AGRICULTURAL AND RESOURCE ECONOMICS
KASETSART UNIVERSITY

Food loss and food waste

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From Food-to-Food Waste

Harvesting

Grading

Transporting

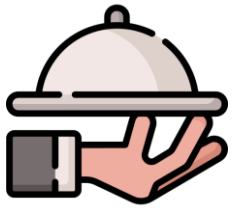
Production

Processing

Packing

Distributing

Selling



Consuming

Food loss

Food waste

From Food to Food Waste

Large quantity

Below criteria/satisfaction

Poor quality

Poor qualityhttp://www.tei.or.th/en/blog_detail.php?blog_id=72

http://www.teachsdgs.org/resources.html


1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Indicator 12.3.1: Global food loss index

Indicator 12.3.1 - Global Food Loss and Waste

SDG target 12.3 has two components, Losses and Waste that should be measured by two separate indicators.

Sub-Indicator 12.3.1.a - Food Loss Index

The Food Loss Index (FLI) focuses on food losses that occur from production up to (and not including) the retail level. It measures the changes in percentage losses for a basket of 10 main commodities by country in comparison with a base period. The FLI will contribute to measure progress towards SDG Target 12.3.

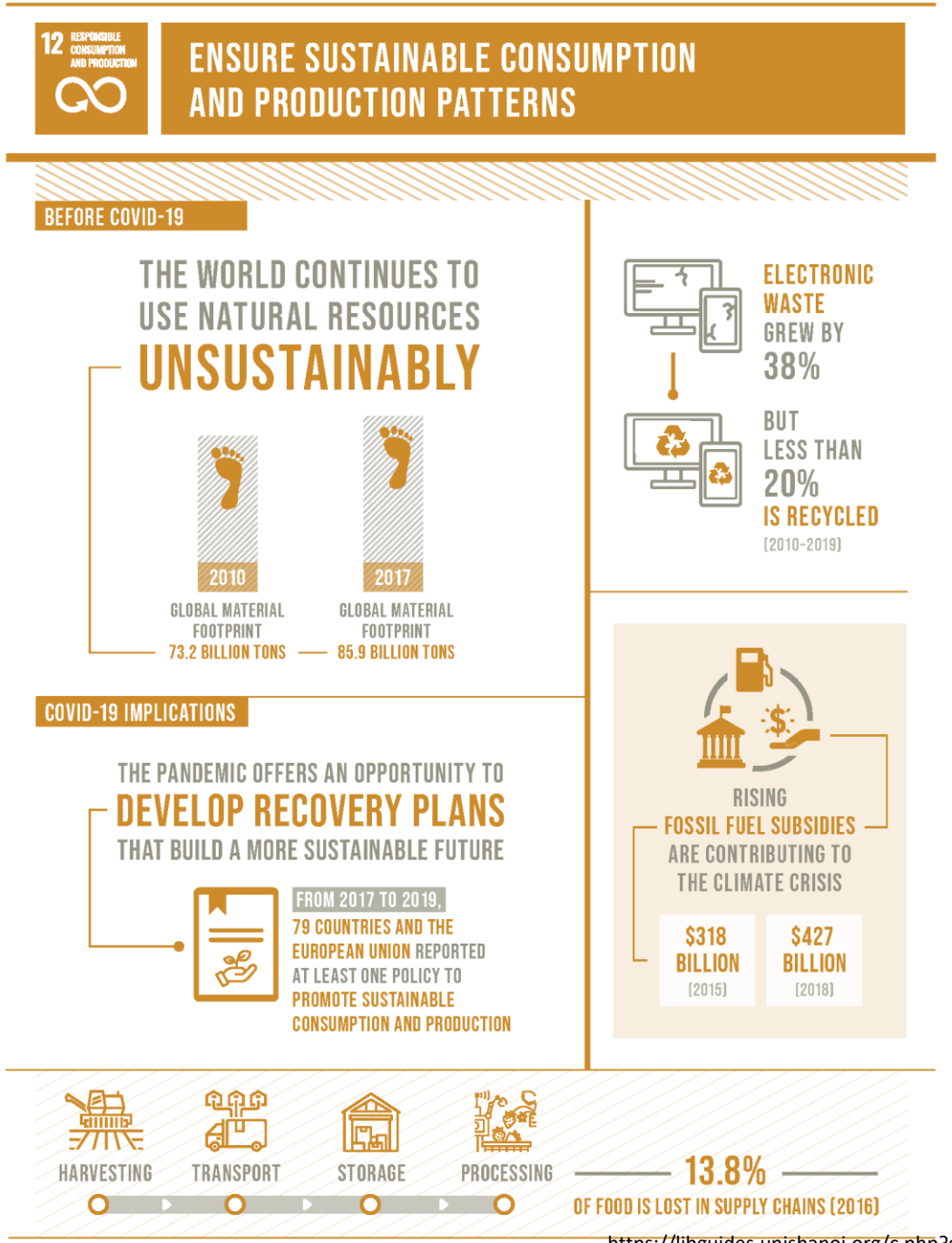
Sub-Indicator 12.3.1.b - Food Waste Index

A proposal for measuring Food Waste, which comprises the retail and consumption levels is under development. UN Environment is taking the lead on this sub-indicator.

Target 12.3

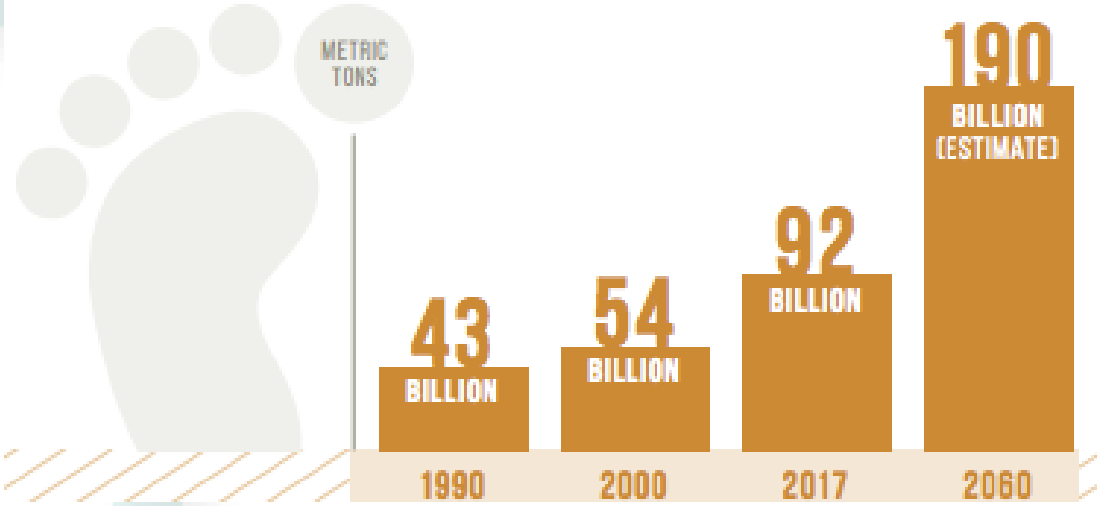
By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.

https://www.fao.org/sustainable-development-goals-data-portal/data/indicators/1231-global-food-losses/en



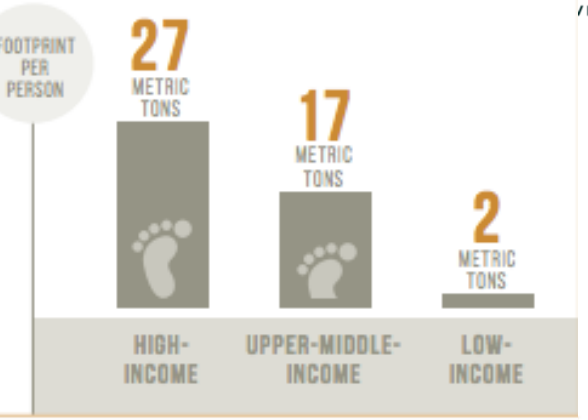
https://libguides.unishanoi.org/c.php?g=777267&p=6772085

THE GLOBAL MATERIAL FOOTPRINT IS RAPIDLY GROWING, OUTPACING POPULATION AND ECONOMIC GROWTH



MATERIAL FOOTPRINT PER CAPITA IN HIGH-INCOME COUNTRIES IS

60% HIGHER THAN IN UPPER-MIDDLE-INCOME COUNTRIES AND MORE THAN **13 TIMES** THE LEVEL OF LOW-INCOME COUNTRIES



DEVELOPED COUNTRIES USE ONE FIFTH OF NATURAL RESOURCES TO PRODUCE THE SAME AMOUNT OF ECONOMIC OUTPUT AS DEVELOPING COUNTRIES

NEARLY 100 COUNTRIES ARE ACTIVELY ADOPTING POLICIES AND MEASURES TO PROMOTE SUSTAINABLE CONSUMPTION AND PRODUCTION

303 POLICIES AND INSTRUMENTS ARE IN PLACE GLOBALLY

https://libguides.unishanoi.org/c.php?g=777267&p=6772085

Publications 2015-2019

12

Responsible consumption and production

2015-2019
Output, Impact, Collaboration

Research supporting SDG12 has grown since 2015, with a compound annual growth rate of 11.6% compared to nearly 3.5% for research in all fields.

China produces the most research supporting SDG12, followed by the US, United Kingdom, India and Italy. Seven of the 10 most prolific locations are high income locations (accounting for more than 37,400 publications); two are upper-middle income locations (China and Brazil) and one is a lower-middle income location (India). No low income locations featured in the top 50.

The top five locations for which research on SDG12 represents the largest share of their research portfolio are Ghana, Nigeria, Sri Lanka, Latvia and Malaysia.

International collaboration yielded 24% of research on SDG12. High income locations collaborated with low income locations on 1% of their total SDG12 research, while nearly 58% of the related output from low income locations came from collaboration with high income locations.

As a measure of academic impact measured by citation, the field weighted citation impact (FWCI) for SDG12 research was above average every year, with an average of 1.36 over the period.

RELX SDG Resource Centre

ELSEVIER

This analysis builds on Elsevier's Sustainability Science in a Global Landscape report, which was released in 2015 to coincide with the launch of the SDGs. See a 2017 update on key findings on the RELX SDG Resource Centre. Help us to provide insight into SDG research.
Click here to review the research
See the methodology and definitions

84,127 Publications in period

11.6% Compound Annual Growth Rate in the period

61.7% Publications from high-income locations

2.0% Academic corporate collaboration

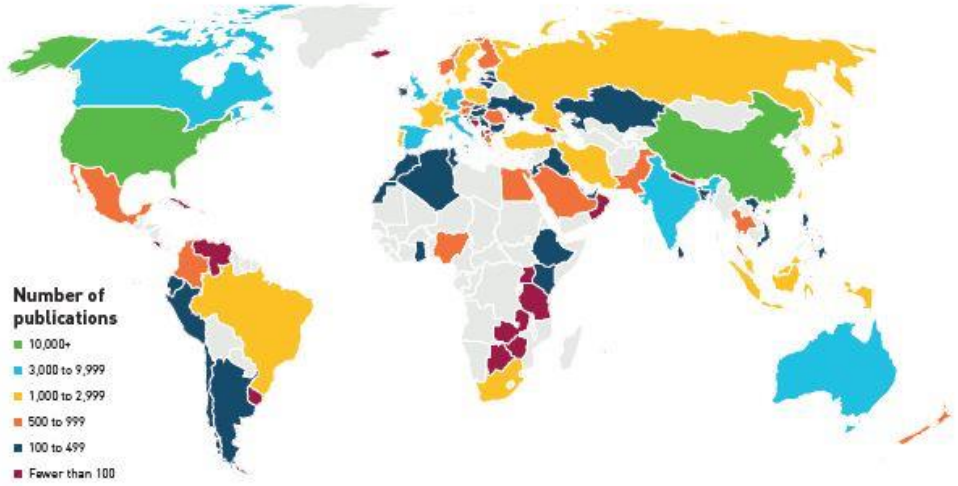
0.2% Publications from low-income locations

1.36 Field-Weighted Citation Impact

24.2% Publications with international collaboration

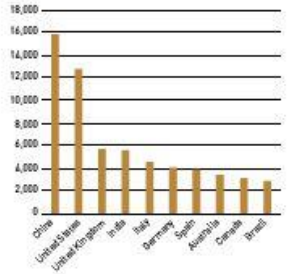
What is FWCI?

Field-weighted citation impact is an indicator of scholarly impact based on the number of times the publication was cited in other research. An FWCI of above 1.0 indicates the impact is above the normalised average

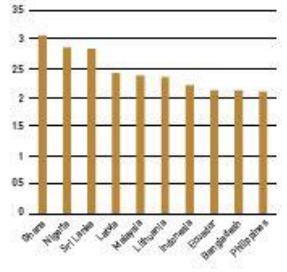


Key themes in SDG12 Research

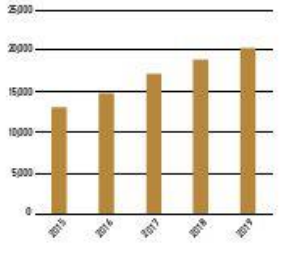
Top 10 locations by publication



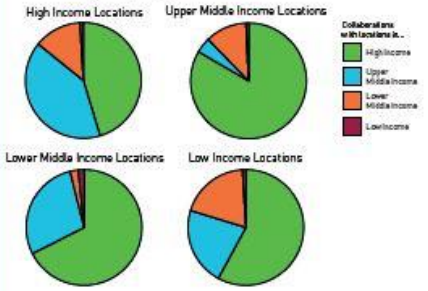
Top 10 locations by RAI *(Relative Activity Index)



Volume of publications supporting SDG12

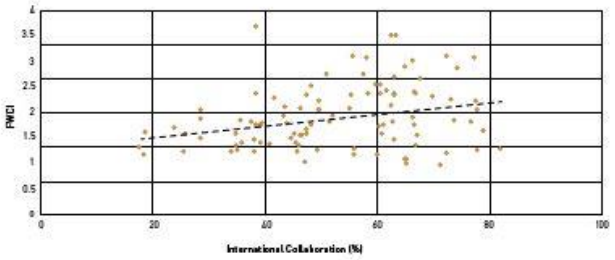


International collaboration between income groups by location

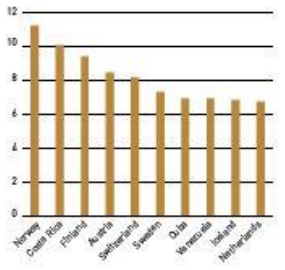


International collaboration and research impact

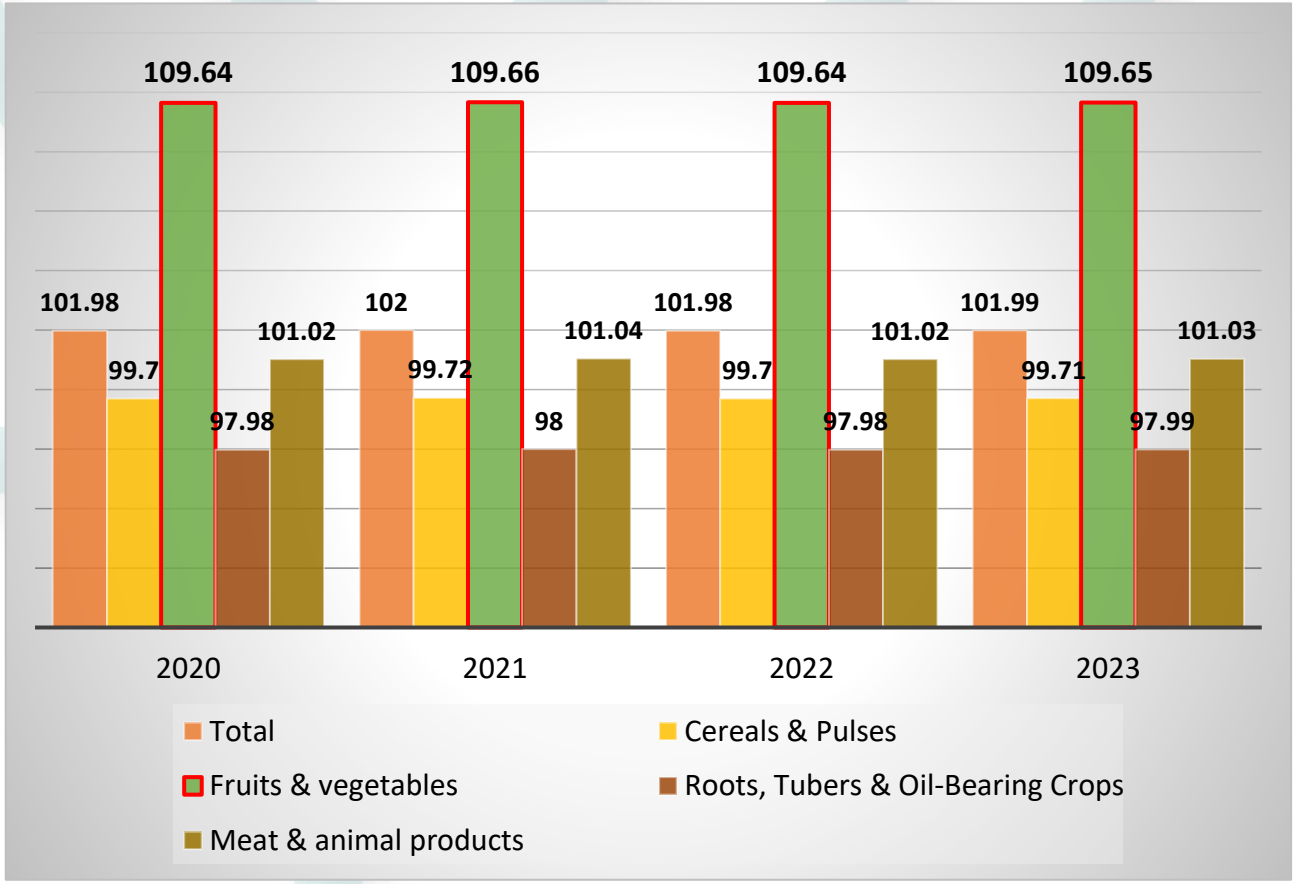
*Relative Activity Index is a measure of the proportion of the country's research output in the subject, relative to the proportion seen globally



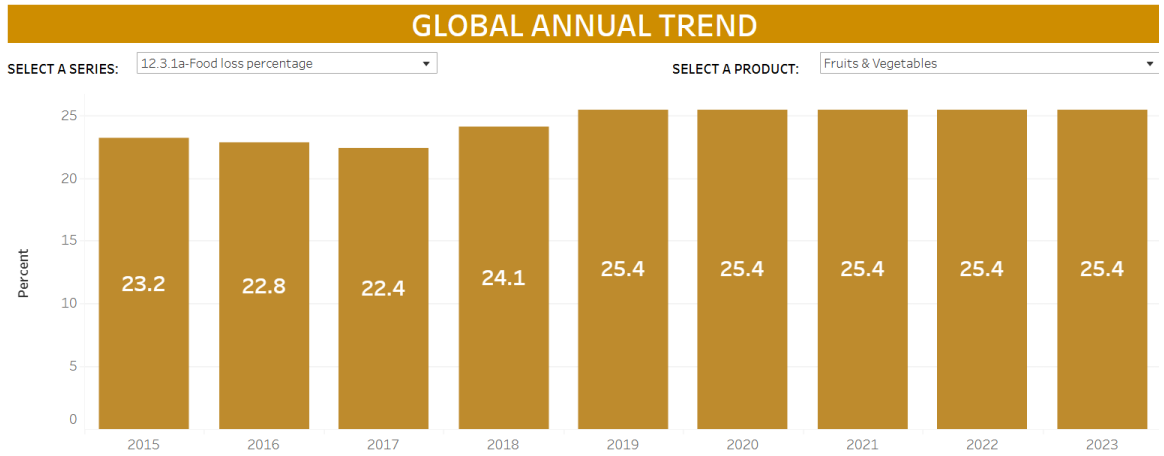
Top 10 locations for corporate-academic collaboration



Indicator 12.3.1: Global food loss index



Food loss percentage: Fruits & Vegetables



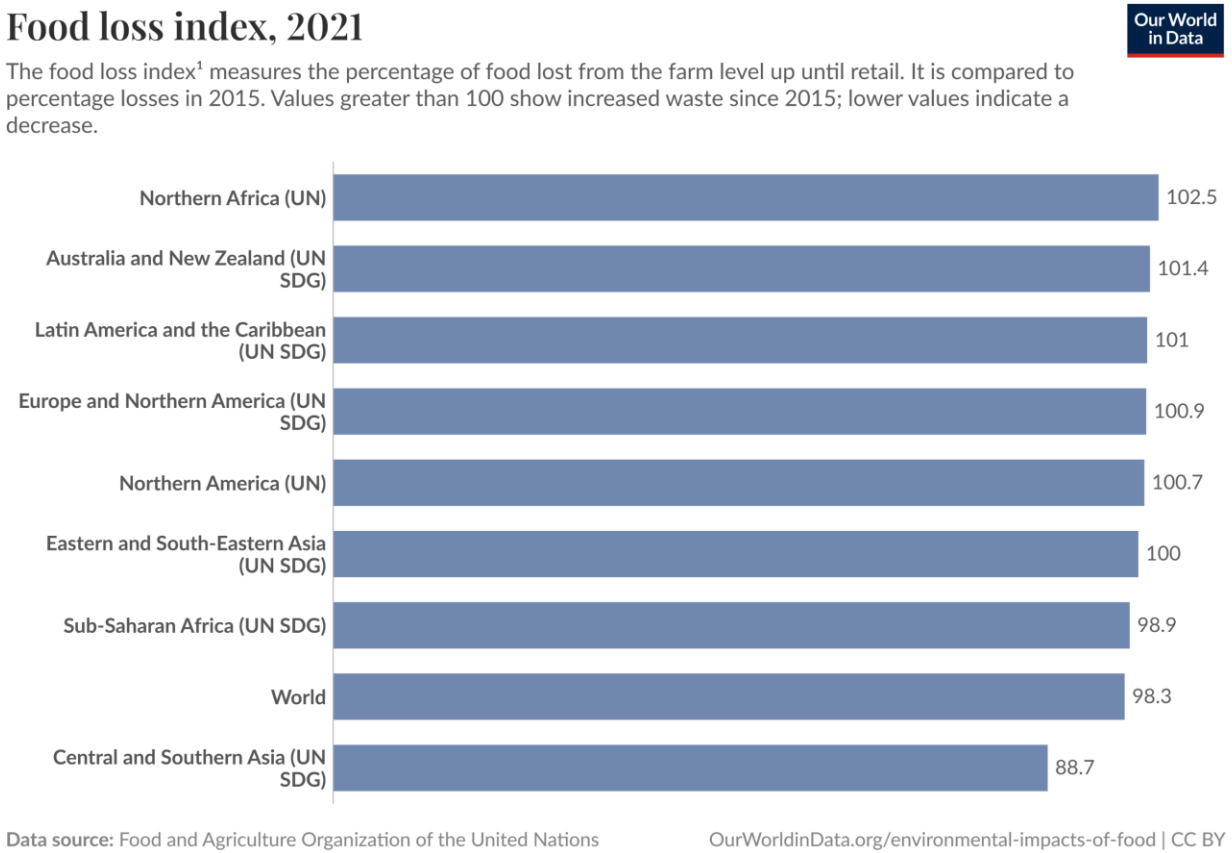
METHODOLOGY FOR CURRENT STATUS ASSESSMENT

For indicators without a numerical yardstick the current status is assessed by computing the quintile distribution of the country values. Then the World is assigned to one of the five quintiles, depending on the global value of the indicator, as described in The FAO methodology to measure progress towards the achievement of SDG targets and goals.

Note: This indicator does not present data at a country level, for this reason it is not possible to assess the current status resulting in the display message:[Assessment not available].

https://de-public-statsuite.fao.org/

Food loss index, 2021



1. Food loss index The food loss index measures how losses in the food supply chain have changed relative to 2015.
Food "losses" are defined as the loss or wastage of food from the farm up to the retail level. Pre-harvest losses, and retail and consumer waste are not included.
Food losses are measured across five food groups: cereals & pulses; fruits & vegetables; roots, tubers and oil crops; animal products; and seafood.
The percentage of food that is lost across the supply chain in 2015 is given a value of 100 as a baseline. If the index value is greater than 100 then food losses have increased since 2015. If the value is less than 100, they've decreased.

UNEP's Food Waste Index report (2021)

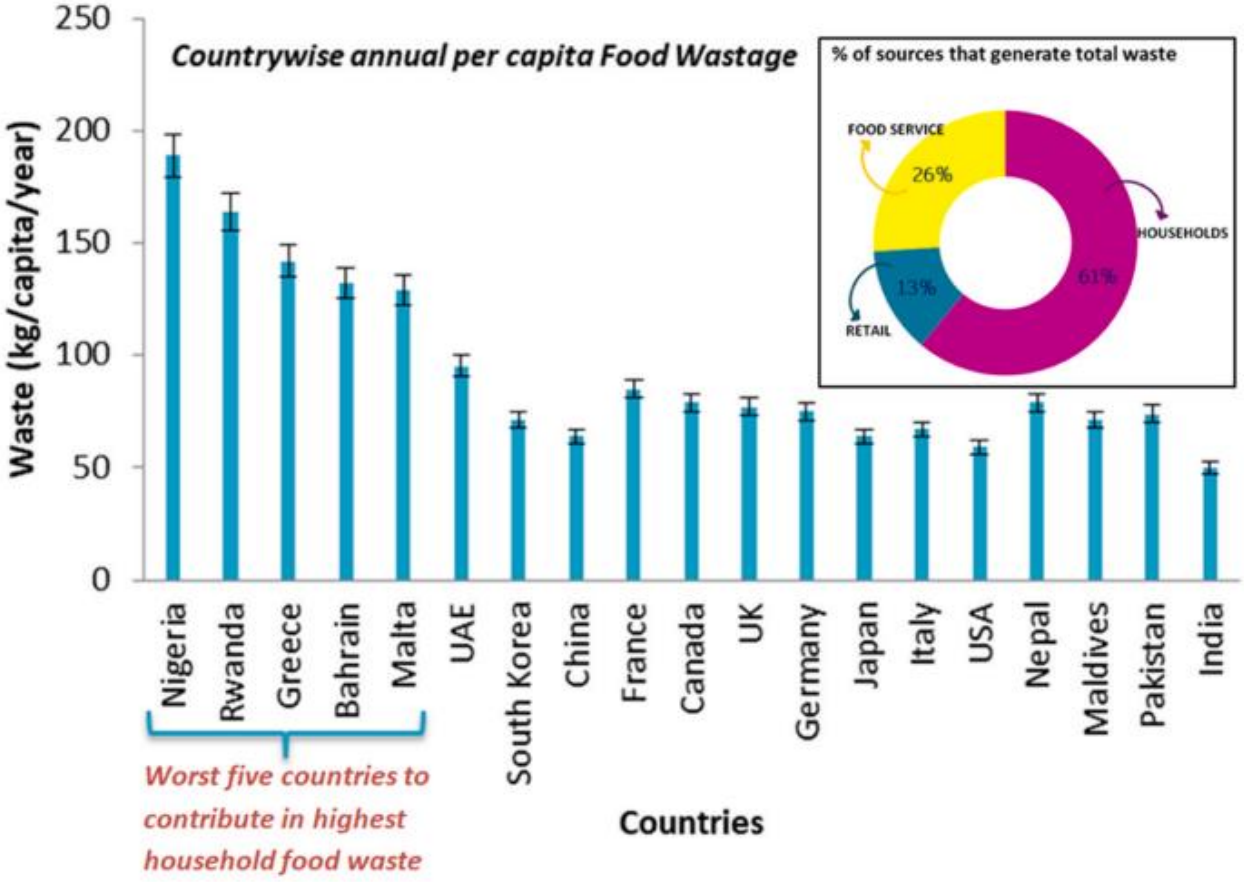


Fig. 1. UNEP's Food Waste Index report (2021).

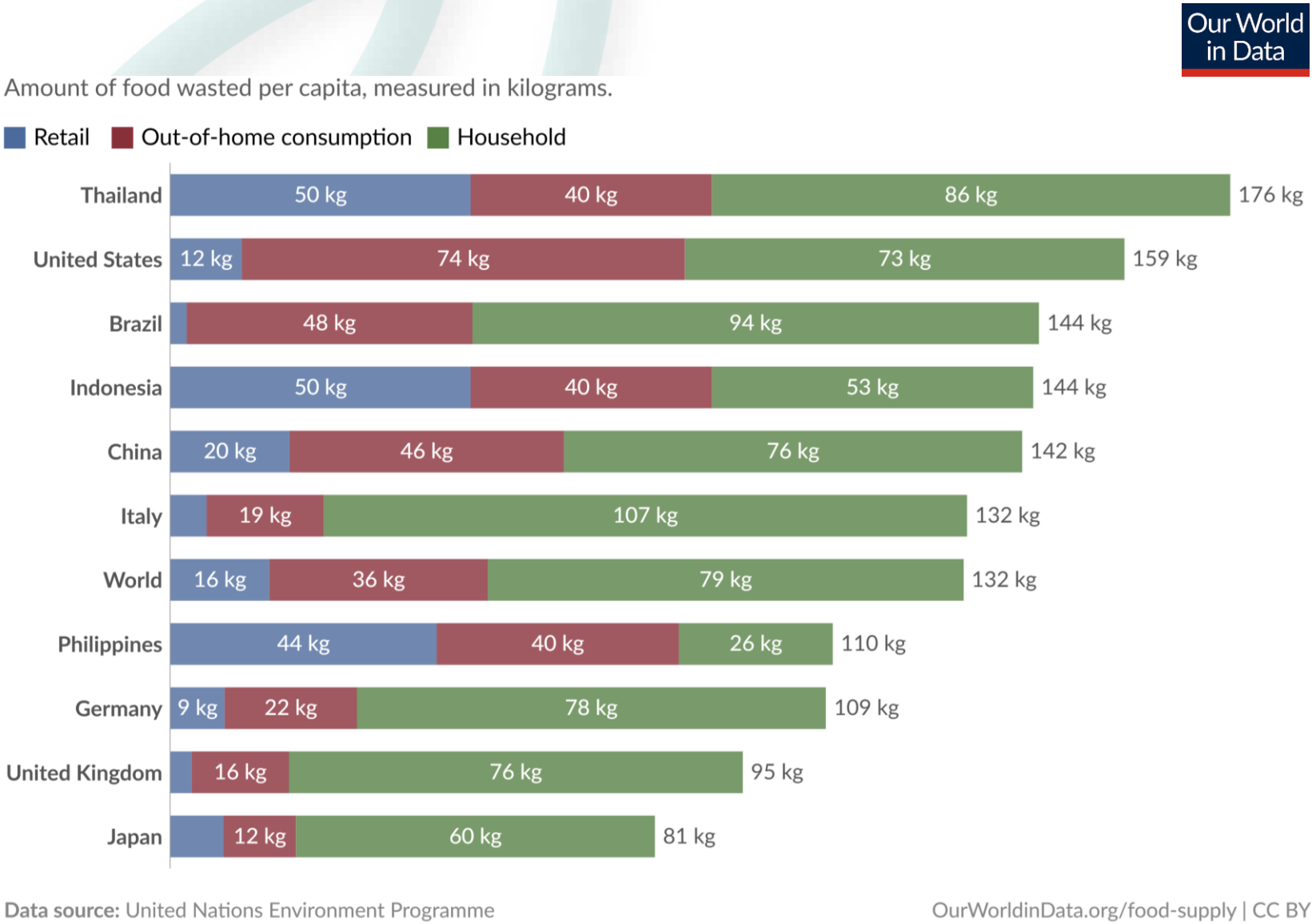
Batool, F., Kurniawan, T. A., Mohyuddin, A., Othman, M. H. D., Aziz, F., Al-Hazmi, H. E., ... & Anouzla, A. (2024). Environmental impacts of food waste management technologies: A critical review of life cycle assessment (LCA) studies. Trends in Food Science & Technology, 143, 104287.

6% of global greenhouse gas emissions come from food losses and waste

Note: One-quarter of food emissions comes from food that is never eaten: 15% of food emissions from food lost in supply chains; and 9% from consumer waste.
Data source: Joseph Poore & Thomas Nemecek (2018). Reducing food's environmental impacts through producers and consumers. *Science*.
OurWorldinData.org – Research and data to make progress against the world's largest problems. Licensed under CC-BY by the author Hannah Ritchie.

Hannah Ritchie (2020) - "Food waste is responsible for 6% of global greenhouse gas emissions" Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/food-waste-emissions' [Online Resource]

Food waste per capita, 2022



Food loss percentage in 2021

Circular model in FLW management

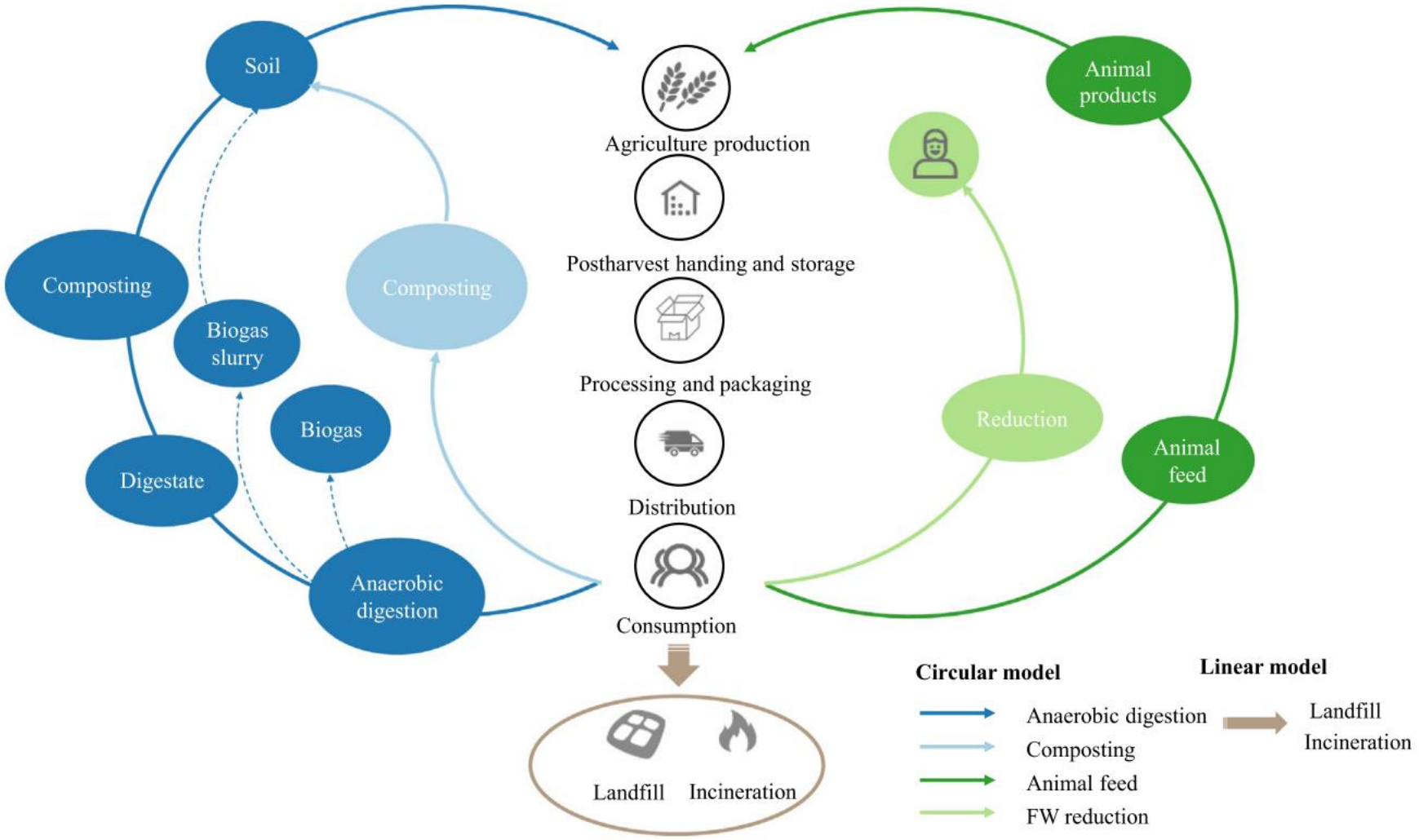
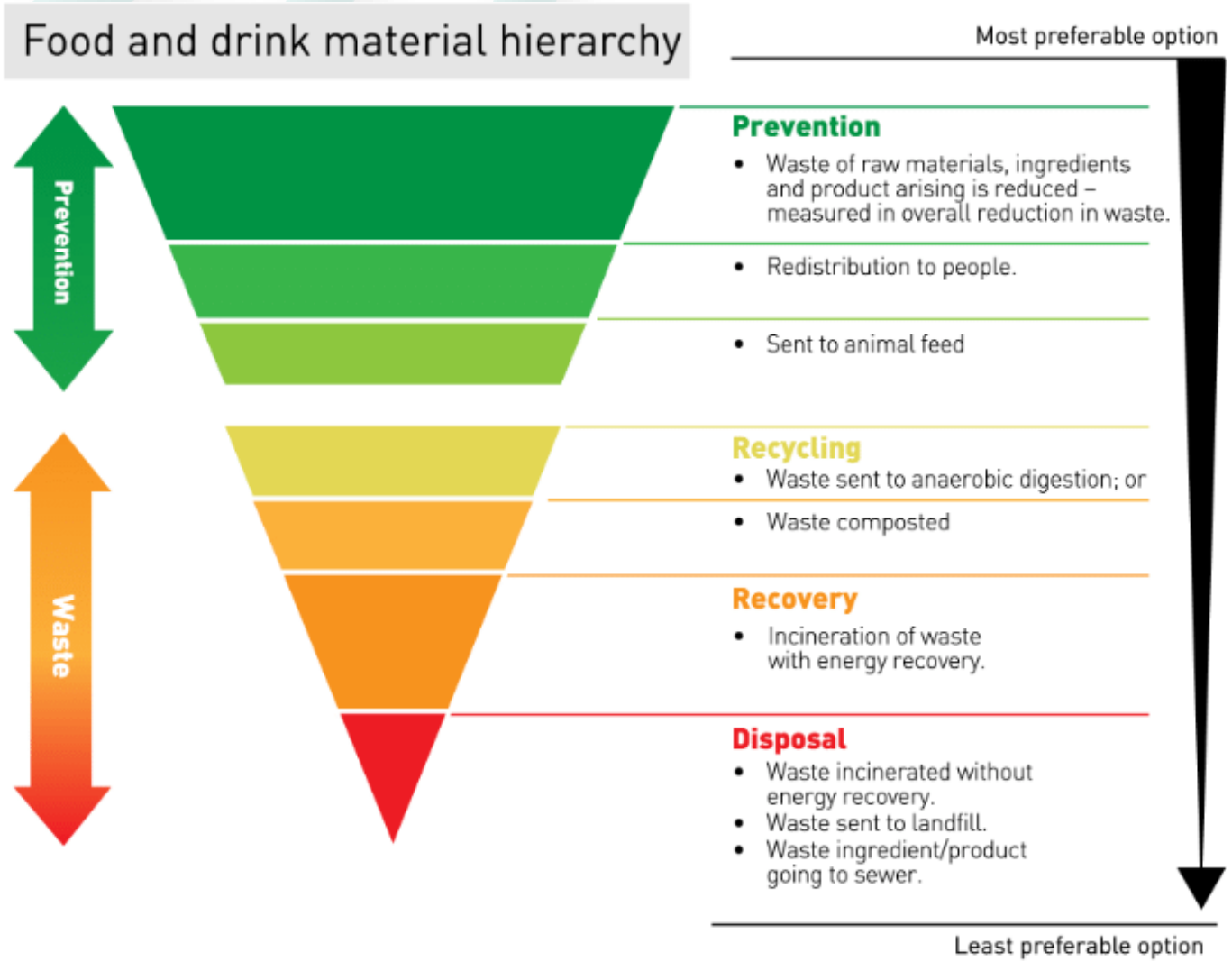


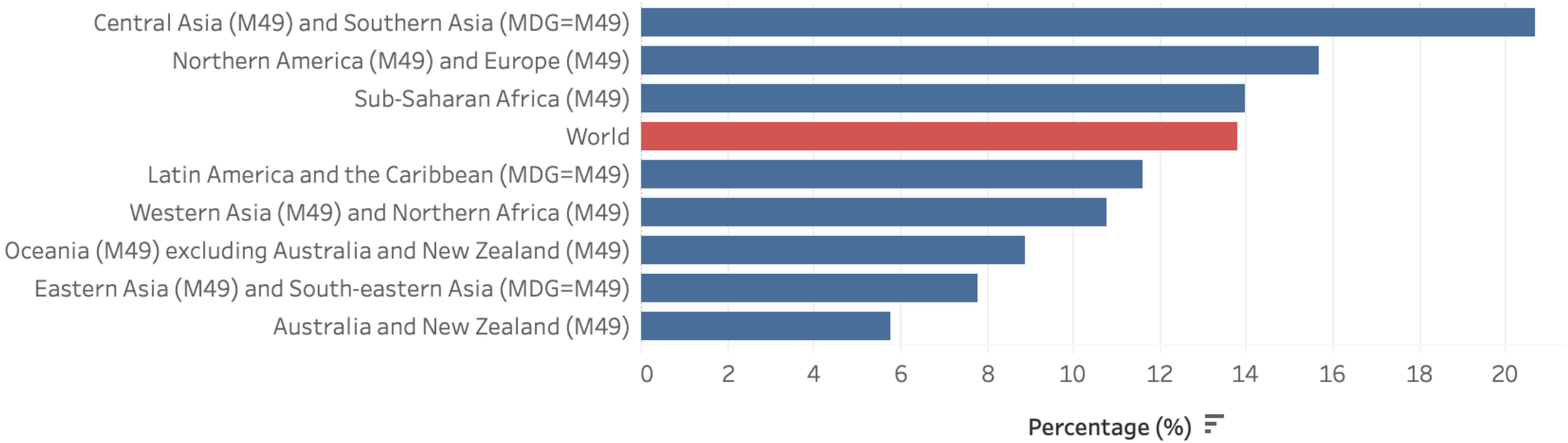
Fig. 2. Linear and circular model in FLW management.

Wang, Y., Yuan, Z., & Tang, Y. (2021). Enhancing food security and environmental sustainability: A critical review of food loss and waste management. Resources, Environment and Sustainability, 4, 100023.


Food and drink material hierarchy
Most preferable option
Prevention
Waste
Prevention
• Waste of raw materials, ingredients and product arising is reduced – measured in overall reduction in waste.
• Redistribution to people.
• Sent to animal feed
Recycling
• Waste sent to anaerobic digestion; or
• Waste composted
Recovery
• Incineration of waste with energy recovery.
Disposal
• Waste incinerated without energy recovery.
• Waste sent to landfill.
• Waste ingredient/product going to sewer.
Least preferable option

Percentage of food loss by region, 2016

Sub-indicator 12.3.1.a - Food Loss Index from post-harvest to distribution, 2016



Five policy-makers needs on food loss and waste: what can be answered and what needs to be further developed.

	Policy-relevant questions	What is known	What needs greater effort by practitioners
Q1	*Do we know how much food is lost or wasted?*	• In the aggregate, a sizeable amount of food is being lost or wasted. • Methodologies are being improved (FAO, 2019; FLW Protocol, 2016). However, it is difficult to harmonize approaches (Chaboud and Daviron, 2017; Ellison et al., 2019)	• Identifying critical loss points. • Measurement approaches. • Opportunities using blockchain.
Q2	*What are the causes of FLW?*	• Food prices relative to production costs are critical explanatory variables in determining FLW rates. • Economic incentives for adoption of FLW reducing technologies are weak Deficiencies in public infrastructure.	• Better understanding of private benefits and costs as key determinants of FLW. • Identifying indirect causes that need to be addressed as part of broader agri-food value chain development policies.
Q3	*What interventions are best suited to address FLW and how to target them? Should policymakers focus on loss, waste, or both?*	• Depends on the underlying motivation of reduction (FAO, 2019). Even the appropriate measure (losses in tons, nutritional or economic value) depends on the objective (FLW Protocol, 2016). • Strategies for reducing food losses and food waste will have to be different: for waste reduction consumer awareness is key; for loss reduction understanding private costs and benefits and what drives them is key.	• FLW reduction should be treated as an intermediate goal and interventions designed and targeted in function of the policy's ultimate goal (e.g. food security, reducing GHG emissions, etc.) • Based on answers to Q1 and Q2, identify stakeholders for whom interventions can be most effective.
Q4	*What is the rationale for public intervention? How ambitious should we be in setting reduction targets?*	• Overall economic welfare improves when lower FLW implies improved efficiency of food systems. • Producing food that is lost or wasted has an environmental impact (Kummu et al., 2017). • Food security and nutrition improves by reducing losses, as – in principle – more food becomes available at lower prices, benefiting households that are net buyers of food. Food banks that avoid food waste provide support to the food insecure. • Achieving zero FLW may not be realistic, given increasing marginal cost of investing in FLW reduction (Ellison et al., 2019).	• Need to focus more on quantifying the actual environmental improvement obtained by specific interventions to reduce FLW once economic feedbacks of an intervention are taken into account. • More research is needed on the distributional effects of FLW interventions: reducing losses could harm producers because of lower prices. • Improving the assessment of efficiency, environmental and food security benefits of interventions, since there is very limited knowledge about societal benefits of reduction in FLW.
Q5	*Are there trade-offs and unintended consequences of reducing FLW?*	• Impacts will be felt both upstream and downstream of an intervention. For example, reductions at one stage can trigger losses and waste elsewhere. • FLW reduction leading to lower prices may affect incomes of food producers and weaken economic incentives to invest in FLW reduction. • Efforts at improving food safety (reducing contaminants and spoilage) may cause higher reported FLW.	• Better understanding of how FLW reduction at one stage of the food value chain impacts market conditions upstream and downstream the supply chain. • Identify trade-offs between different objectives associated with FLW reduction.

Cattaneo, A., Sánchez, M. V., Torero, M., & Vos, R. (2021). Reducing food loss and waste: Five challenges for policy and research. Food Policy, 98, 101974.

Timeline of EU food waste reduction legislative proposal.

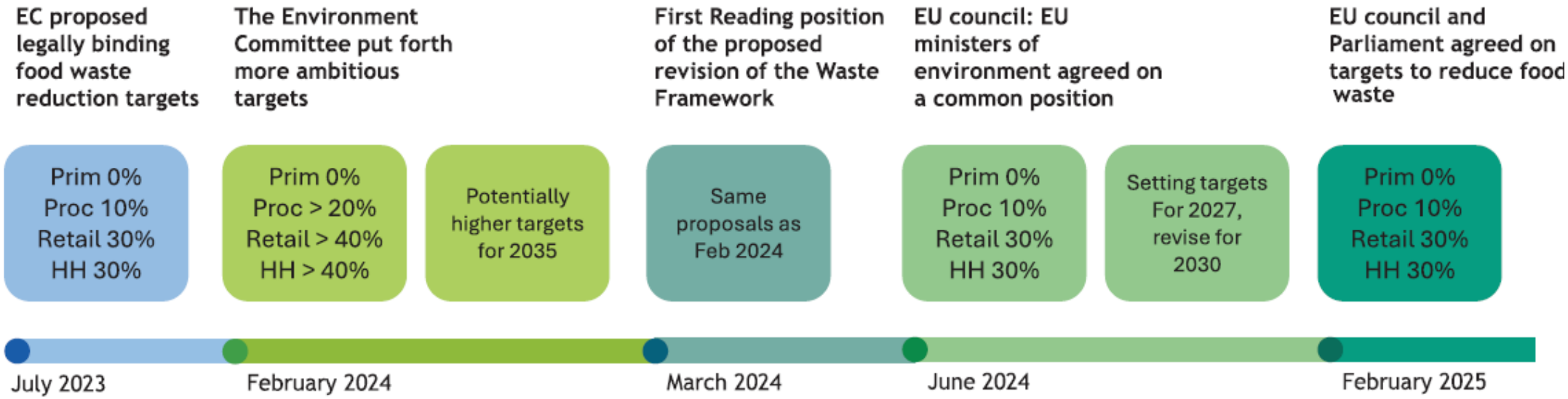


FIGURE 1 | Timeline of EU food waste reduction legislative proposal.

Source: Philippidis, G., de Jong, B., M'barek, R., & Bartelings, H. (2025). Doing More With Less: Cutting Food Loss and Waste in the EU and Its Impact on Food Security. Sustainable Development.

Tackling Thailand's food-waste crisis

Fig. Shoppers select fresh produce at a supermarket. (Photo by Patipat Janthong)

Source: https://www.bangkokpost.com/opinion/opinion/1778159/tackling-thailands-food-waste-crisis

เครื่องกำจัดขยะเศษอาหาร

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https://www.hassthailand.co/?gad_source=1&gad_campaignid=22137431262&gbraid=0AAAAACVh1_xMUl8lw-RWzSB9tgtTuC4pM&gclid=CjwKCAjwmNLHBhA4EiwA3ts3mVOkB6VKapxe21RkJa3U_Cgzvsa3cns8TVgchrpemrSFWTIZM7Sd1BoCTAEQAvD_BwE

https://homemiofficial.com/products/homemi-%E0%B9%80%E0%B8%84%E0%B8%A3%E0%B8%B7%E0%B9%88%E0%B8%AD%E0%B8%87%E0%B8%A2%E0%B9%88%E0%B8%AD%E0%B8%A2%E0%B9%80%E0%B8%A8%E0%B8%A9%E0%B8%AD%E0%B8%B2%E0%B8%AB%E0%B8%B2%E0%B8%A3%E0%B8%AD%E0%B8%B1%E0%B8%95%E0%B9%82%E0%B8%99%E0%B8%A1%E0%B8%B1%E0%B8%95%E0%B8%B4-food-waste-composter-%E0%B9%80%E0%B8%84%E0%B8%A3%E0%B8%B7%E0%B9%88%E0%B8%AD%E0%B8%87%E0%B8%81%E0%B8%B3%E0%B8%88%E0%B8%B1%E0%B8%94%E0%B9%80%E0%B8%A8%E0%B8%A9%E0%B8%AD%E0%B8%B2%E0%B8%AB%E0%B8%B2%E0%B8%A3%E0%B8%84%E0%B8%A7%E0%B8%B2%E0%B8%A1%E0%B8%88%E0%B8%B8-3-%E0%B8%A5%E0%B8%B4%E0%B8%95%E0%B8%A3-%E0%B8%A3%E0%B8%B8%E0%B9%88%E0%B8%99-hm0080-p-wh?srsltid=AfmBOor4Mr2DTTkmx1eEEYofTSRWYWQkue3KB3O5ypoobJ1skBZRcip4

Black Soldier Fly: BSF






https://www.vcanmanagement.com/about-5

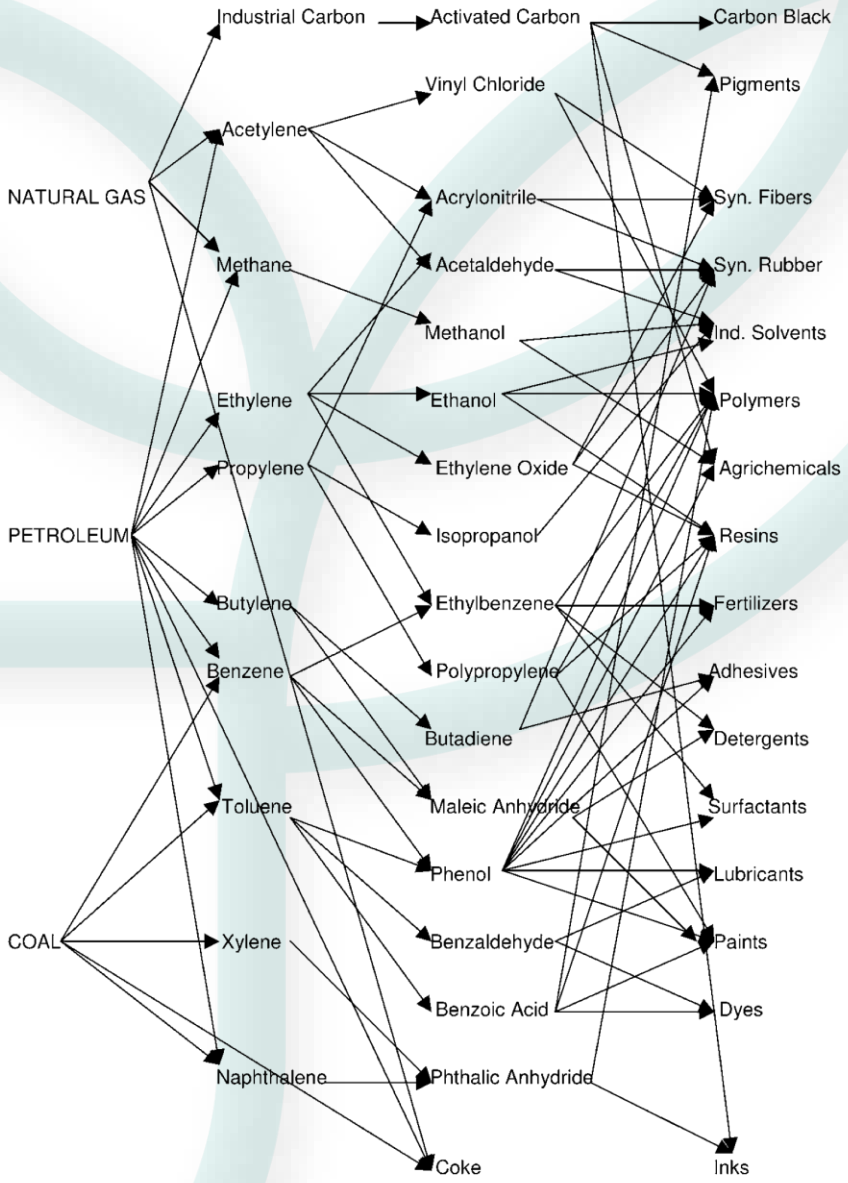
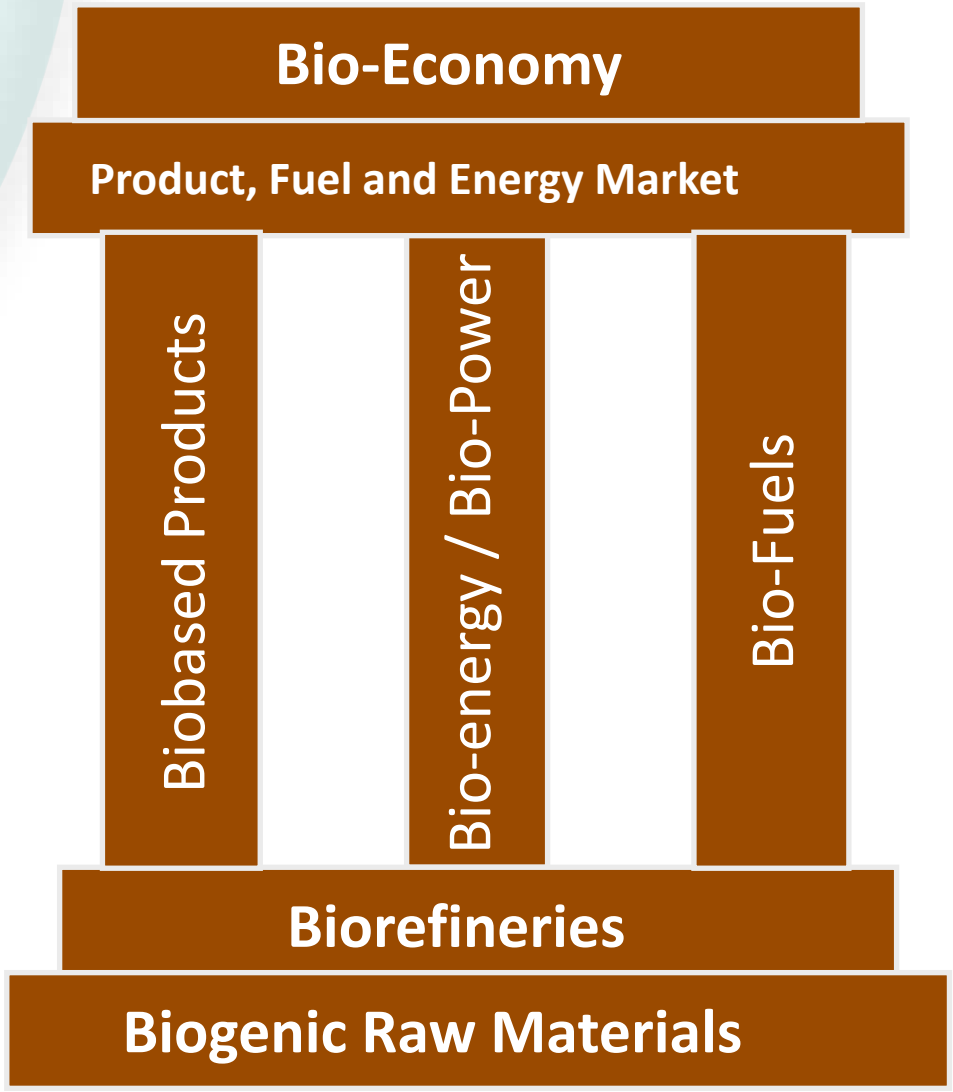
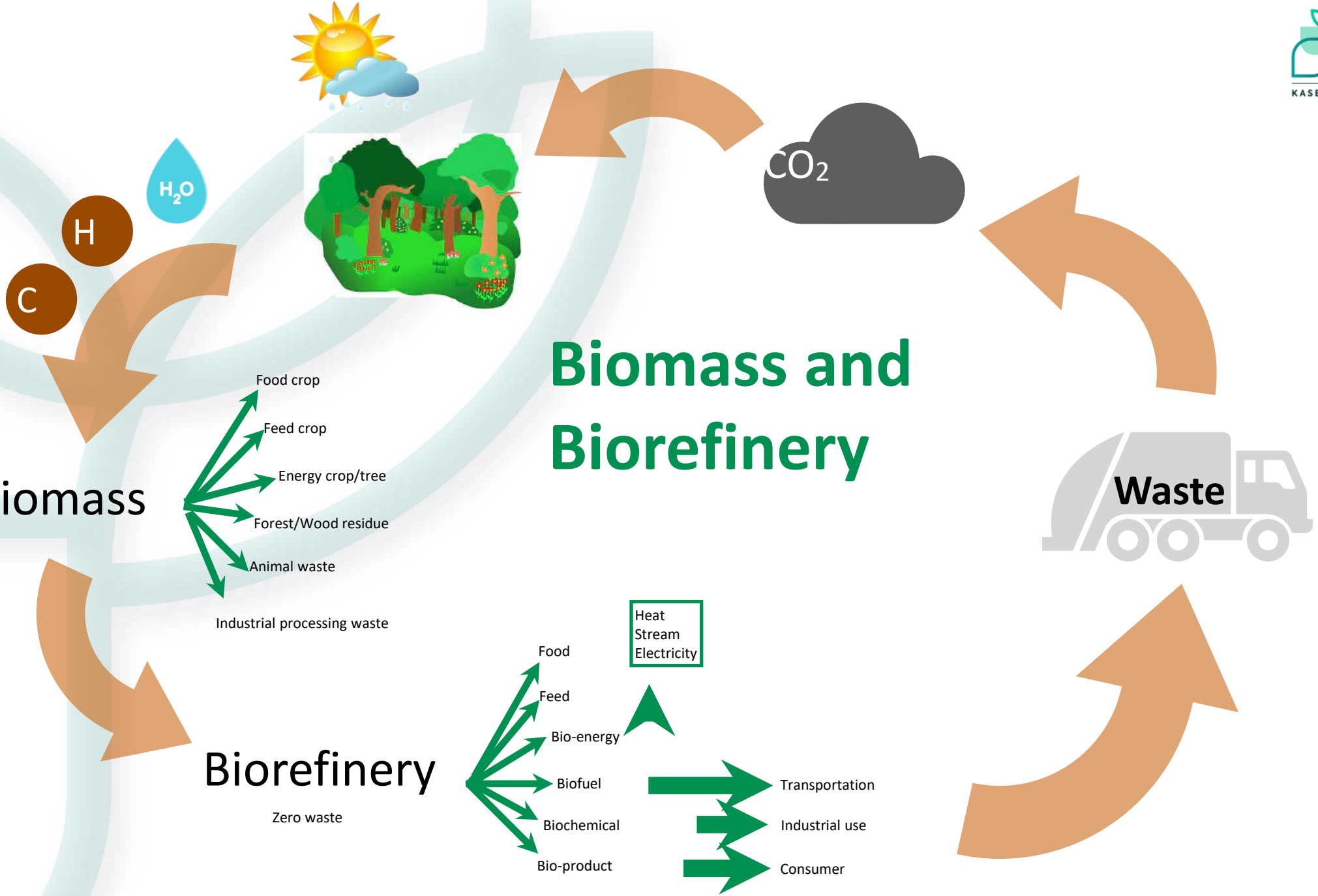


Fig. 5.1 Fossil sources of industrial organic chemicals [1].



Biomass and Biorefinery



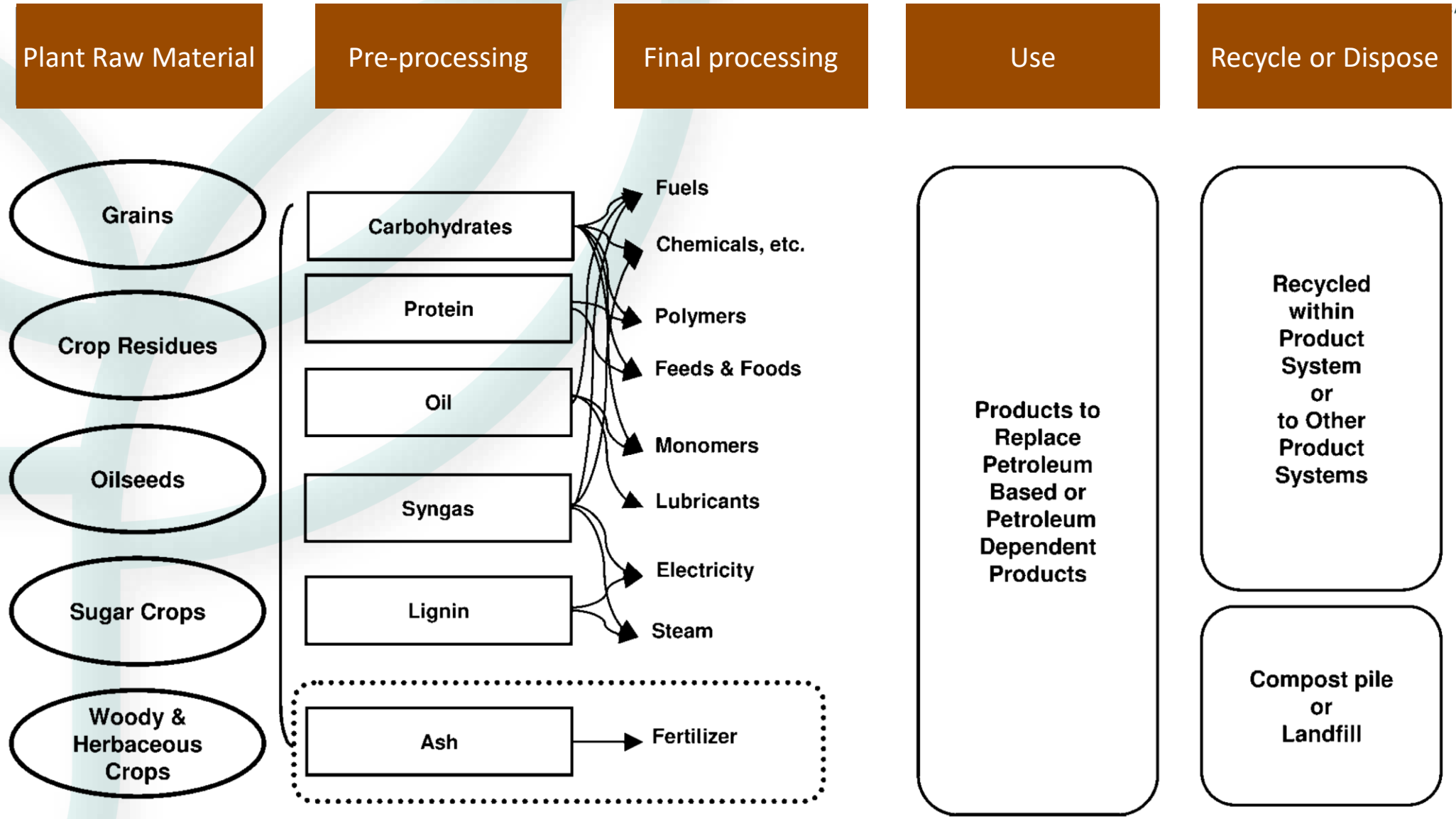
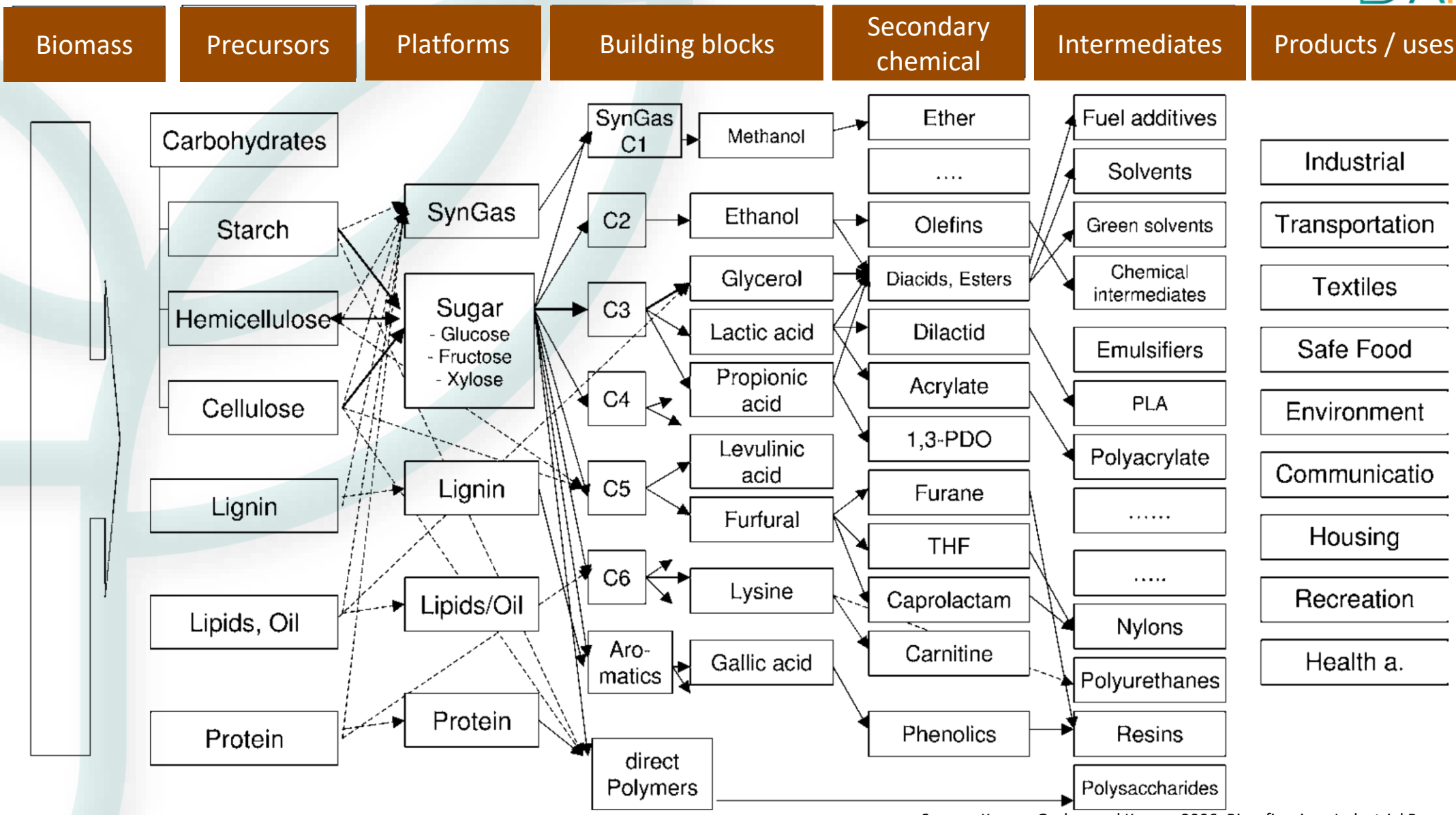


Fig. 2.2 Life cycle overview of biobased products [9].

Source: Kamm, Gruber and Kamm. 2006. Biorefineries - Industrial Processes and Products : Status Quo and Future Directions Volume 1. Weinheim: Wiley-VCH p. 47



Source: Kamm, Gruber and Kamm. 2006. Biorefineries - Industrial Processes and Products : Status Quo and Future Directions Volume 1. Weinheim: Wiley-VCH

Fig. 1.8 Model of a biobased product flow-chart for biomass feedstock [98].

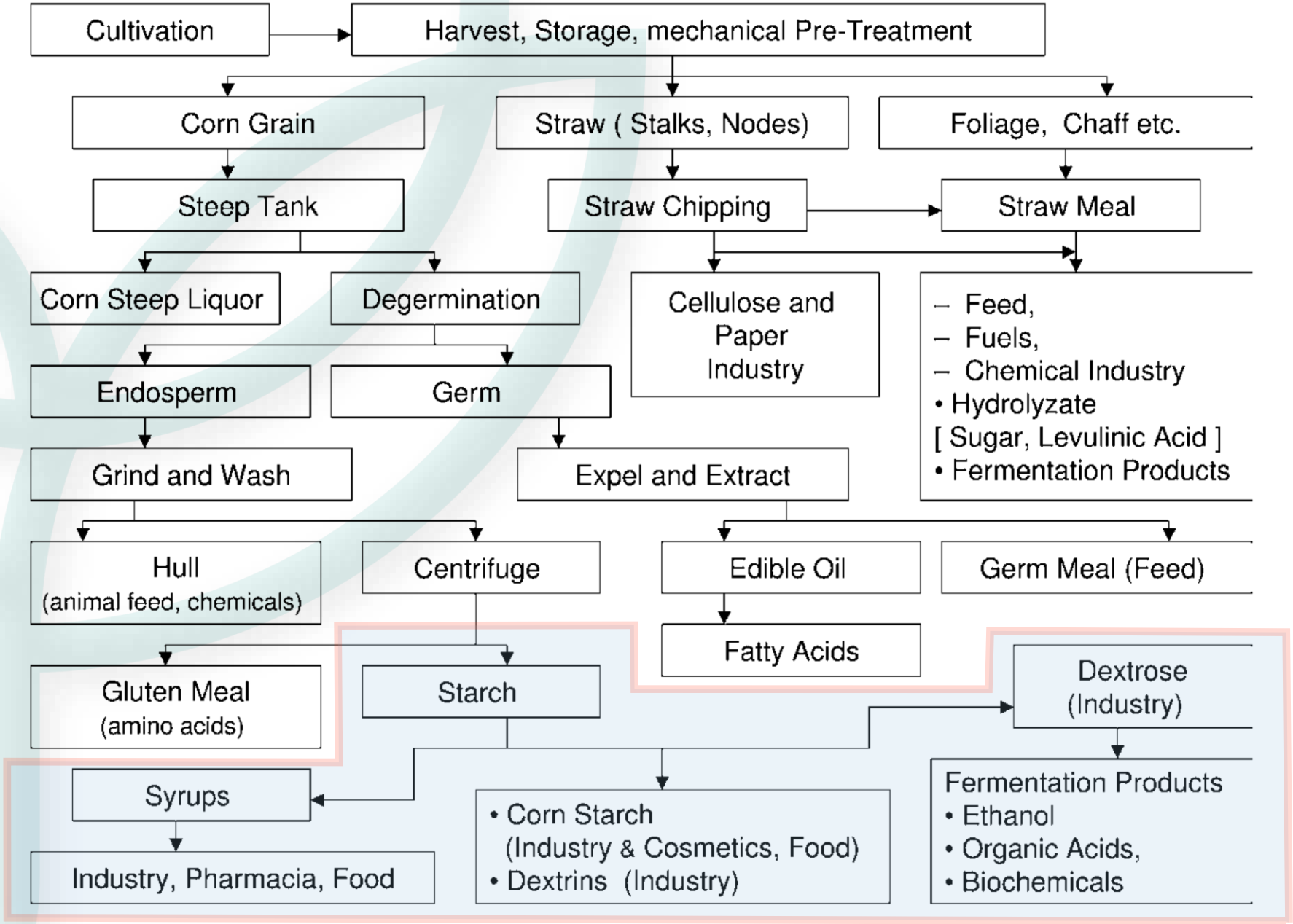
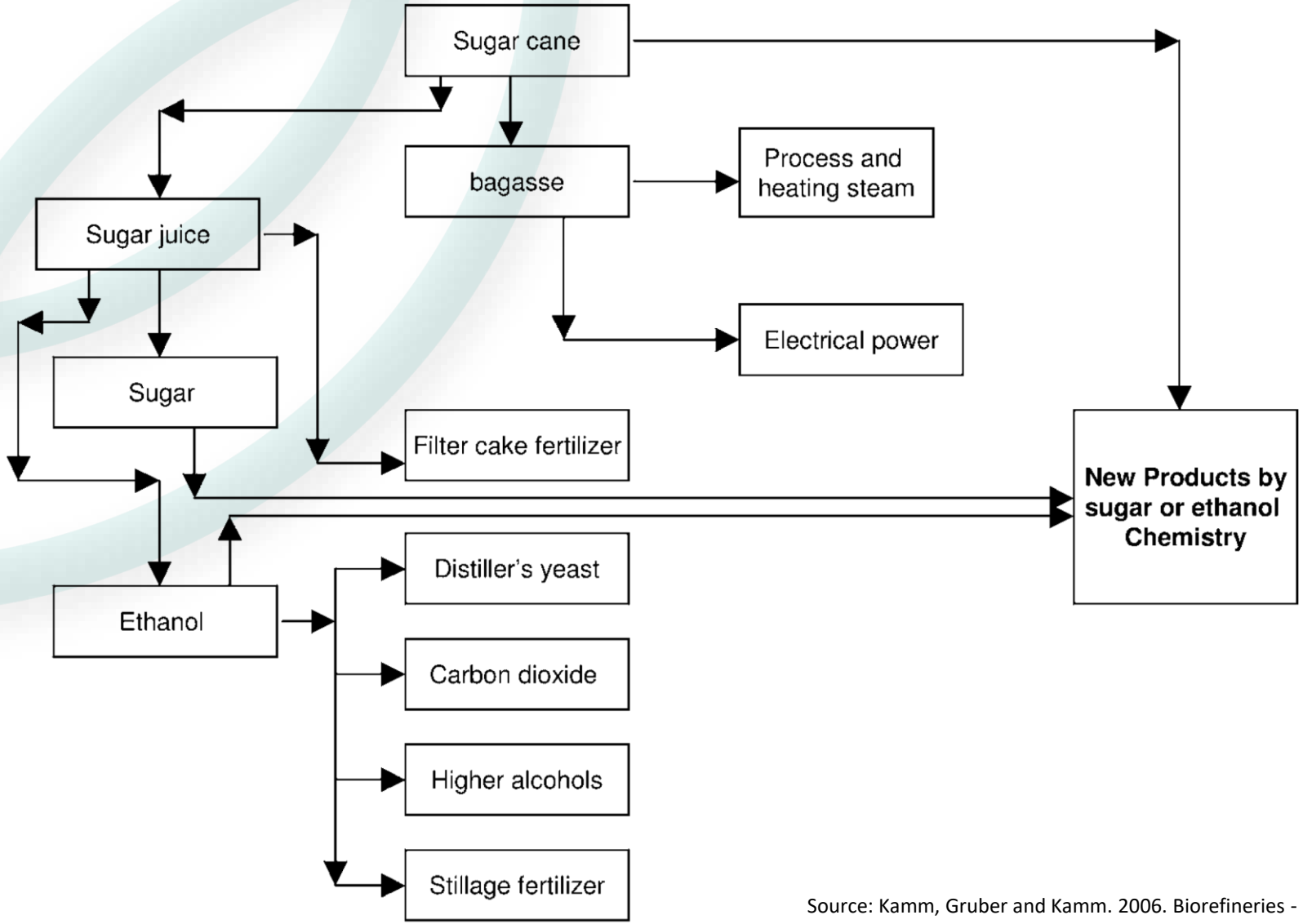


Fig. 1.15 Products from a whole-crop wet mill-based biorefinery.

Source: Kamm, Gruber and Kamm. 2006. Biorefineries - Industrial Processes and Products : Status Quo and Future Directions Volume 1. Weinheim: Wiley-VCH

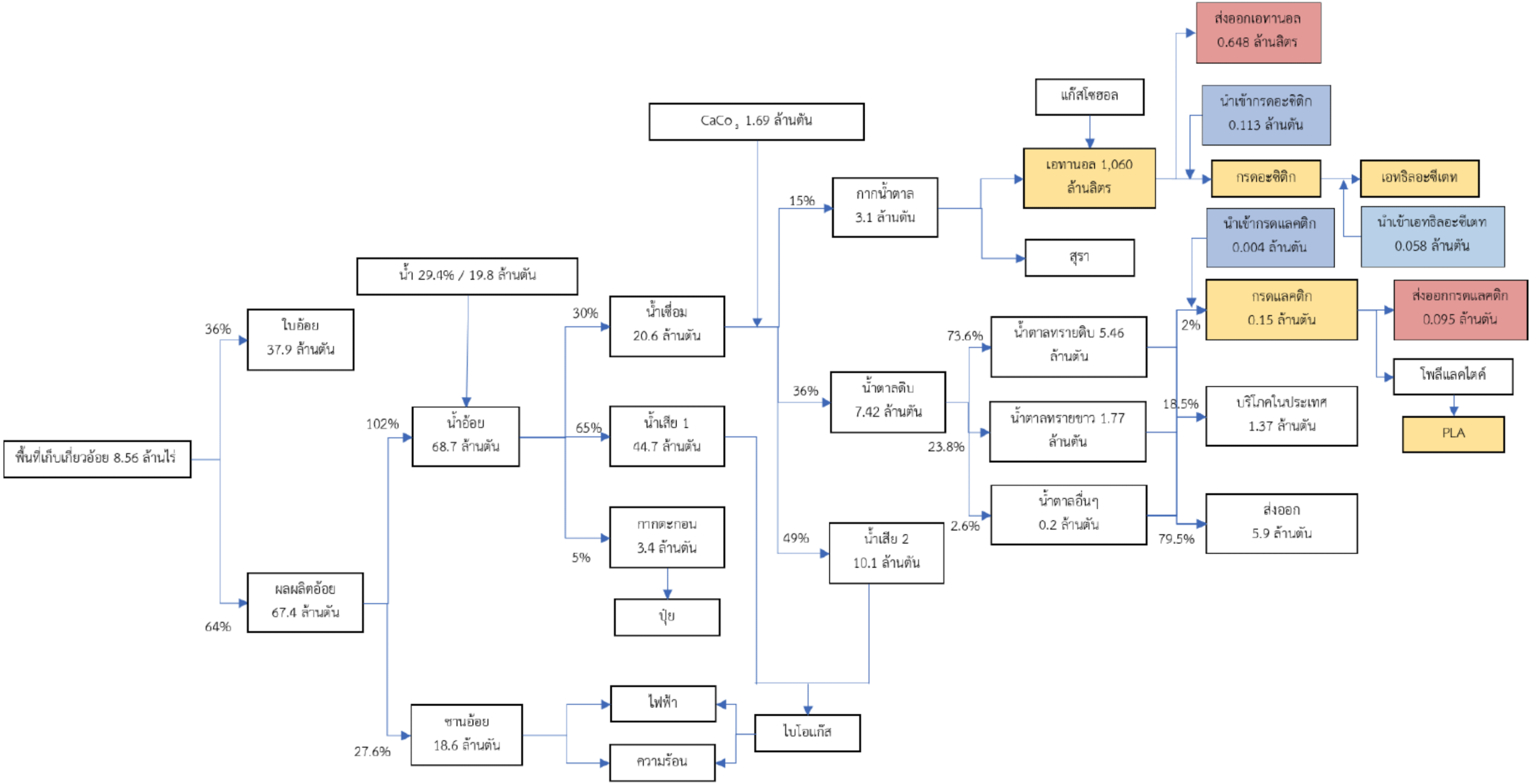
Sugar cane agro-industry in Brazil



Source: Kamm, Gruber and Kamm. 2006. Biorefineries - Industrial Processes and Products : Status Quo and Future Directions Volume 1. Weinheim: Wiley-VCH

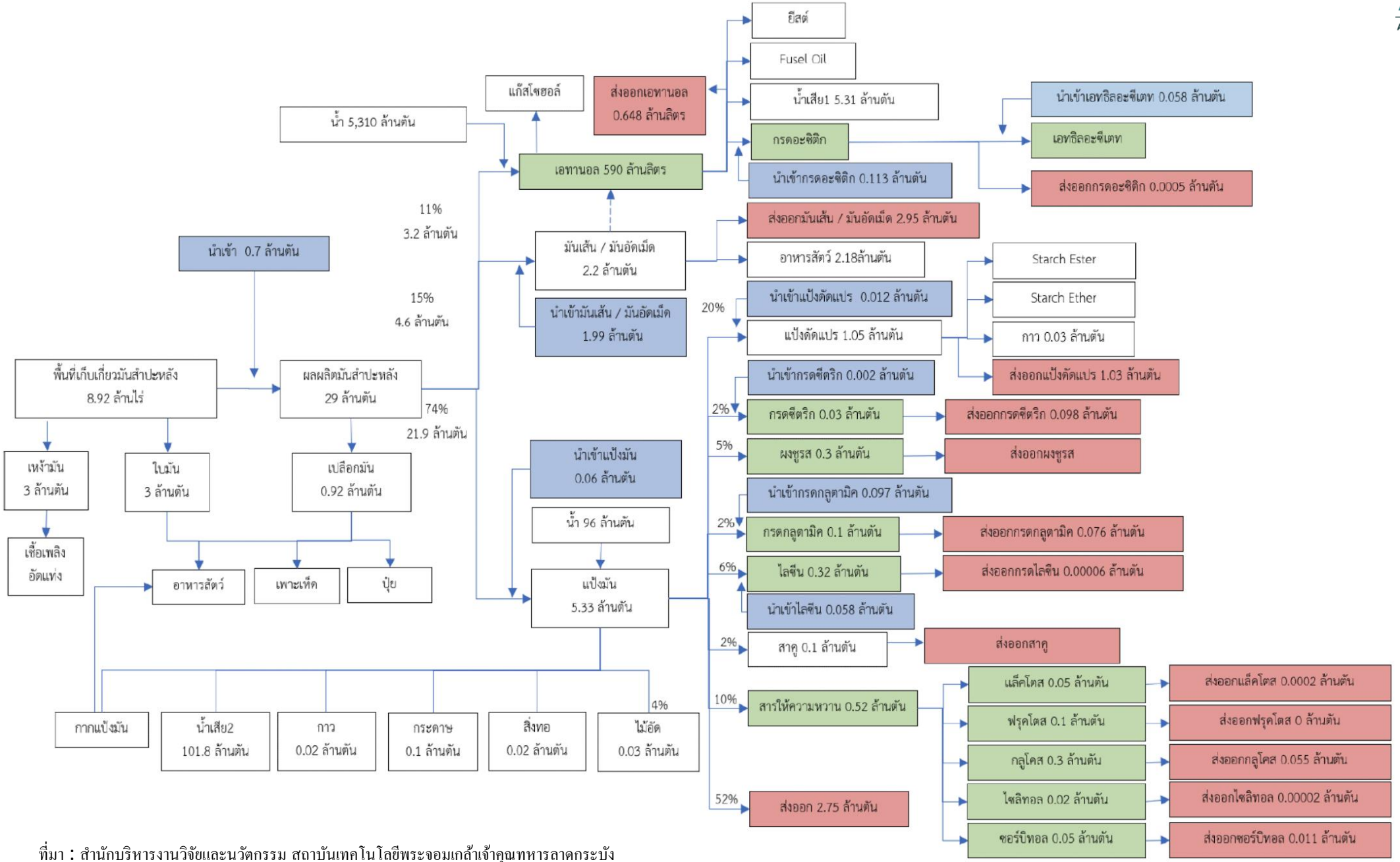
Fig. 10.1 Sugar cane processing to sucrose, ethanol, by-products, and new products.

Value Chain of Biorefinery industry from Sugar cane



ที่มา : สำนักบริหารงานวิจัยและนวัตกรรม สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง

Value Chain of Biorefinery industry from Cassava



ที่มา : สำนักบริหารงานวิจัยและนวัตกรรม สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง