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PISA AGRICULTURAL ECONOMICS
Food and rural studies for sustainability

UNIVERSITÀ DI PISA

Food waste, food loss and new bio-economy models

Gianluca Brunori

The problem

SCIENCE ADVANCES | RESEARCH ARTICLE

ENVIRONMENTAL STUDIES

Earth beyond six of nine planetary boundaries

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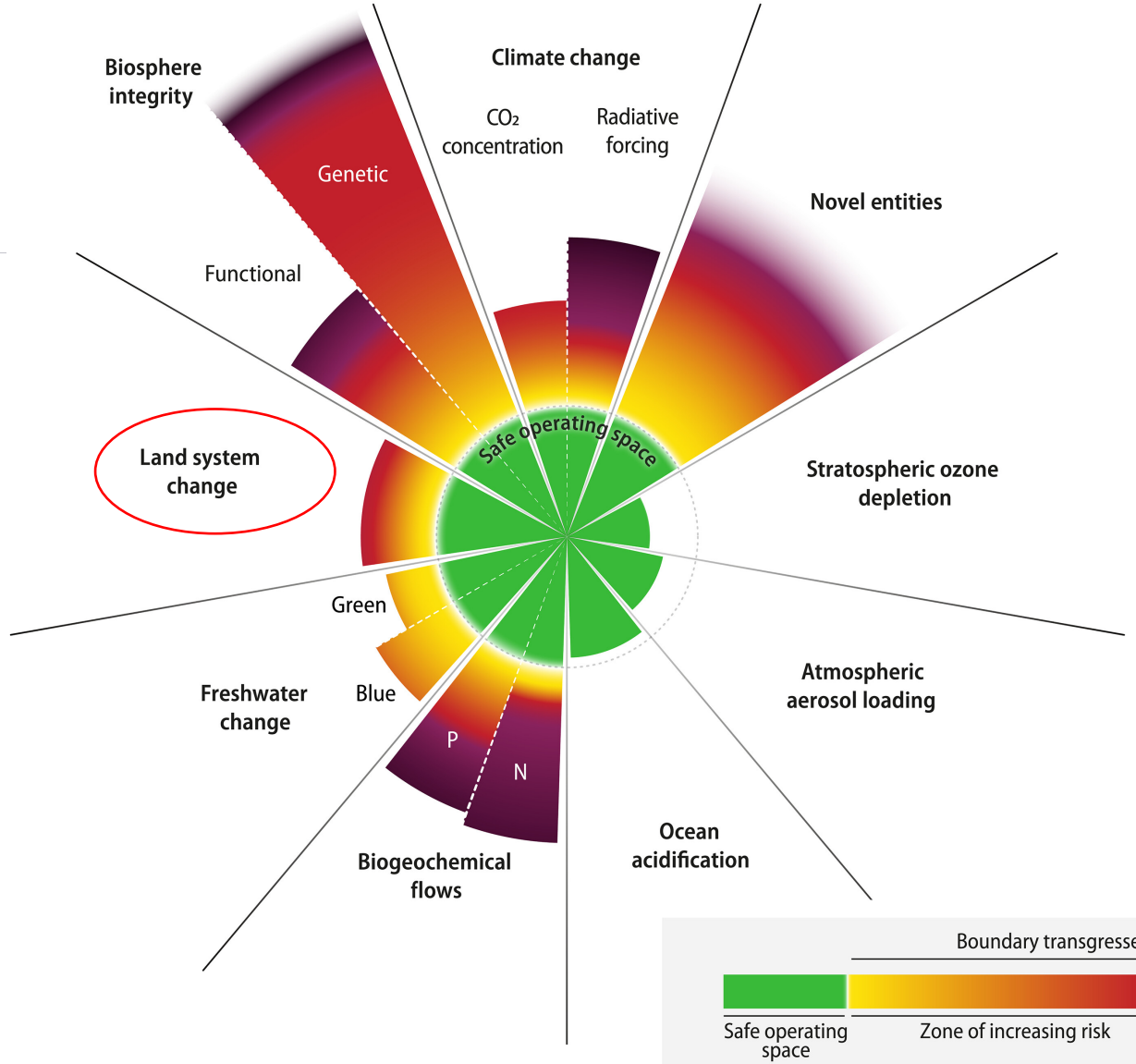
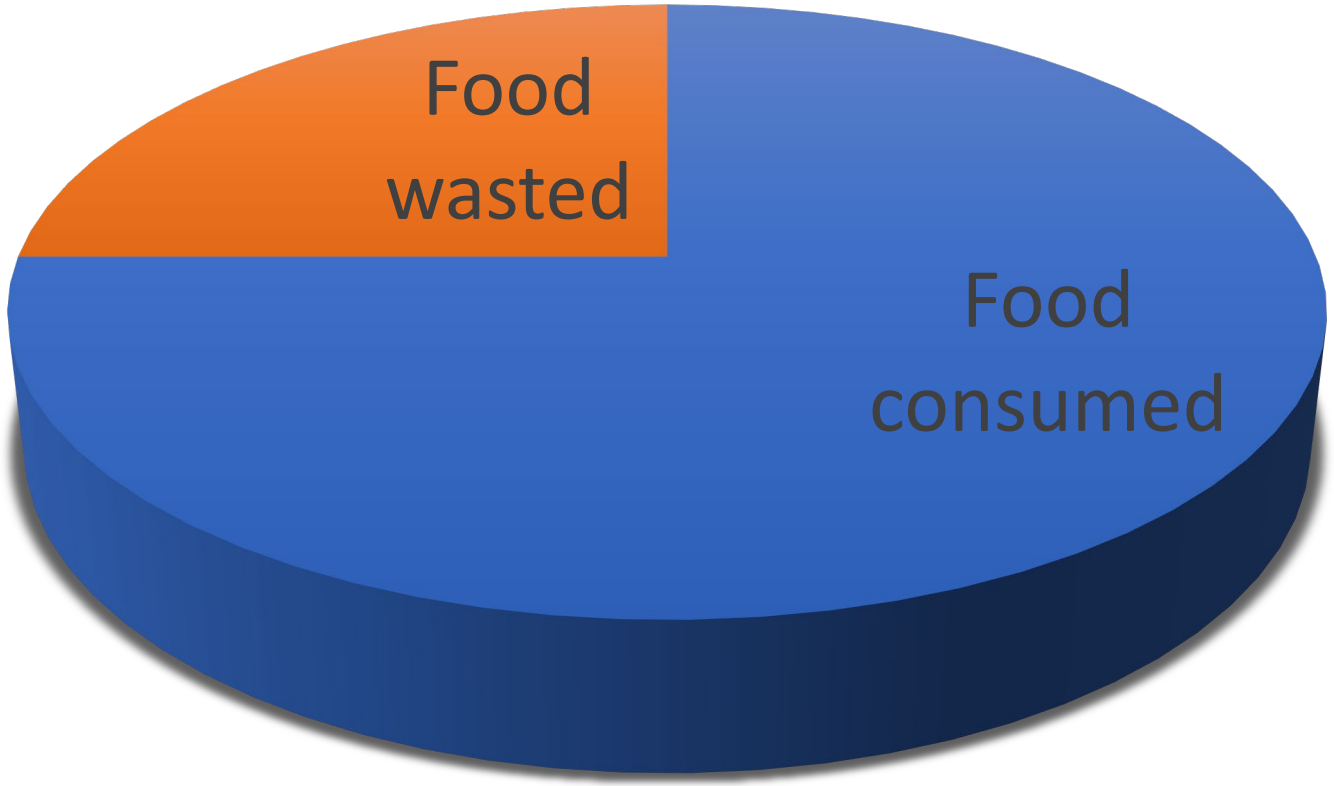
This planetary boundaries framework update finds that six of the nine boundaries are transgressed, suggesting that Earth is now well outside of the safe operating space for humanity. Ocean acidification is close to being breached, while aerosol loading regionally exceeds the boundary. Stratospheric ozone levels have slightly recovered. The transgression level has increased for all boundaries earlier identified as overstepped. As primary production drives Earth system biosphere functions, human appropriation of net primary production is proposed as a control variable for functional biosphere integrity. This boundary is also transgressed. Earth system modeling of different levels of the transgression of the climate and land system change boundaries illustrates that these anthropogenic impacts on Earth system must be considered in a systemic context.

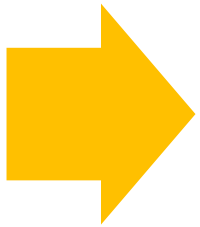


The context



The solution

Less food wasted



Less pressure on land

What is waste?

Loss: biomass that does not reach the final user

Residue: what is left after a transformation or a transaction

Waste: biomass that loses value because it is not used

Where is food waste generated?

At farm level

Box 3. Snapshot case: poor post-harvest facilities

©FAO / V. MAXIMOV

Lack of facilities for rice threshing, drying and winnowing, Tajikistan

A farmer winnowing rice in Tursunzade, Tajikistan in 2010. Sun drying exposes rice to rodents and parasites, which may eat or damage the harvested crops. Proper storage facilities are also important in order to reduce the amounts of food lost during post-harvest handling and storage.

Along the supply chain

Box 4. Snapshot case: food safety at risk

Rickshaws transporting milk in Bangladesh
Rickshaws transporting milk from the countryside to processing plants in Baghabarighat, Bangladesh. Transporting milk in the warm and humid climate of Bangladesh without a proper cold chain may cause milk losses. The rickshaw transportation on narrow and winding roads prolongs the time milk is handled in warm temperatures.

Source: FAO

Before selling

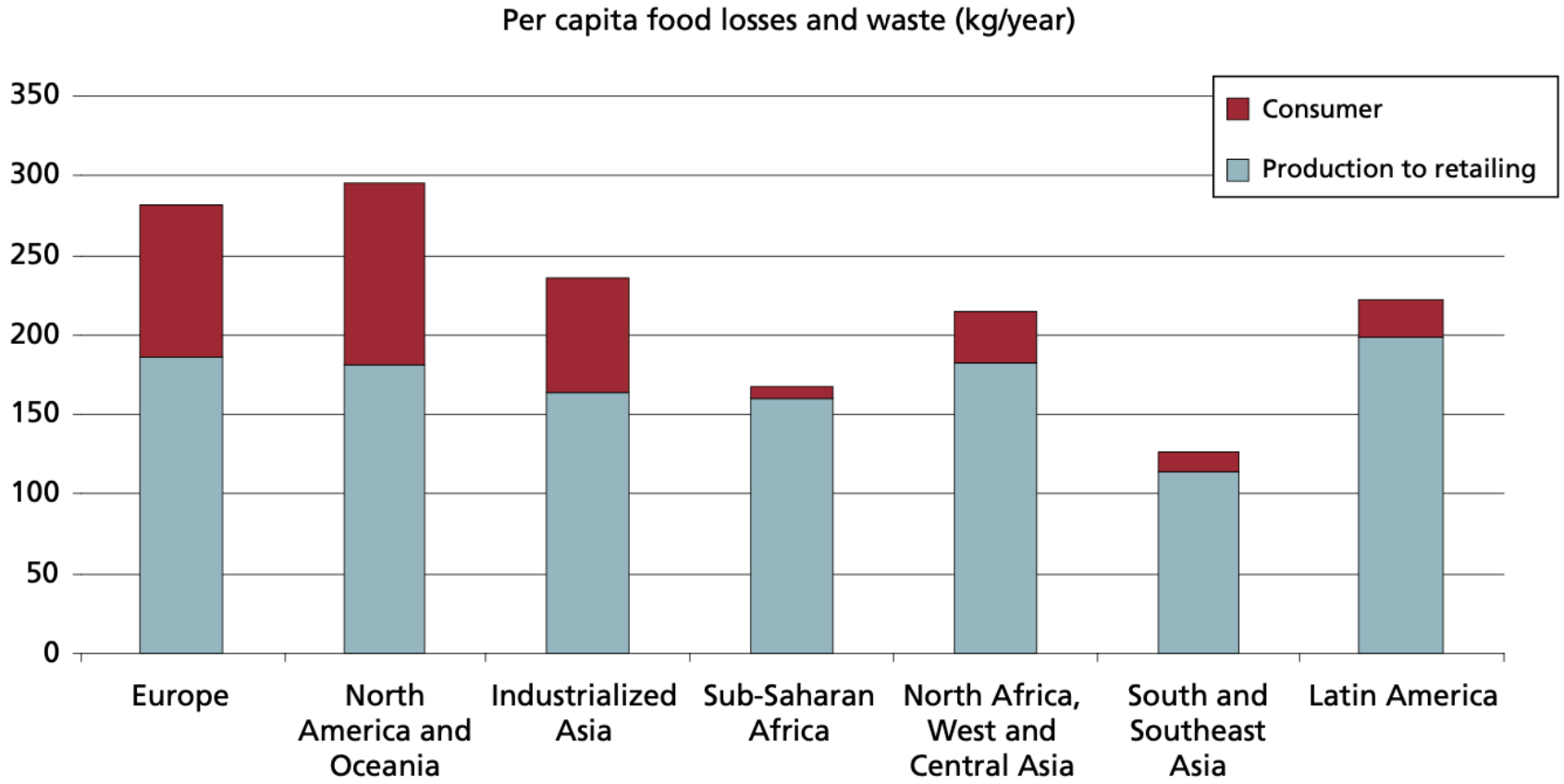
At the selling point

Unsold stock

At consumption level

Different waste patterns in the world

Figure 2. Per capita food losses and waste, at consumption and pre-consumptions stages, in different regions

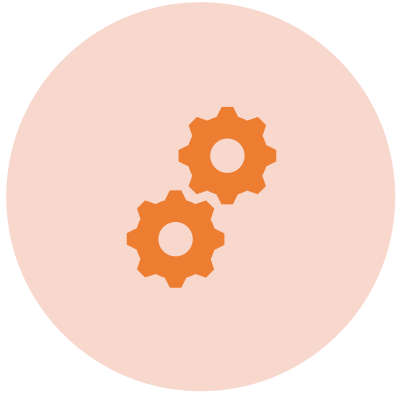


Drivers of waste generation

- **Technological**: infrastructures, equipment, bioprocessing technologies
- **Regulatory**: constraints and incentives to reduce, reuse and recycle
- **Economic**: prices, costs
- **Social**: perception of value, patterns of daily life

Technology drivers of waste reduction

EQUIPMENT AND INFRASTRUCTURES



INFORMATION MANAGEMENT

BIOPROCESSING TECHNOLOGIES

Sustainable technologies

Promethean Power Systems

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Monitoring waste

Photographic software recognizes waste within disposal bins, ascertaining its weight

Monitoring quality

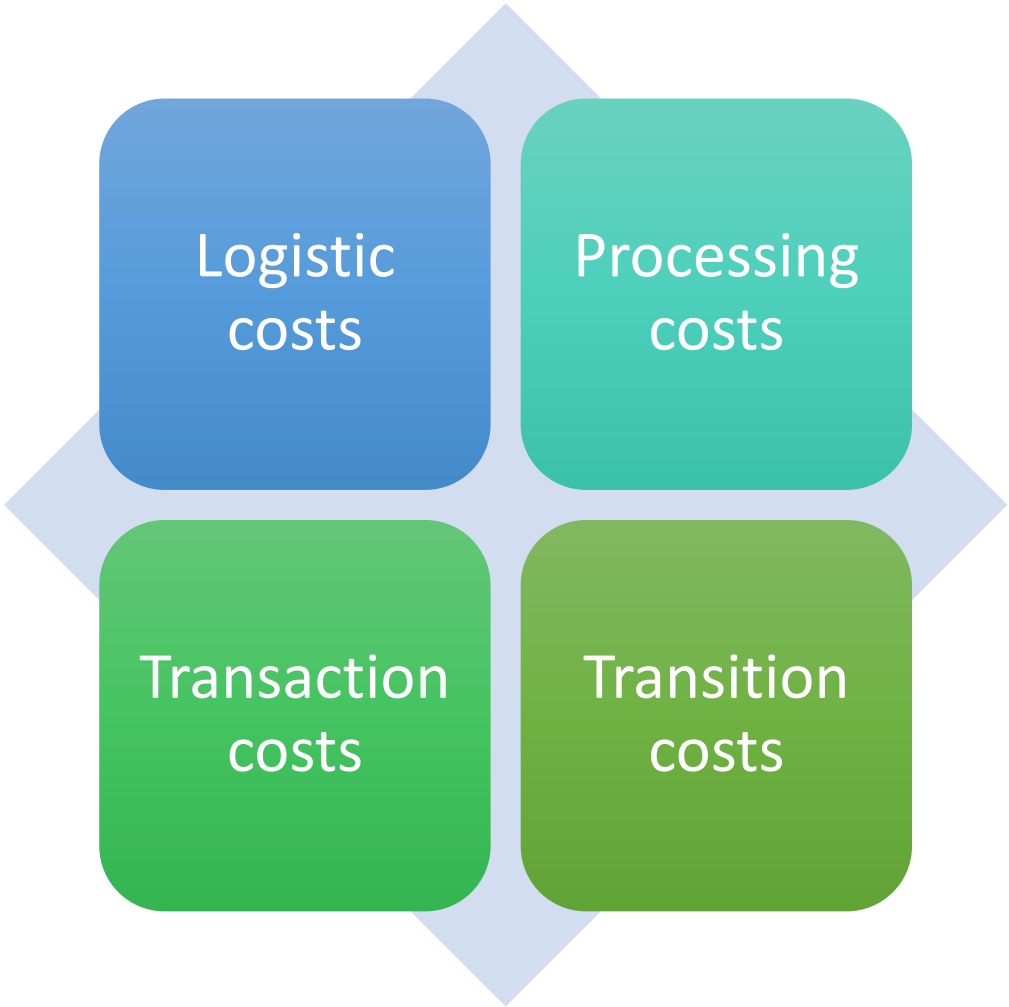
Hyperspectral imaginng to assess the freshness, quality, and longevity of food products.

Maximize reusing

- Analysis of unsold stock
- Matching supply and demand of residues

Extracting biovalue

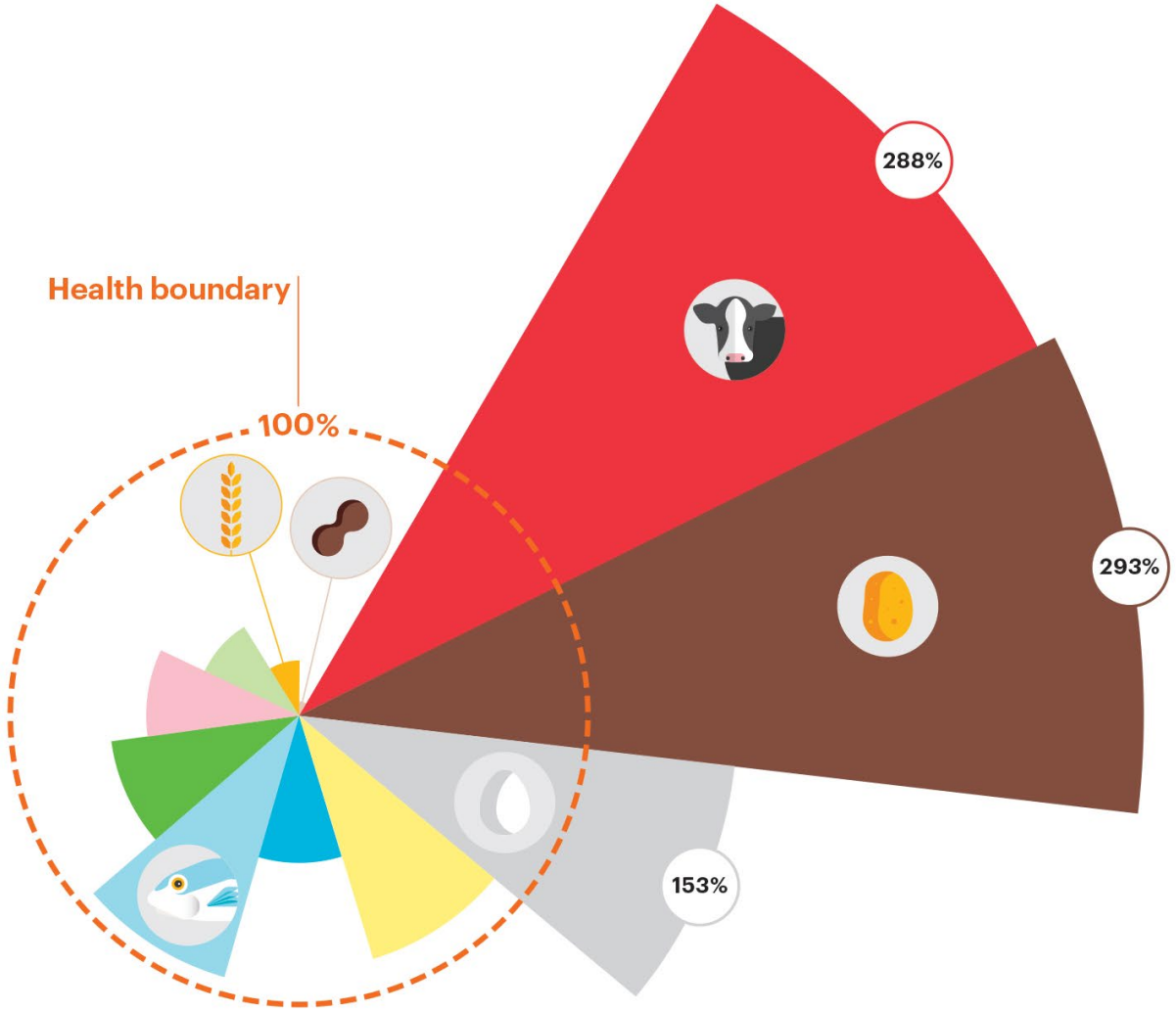
Economic drivers



Social drivers: perception of value

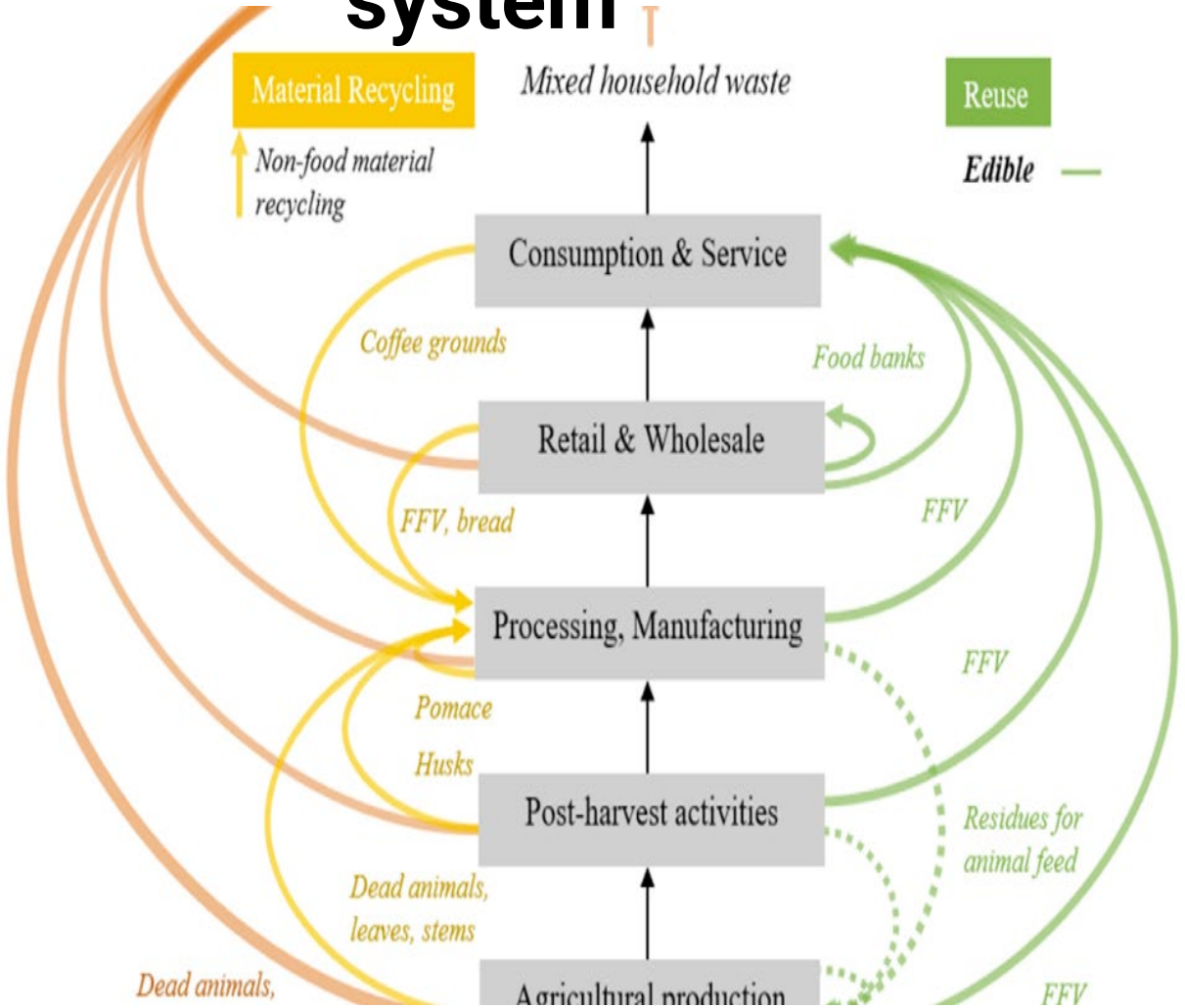
Overnutrition as waste?

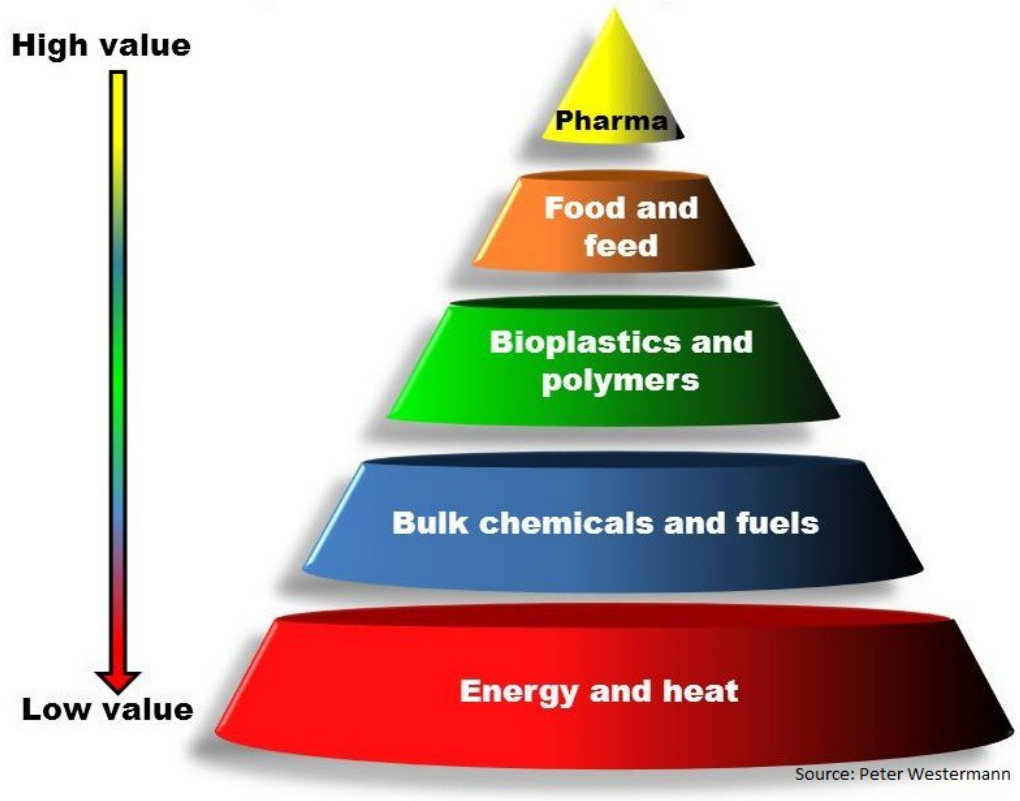
Global



Eat-Lancet report

The solution: redesigning the system





Science of the Total Environment 706 (2020) 136033

Thank you!

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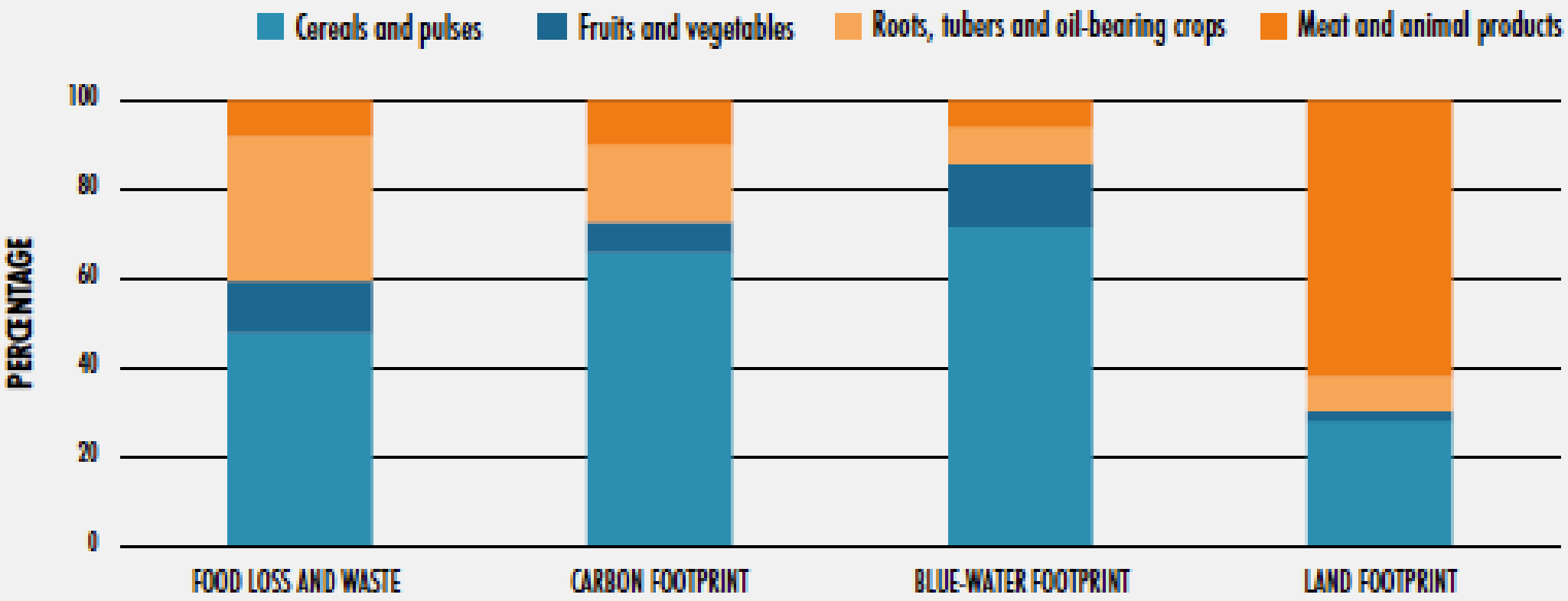
FIGURE 13

RELATIVE CONTRIBUTIONS OF THE MAIN FOOD GROUPS TO OVERALL FOOD LOSS AND WASTE AND THEIR CARBON, BLUE-WATER AND LAND FOOTPRINTS



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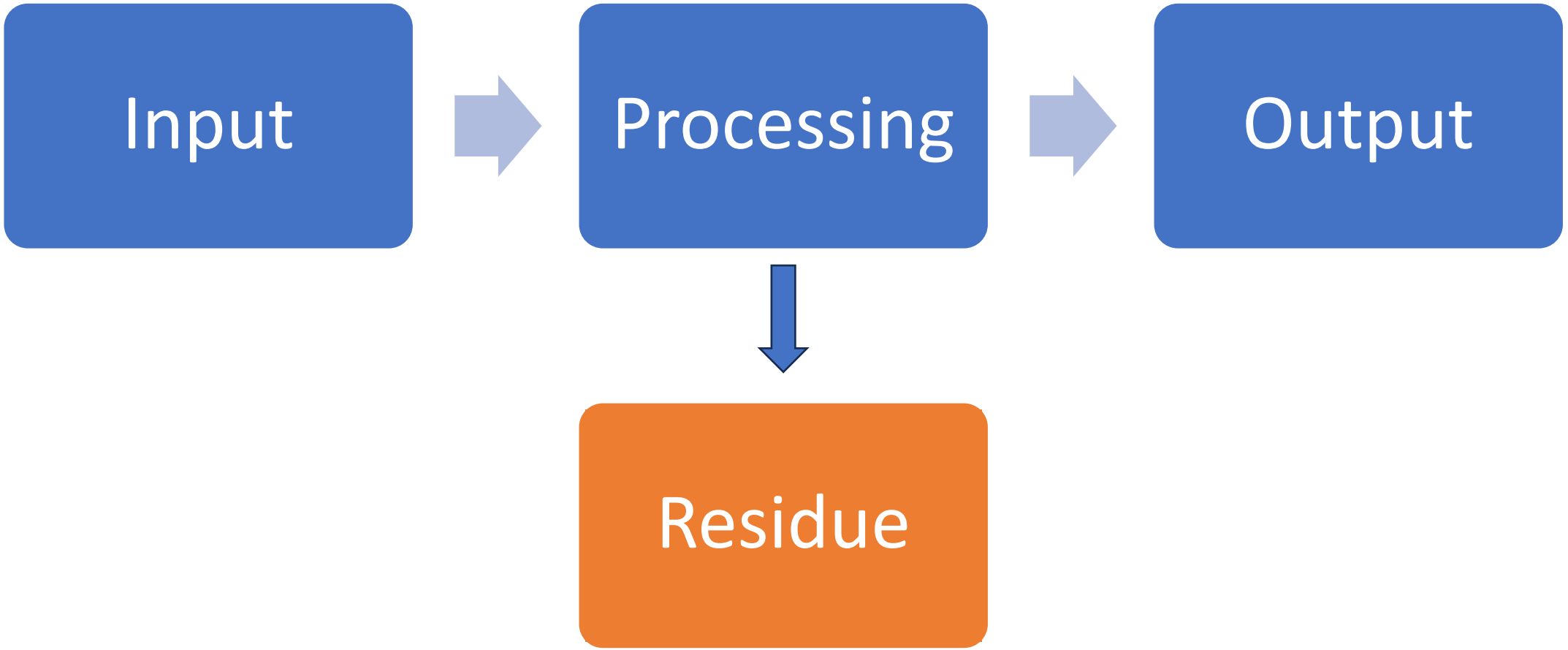
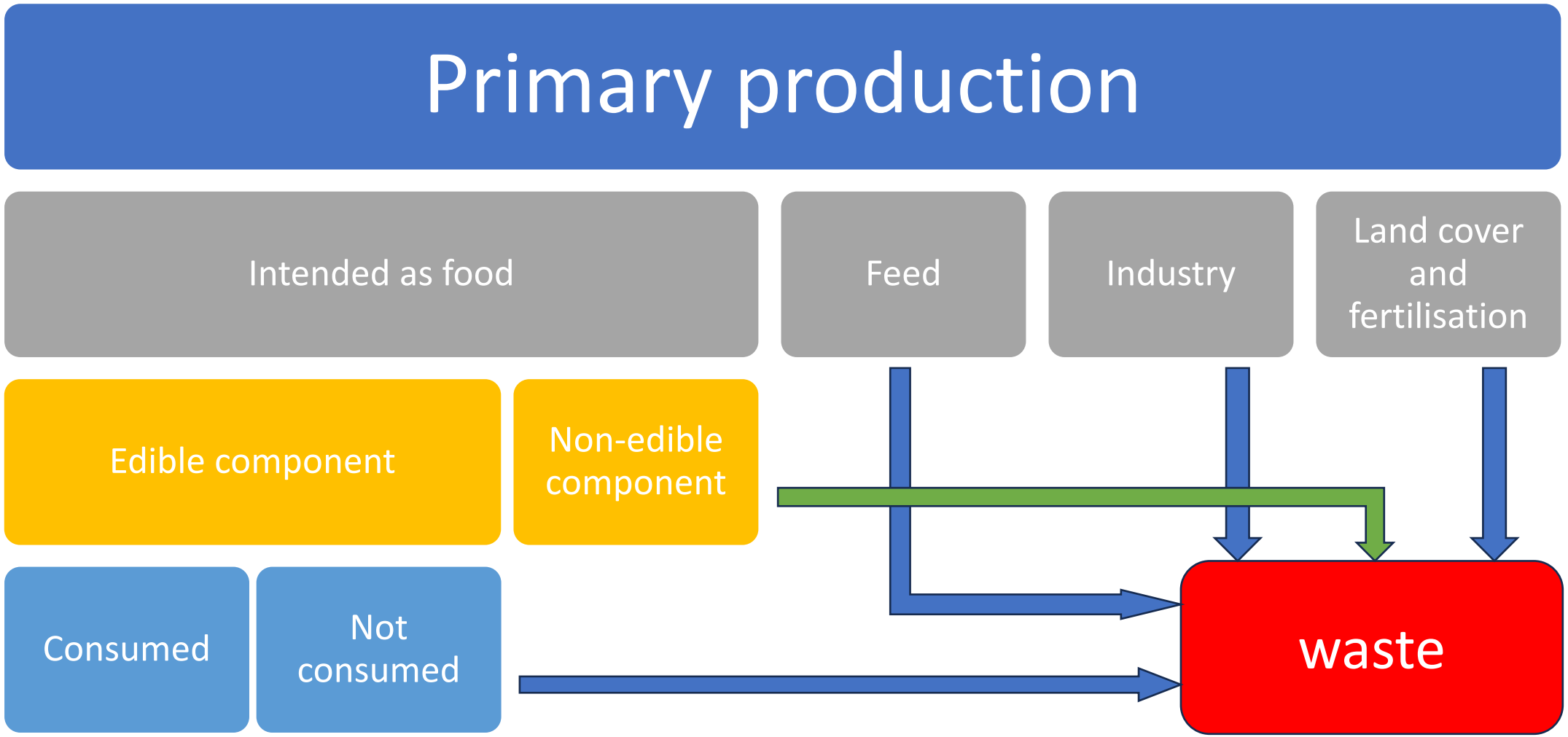
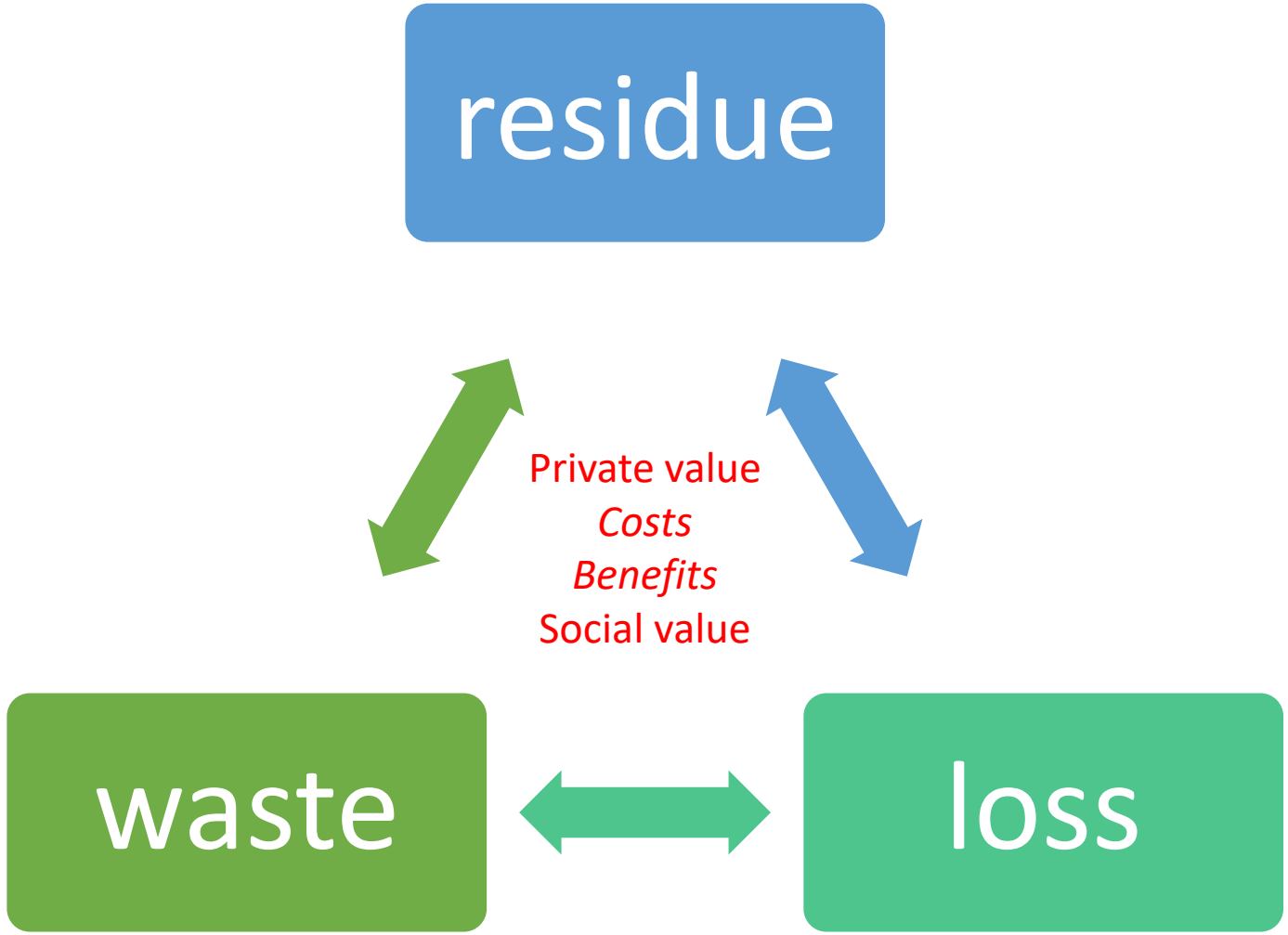
Residue: the oucome of processing



Components of waste



The proportion between waste, residue, and loss is linked to valu



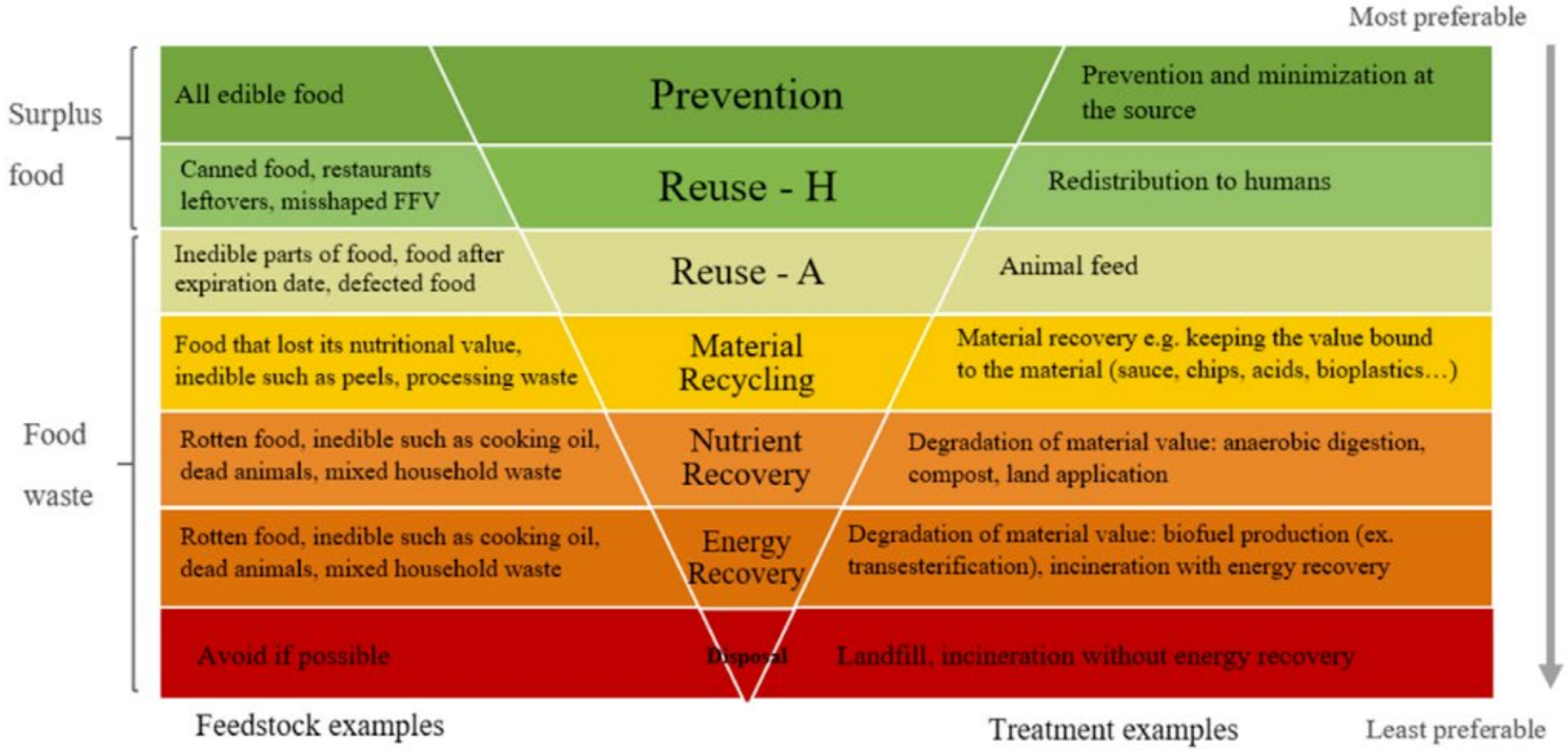
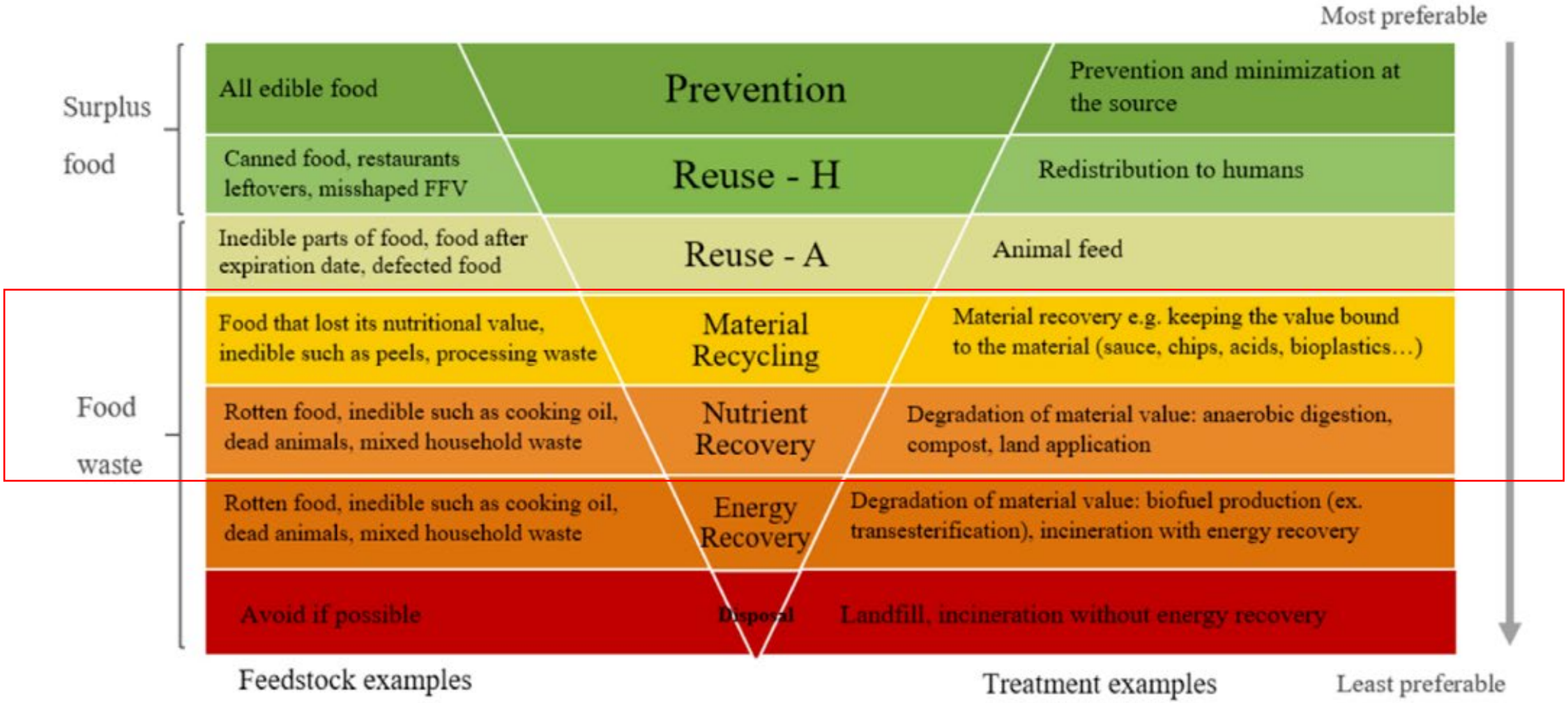


Fig. 1. Updated hierarchy for food surplus and waste proposed herein building on terminology from major European and national projects (UNEP, 2014; WRAP, 2013; FUSIONS: Östergren et al., 2014). *FFV fresh fruits and vegetables.



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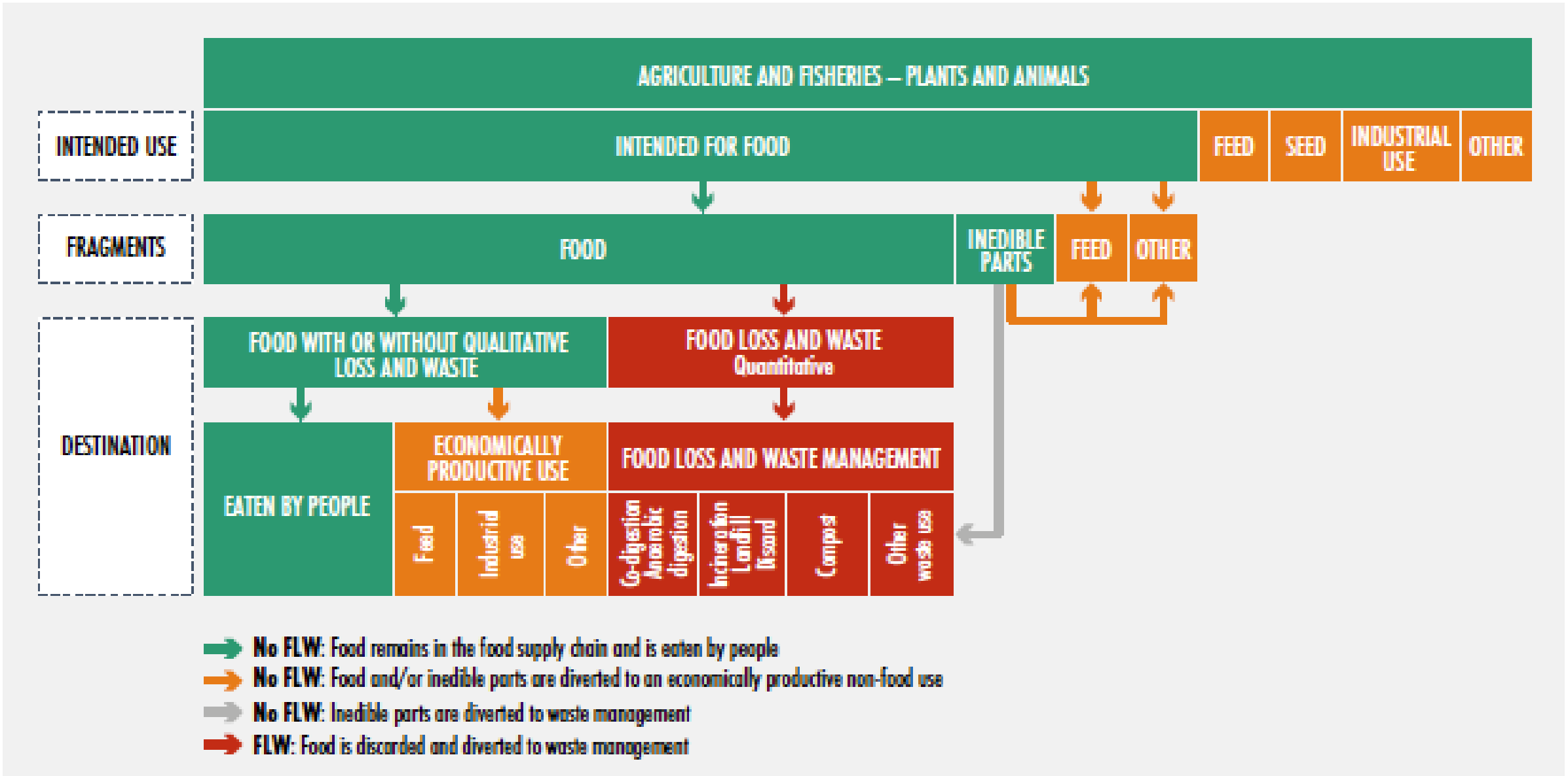

AGRICULTURE AND FISHERIES – PLANTS AND ANIMALS
INTENDED USE
INTENDED FOR FOOD
FEED
SEED
INDUSTRIAL USE
OTHER
FRAGMENTS
FOOD
INEDIBLE PARTS
FEED
OTHER
DESTINATION
FOOD WITH OR WITHOUT QUALITATIVE LOSS AND WASTE
FOOD LOSS AND WASTE Quantitative
EATEN BY PEOPLE
ECONOMICALLY PRODUCTIVE USE
FOOD LOSS AND WASTE MANAGEMENT
Feed
Industrial use
Other
Co-digestion Anaerobic digestion
Incineration Landfill Disposal
Compost
Other waste use
No FLW: Food remains in the food supply chain and is eaten by people
No FLW: Food and/or inedible parts are diverted to an economically productive non-food use
No FLW: Inedible parts are diverted to waste management
FLW: Food is discarded and diverted to waste management

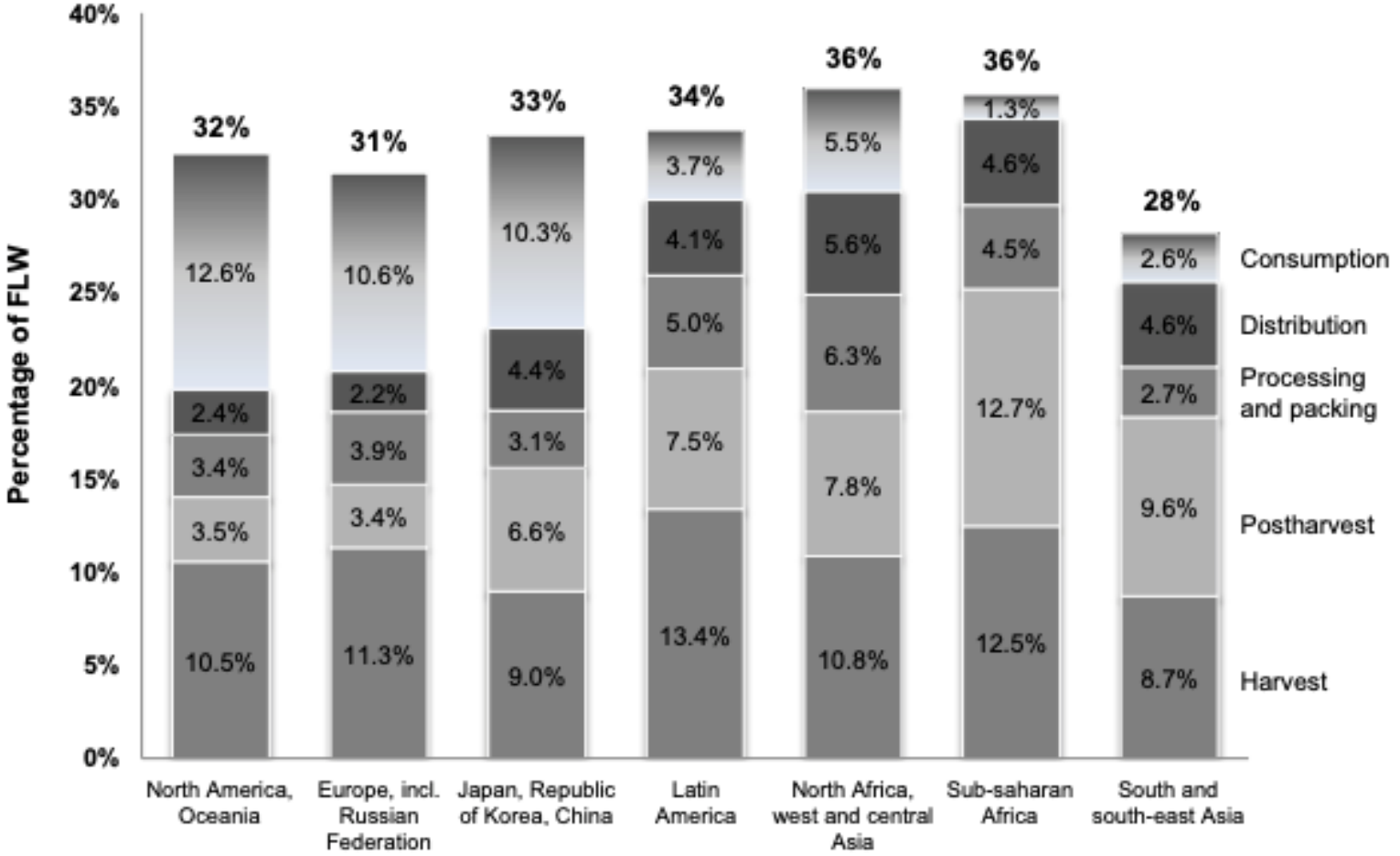
Box 6. Snapshot case: poor market facilities

Central wholesale market in Pakistan

Central wholesale market in Lahore, Pakistan. These bananas are traded among unsanitary conditions, causing major health hazards since food is handled and piled on the ground close to the gutter. This kind of market environment also causes food waste, since the unsanitary conditions and rough handling cause deterioration of fragile fresh products.

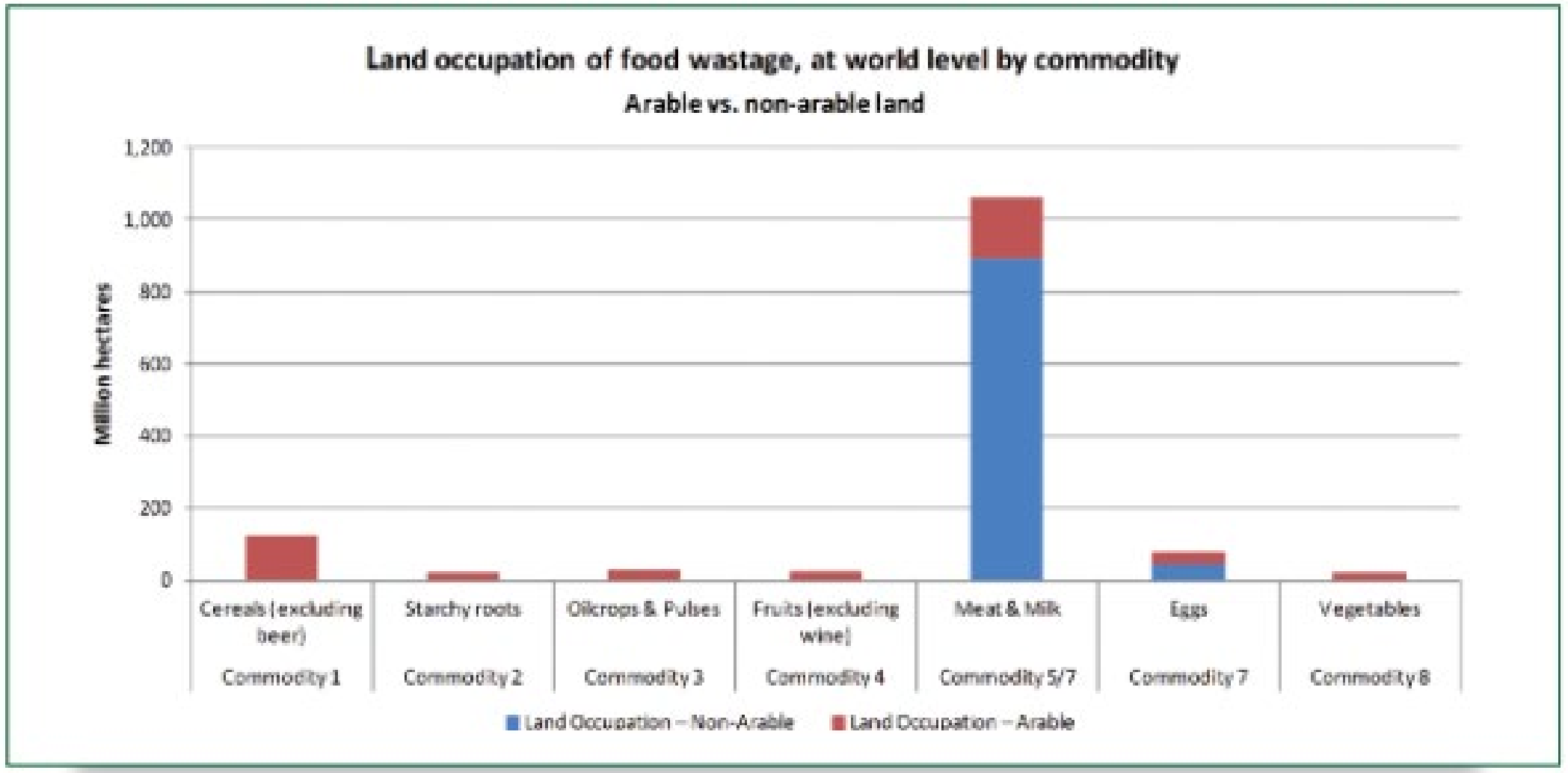

860kg CO_2
810kg CO_2
680kg CO_2
540kg CO_2
350kg CO_2
350kg CO_2
210kg CO_2
North America and Oceania
Industralized Asia
Europe
Latin America
North Africa, Western Asia and Central Asia
South and Southeast Asia
SubSaharan Africa

Figure 3 Distribution of FLW along the food chain in the different world regions



The bars represent the percentages lost or wasted at each step of the chain, expressed in percentage of the initial production (edible part originally intended for human consumption, see Figure. 1). Source: elaborated from Gustavsson et al. *(FAO, 2011a).*

Figure 26: Land occupation of food wastage, at world level by commodity arable land vs. non-arable land



https://www.fao.org/3/i3347e/i3347e.pdf

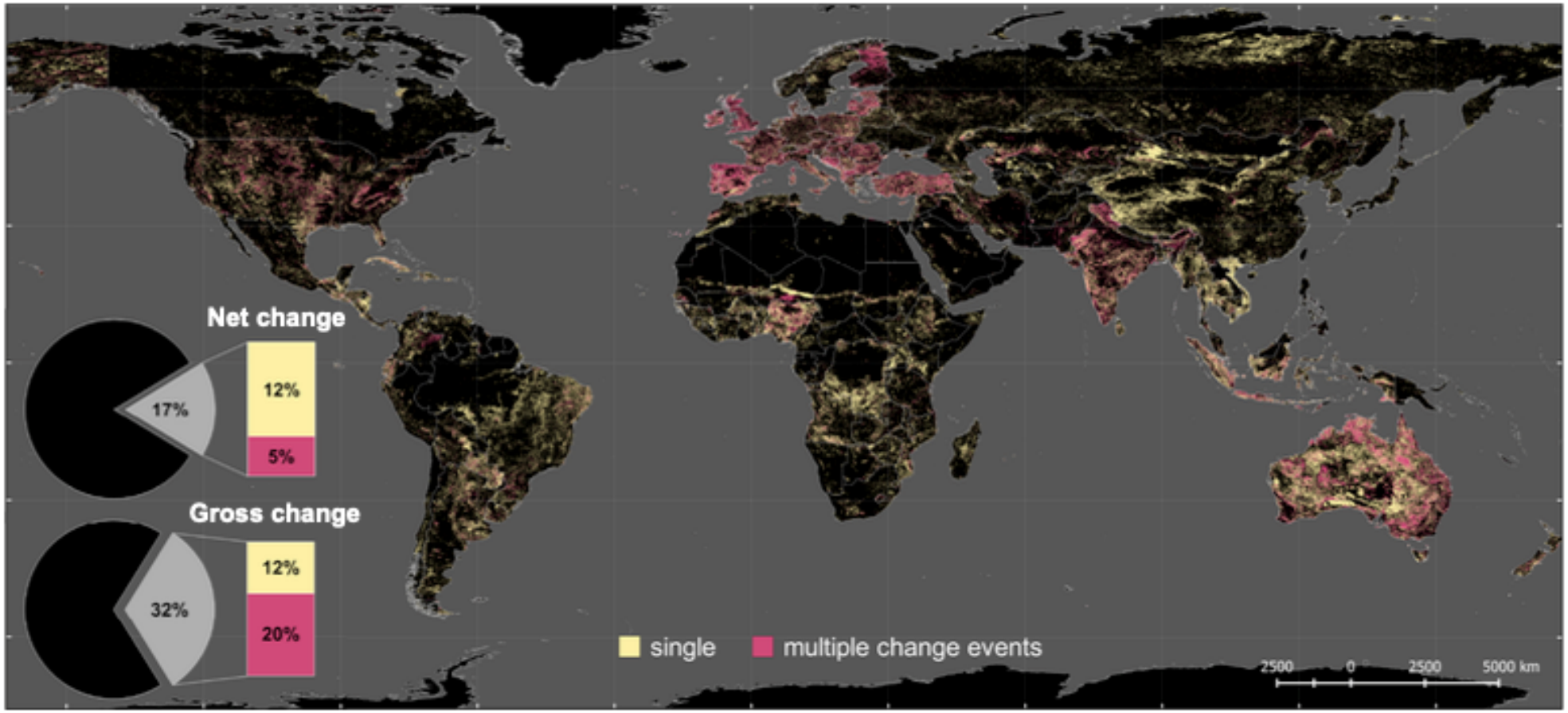


Fig. 1 Spatial extent of global land use/cover change. Share of the total land surface without (net change) and with consideration of multiple changes (gross change) between six major land use/cover categories (urban area, cropland, pasture/rangeland, forest, unmanaged grass/shrubland, non-/sparsely vegetated land) in 1960–2019. The spatial extent of land use/cover change is displayed in yellow (areas with single change events) and red (areas with multiple change events).

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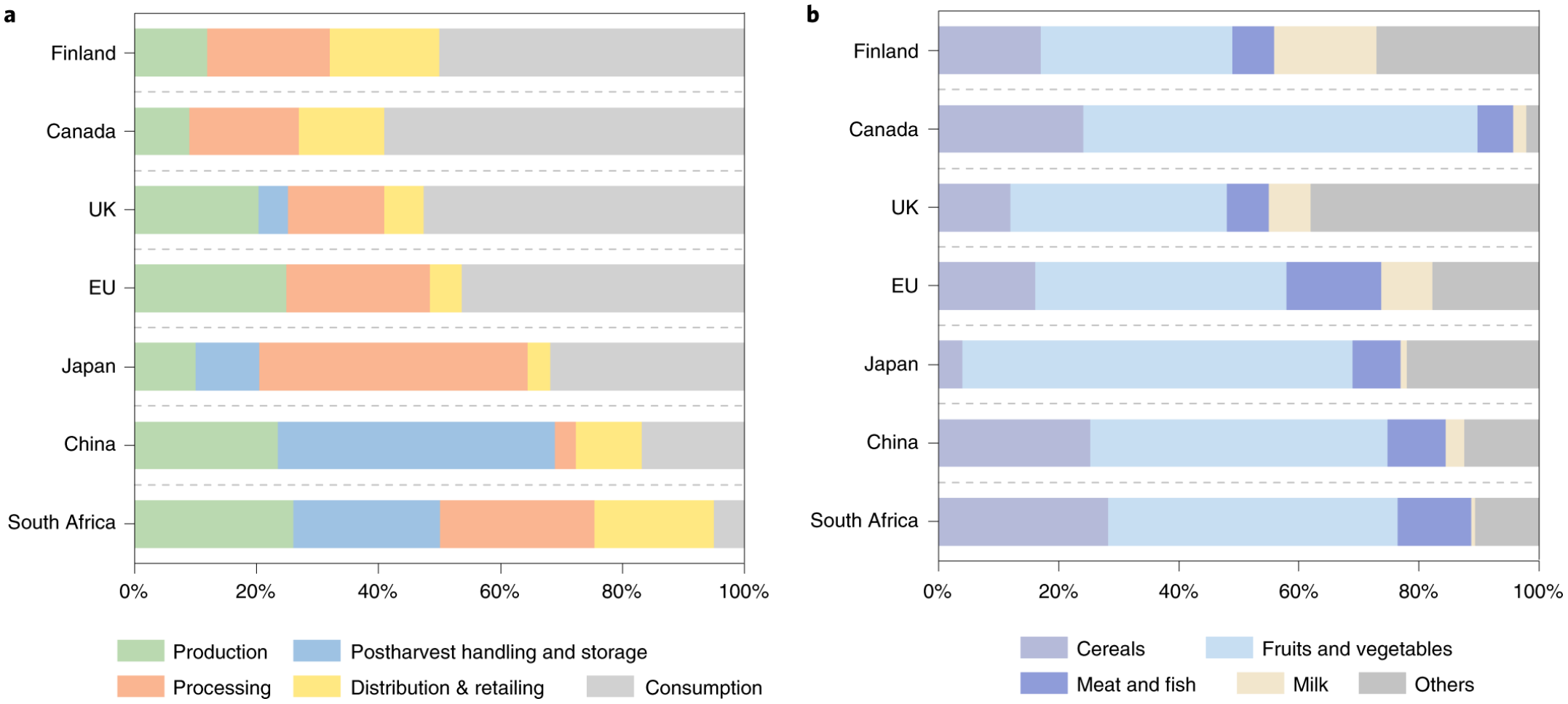
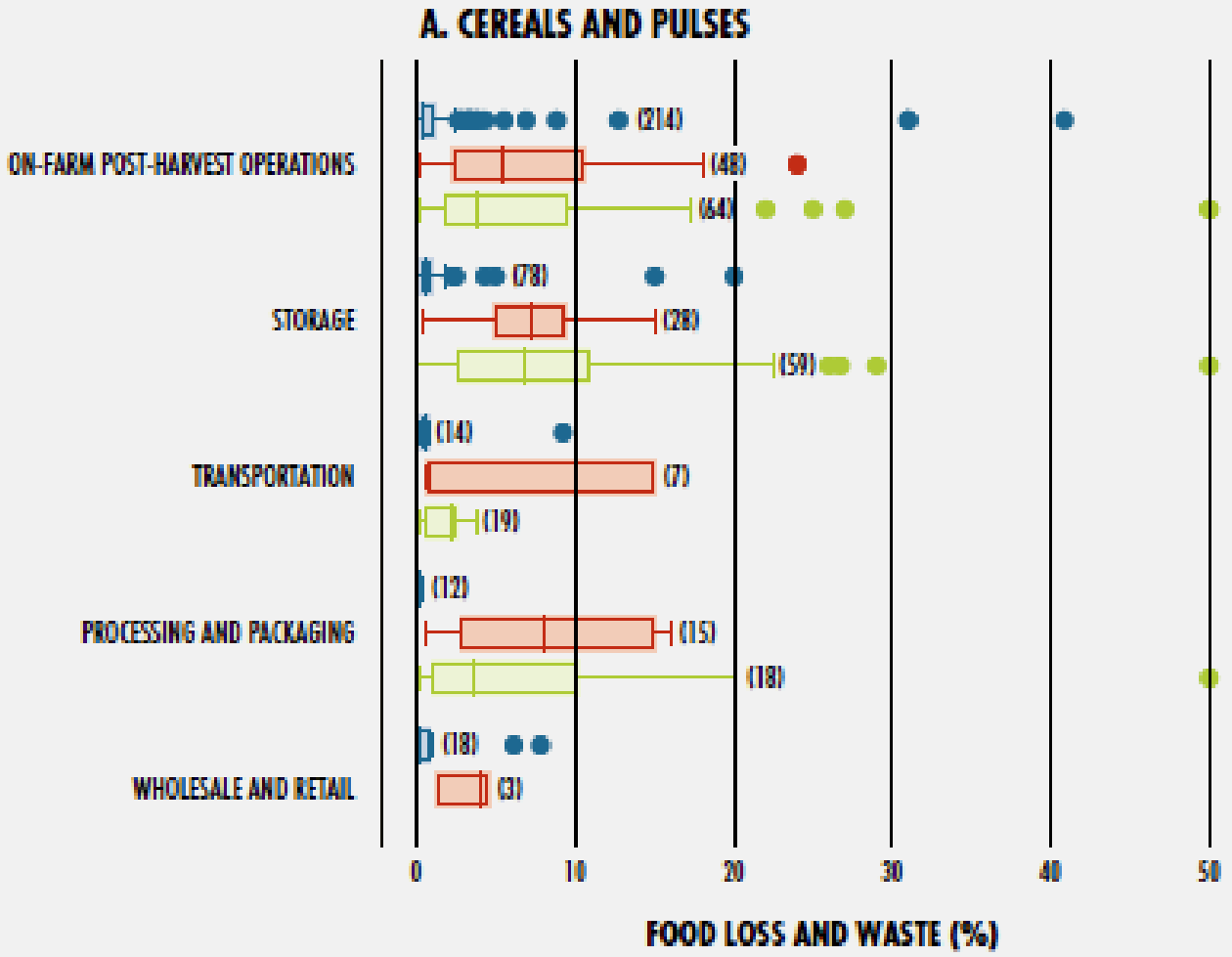
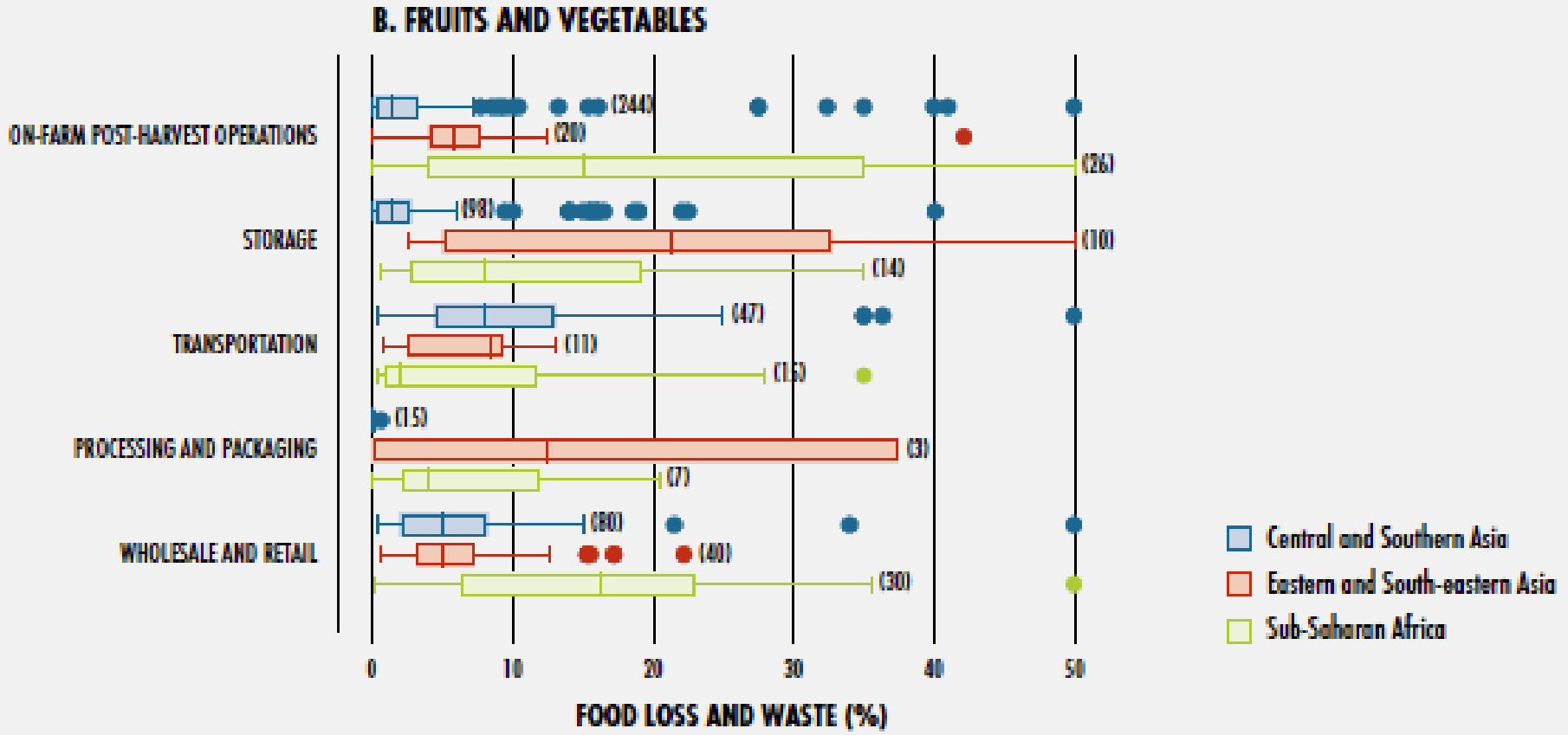


China's food loss and waste embodies increasing environmental impacts
Li Xue, Xiaojie Liu, Shijun Lu, Guangyan Cheng, Yuanchao Hu, Junguo Liu, Zhengxia Dou, Shengkui Cheng & Gang Liu
Nature Food volume 2, pages519–528 (2021)

FIGURE 6

RANGE OF REPORTED FOOD LOSS AND WASTE PERCENTAGES BY SUPPLY CHAIN STAGE, 2000–2017





NOTE: The number of observations is shown in brackets. The dates, 2000–2017, refer to when the measurements were taken; however, the date of publication was used if the study dates were not available or were unclear.
SOURCE: FAO, 2019.