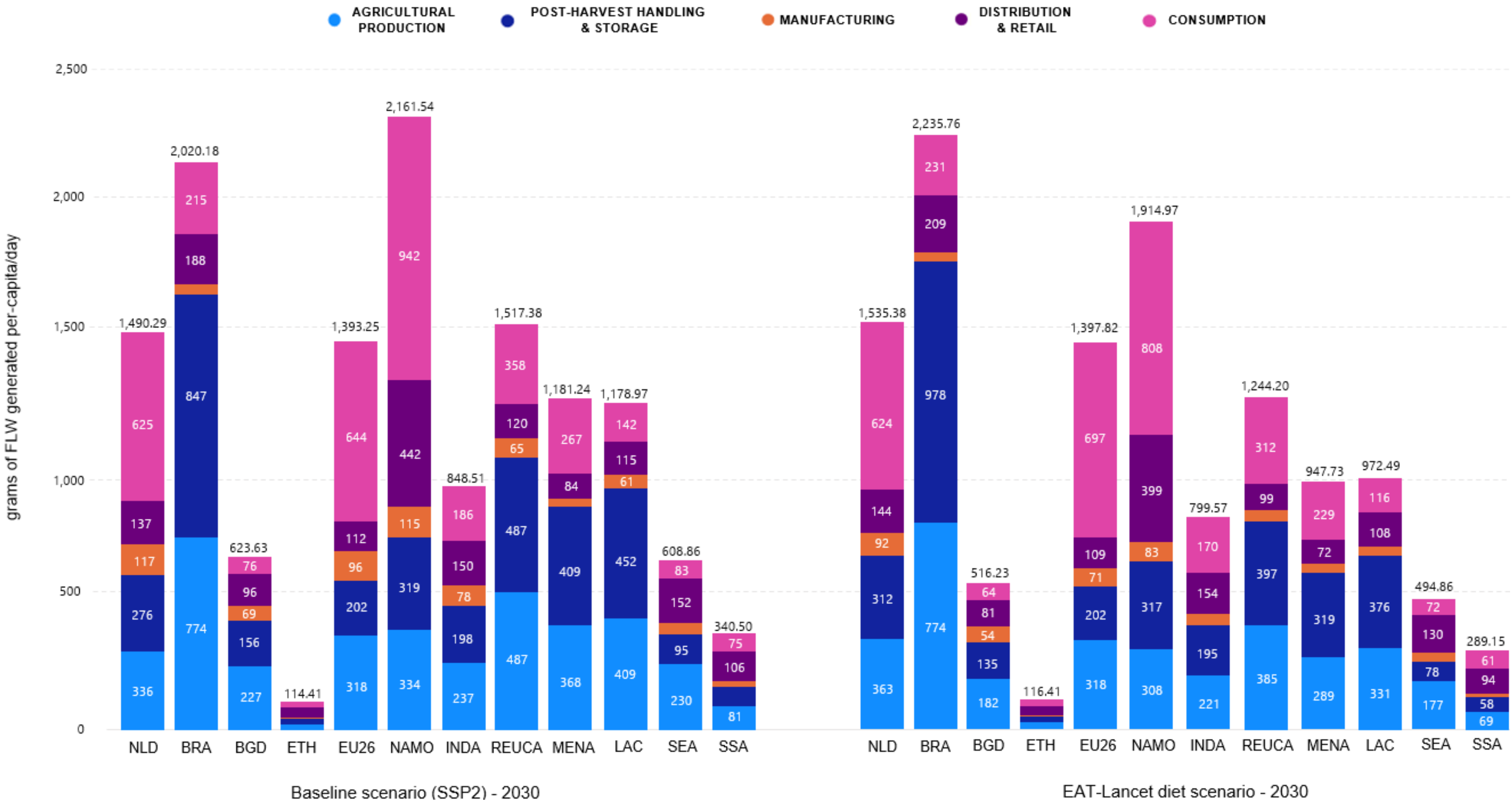

Figure 2. Grams of FLW generated per-capita/day along FSC stages in different regions (2030, by scenario). FLW amounts refer to total final consumption of food excluding biomass losses in non-food biomass use, including both domestic and FLW embedded in imported food. Note we attribute FLW in imports to the location of final consumption but depending on the FSC where FLW occurs the FLW may not be physically present in the location of final consumption.

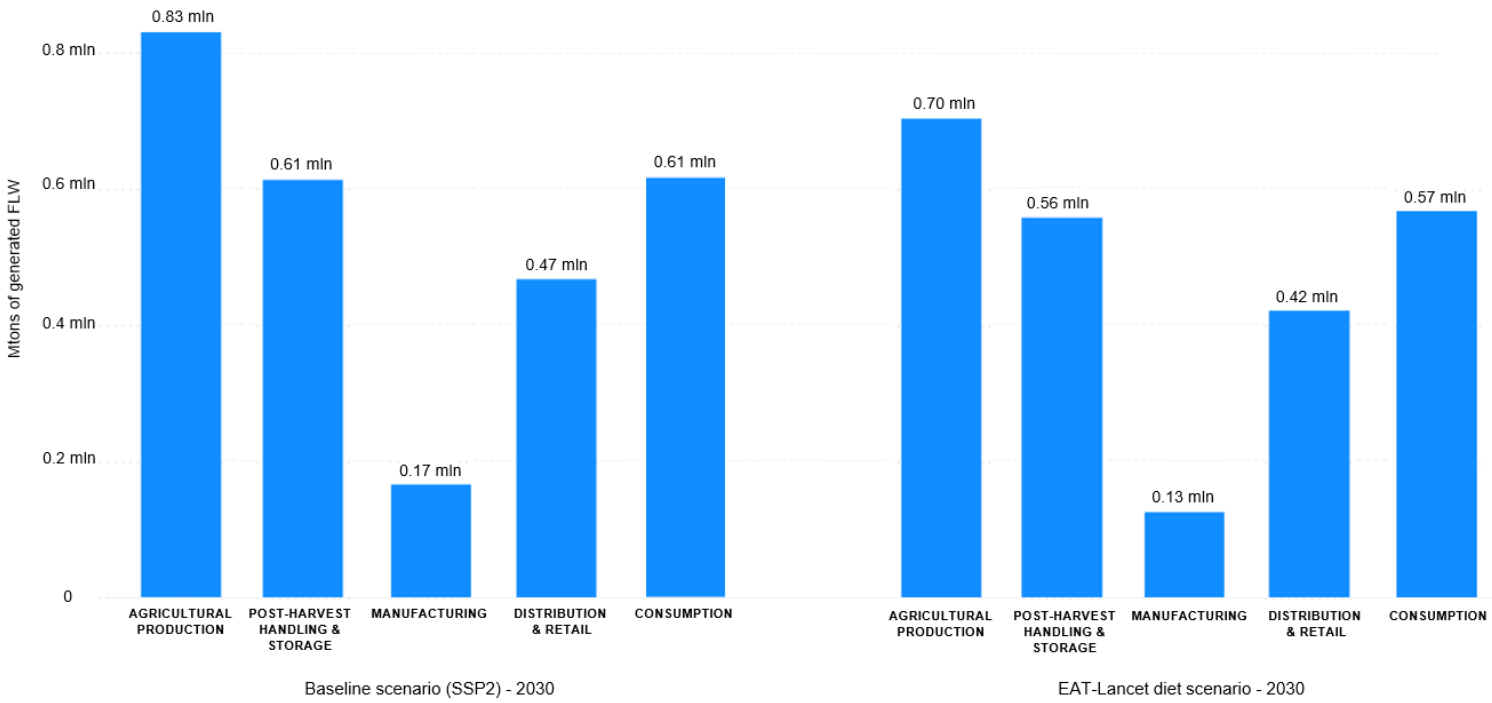

Figure 2 (additional). Mtons of globally generated FLW along each stage of the FSC (2030, by scenario). Estimates refer to the sum of Mtons of FLW generated in different global regions. Figure 2 (additional) illustrates the key global hotspots for FLW generation along global FSC. In the baseline scenario farm-level losses i.e. Agricultural Production and Post-Harvest Handling & Storage, and Consumption waste account for the largest shares of FLW. Similarly, shifting to the EAT-Lancet diet generates largest amounts of losses at primary production and waste at final consumption.

2. The impact of a healthy and sustainable diet on global FLW quality.

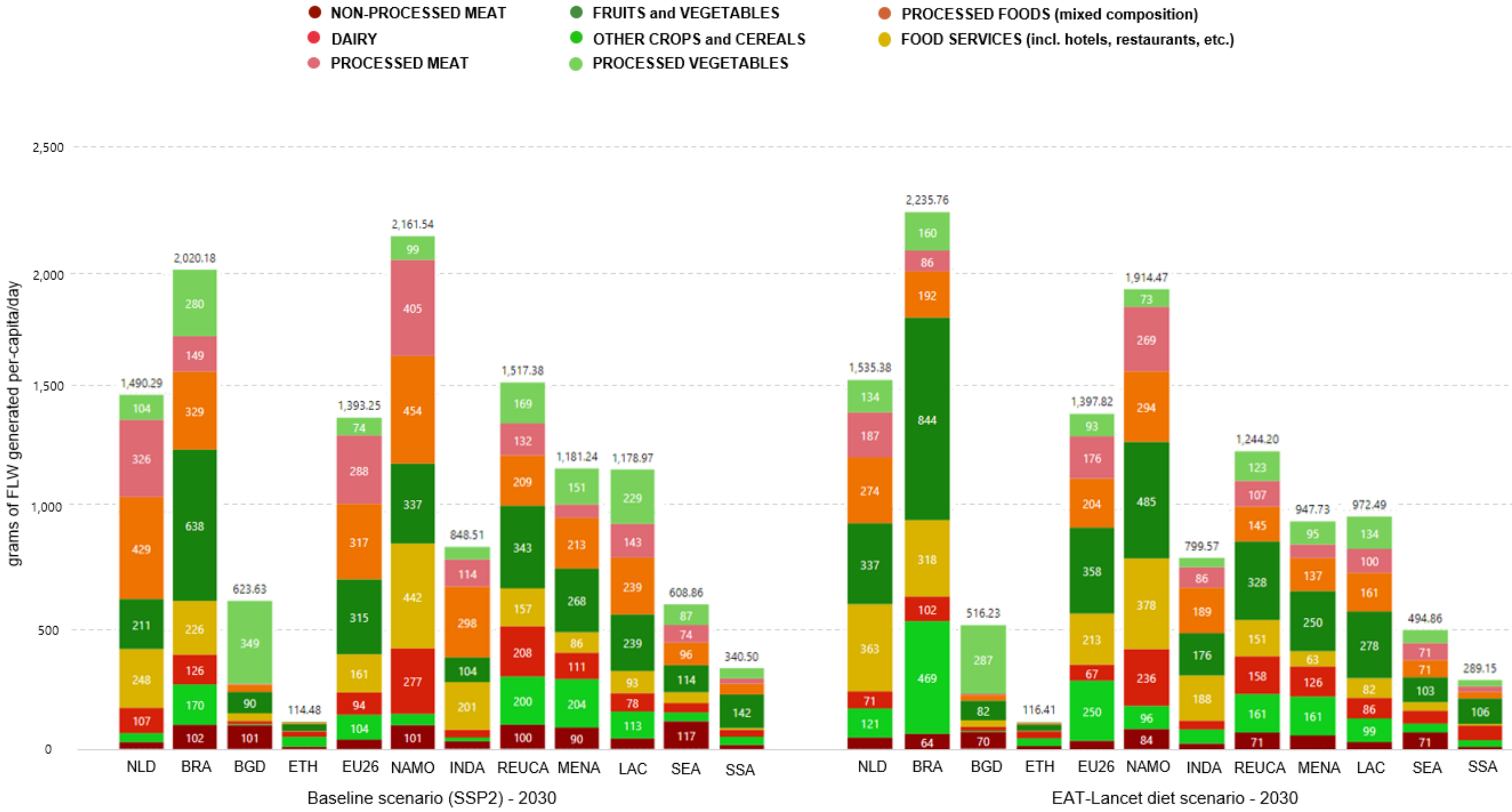

Figure 3. Composition of grams of FLW generated per-capita/day along FSC stages in different regions (2030, by scenario). FLW composition refers to different types of FLW generated by the final consumption of listed food products, domestically or embedded in imports.

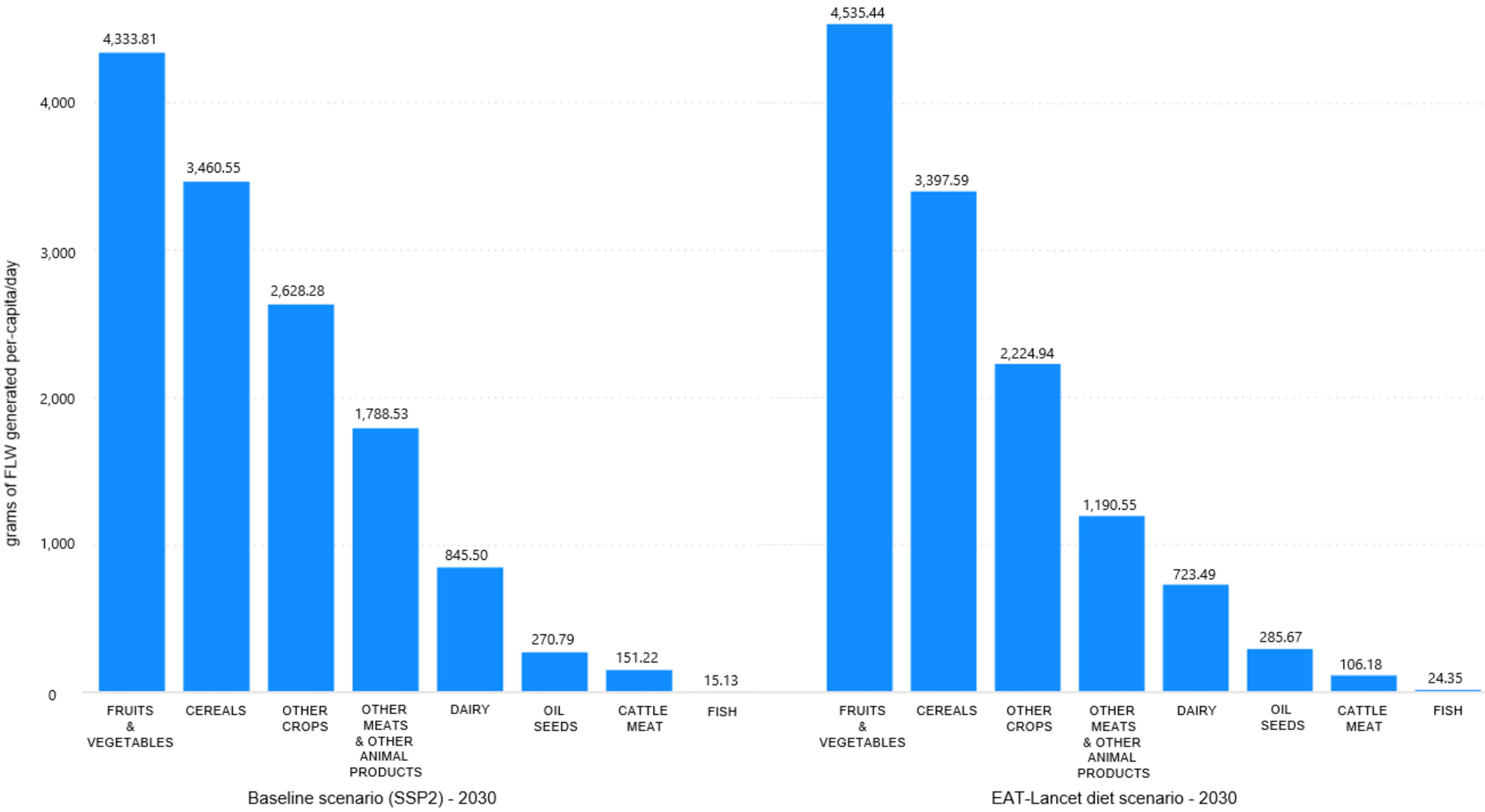

Figure 3 (additional). Primary equivalent composition of grams of FLW generated per-capita/day (2030, by scenario). Estimates refer to the sum of grams of FLW generated in all regions along global FSC. Fruit & vegetables associate with highest shares of FLW per gram of commodity produced and consumed, resulting in largest amounts of total FLW. As the EAT-Lancet diet is by design a plant-based food diet, the dietary transition enlarges total plant-based FLW, mainly decreasing ASF such as other meats & other animal products, dairy and cattle meat. Nonetheless, FLW of crops and cereals decrease as well, reflecting current consumption of such commodities above the EAT-Lancet dietary recommendations.

3. The impact of a healthy and sustainable diet on global FLW location.

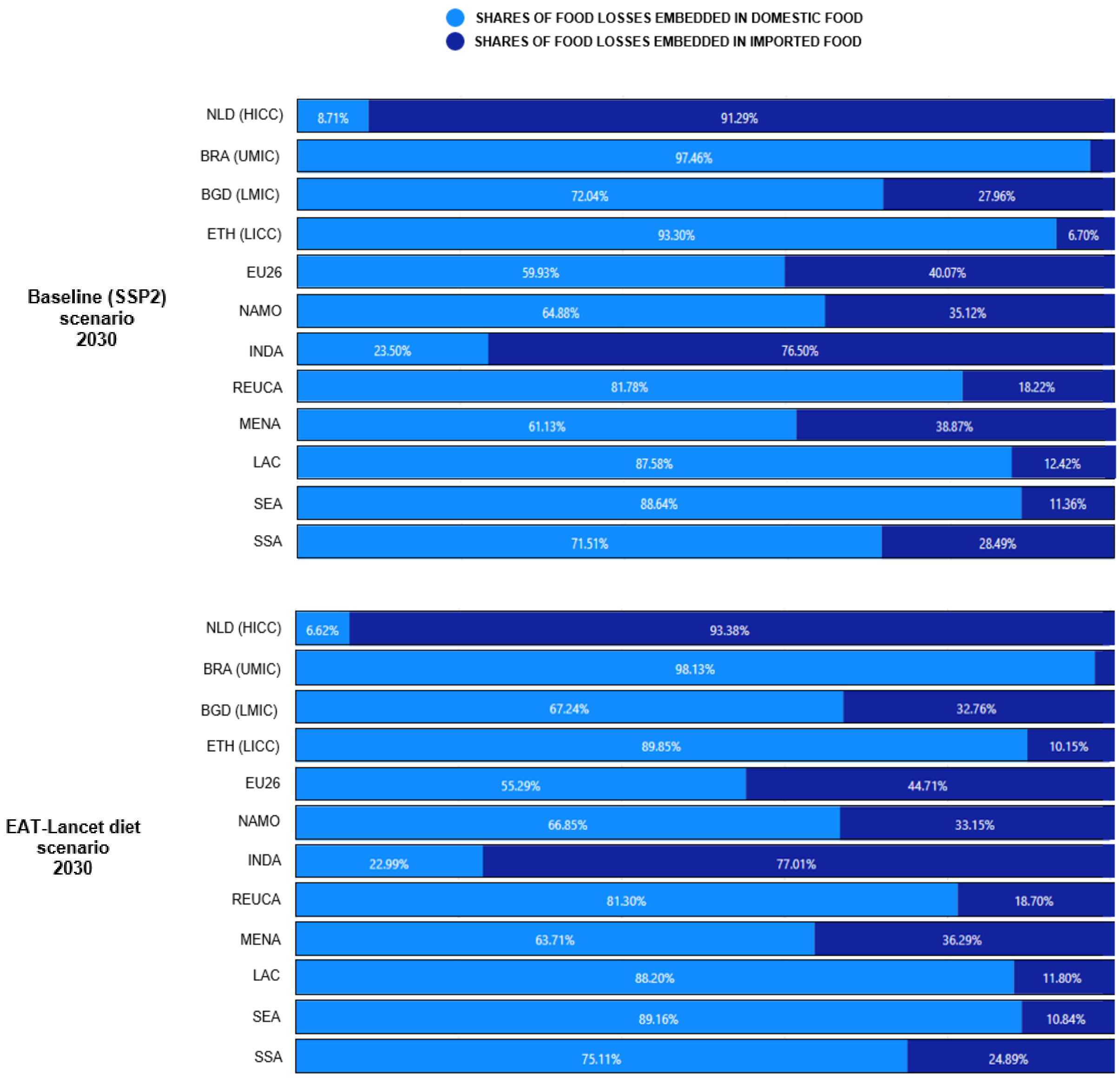

Figure 4.1 (additional). Shares of source of grams of food losses (excl. consumption waste) generated per-capita/day in different regions (2030, by scenario). Amounts refer to the share of the source of food losses generation, indicating if losses are generated from domestically produced food products (i.e. all stages from farm to fork are in the same region), or from products that have been imported at one or more stages of the FSC and then consumed domestically. From figure 4.1 (additional) is possible to observe that transitioning to the EAT-Lancet diet affects the source shares of generated losses mainly in high-income regions such as the Netherlands, Europe-26, and Industrialised Asia. This is mainly due to increasing imports of plant-based foods, generating farm-level losses in exporting low- and mid-income regions. For this, shares of losses generated domestically simultaneously increase in major plant-based food exporters such as South-East Asia, Latin America & Caribbean and Sub-Saharan Africa.

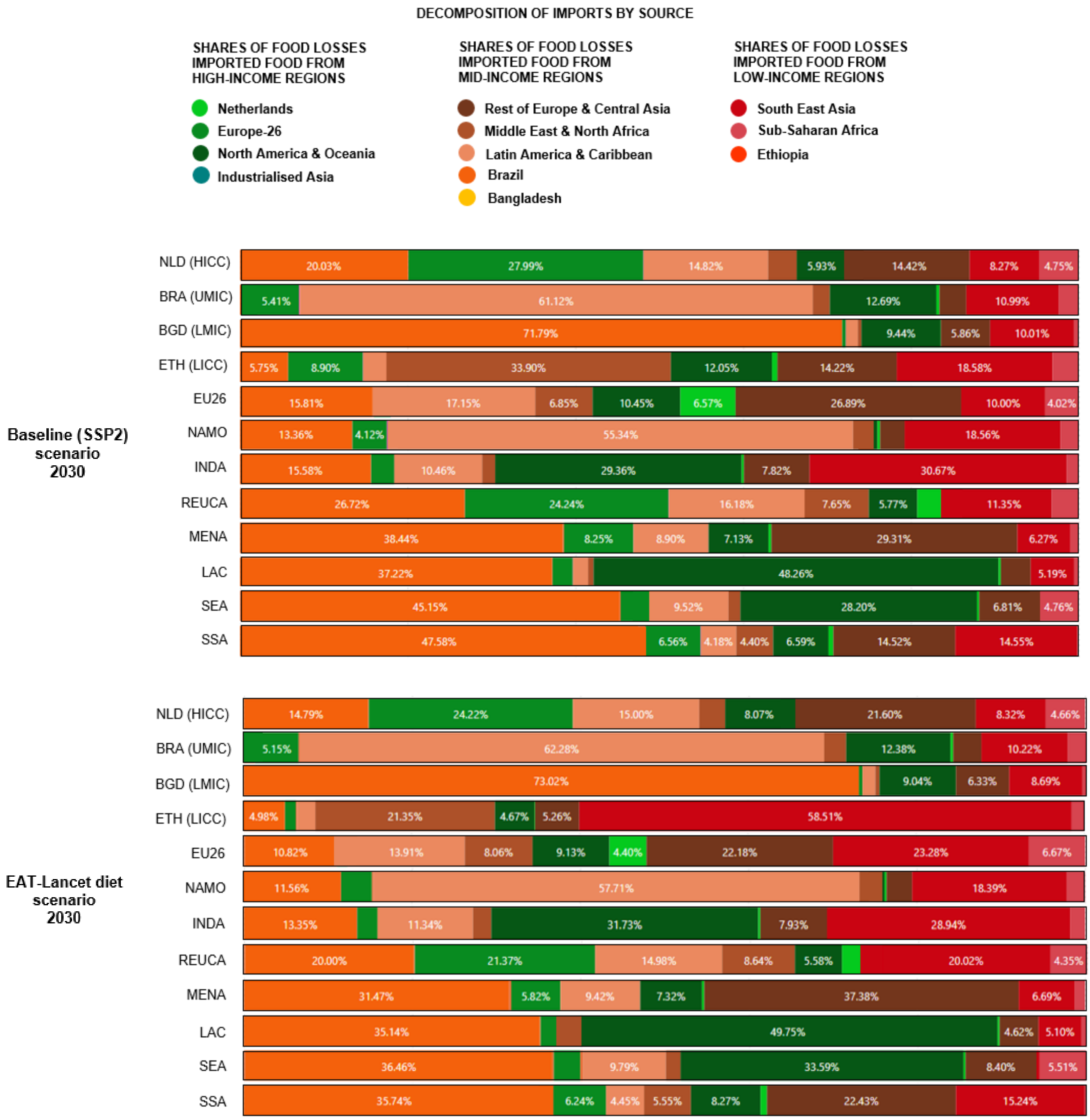

Figure 4.2 (additional). Regional source shares of food losses (excl. consumption waste) generated per-capita/day embedded in imports in different regions (2030, by scenario). Amounts refer to food losses generated products that have been imported from the regions indicated in the legend at one or more stages of the FSC and then consumed domestically. Figure 4.2 (additional) decomposes the imports shares reported in figure 4.1 (additional), illustrating regional sources of imports. High-income regions such as the Netherlands, Europe-26, and North America & Oceania, partially decrease trade among themselves, increasing shares of import-embedded losses in Latin America & Caribbean and South East Asia. Similarly, low-income regions such as Sub-Saharan Africa or Ethiopia increase shares of import-embedded losses from South East Asia, while mid-income regions such Middle East & North Africa increase shares of import-embedded losses from Rest of Europe & Central Asia.

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