



Introduction to Circular Economy

Part 5. The circular bioeconomy: examples of practices and policies



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Wednesday, 14 July 2021



Bioeconomy Definition/Description

- EU description / definition:

“The bioeconomy covers all **sectors** and **systems** that rely on **biological resources** (animals, plants, micro-organisms **and derived biomass**, including organic waste), their functions and principles. It includes and interlinks:

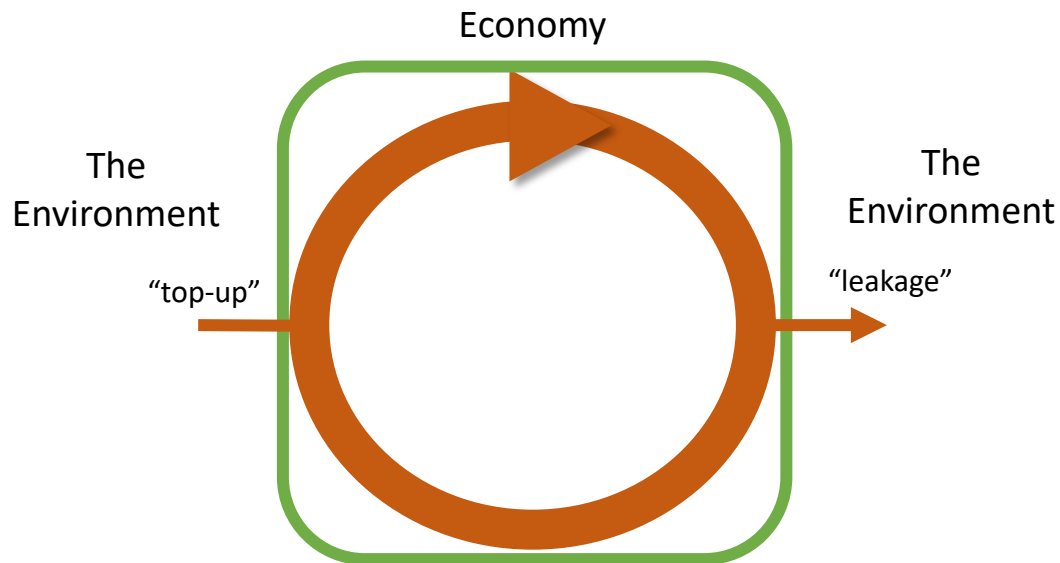
- ✓ all **primary production sectors** that use and produce biological resources (agriculture, forestry, fisheries and aquaculture);
- ✓ all **economic and industrial sectors** that use biological resources and processes to produce food, feed, bio-based products, energy and services; and
- ✓ land and marine ecosystems and the services they provide.

To be successful, the European bioeconomy needs to have **sustainability and circularity at its heart**. This will drive the **renewal of our industries**, the **modernisation of our primary production systems**, the **protection of the environment** and **will enhance biodiversity**.”

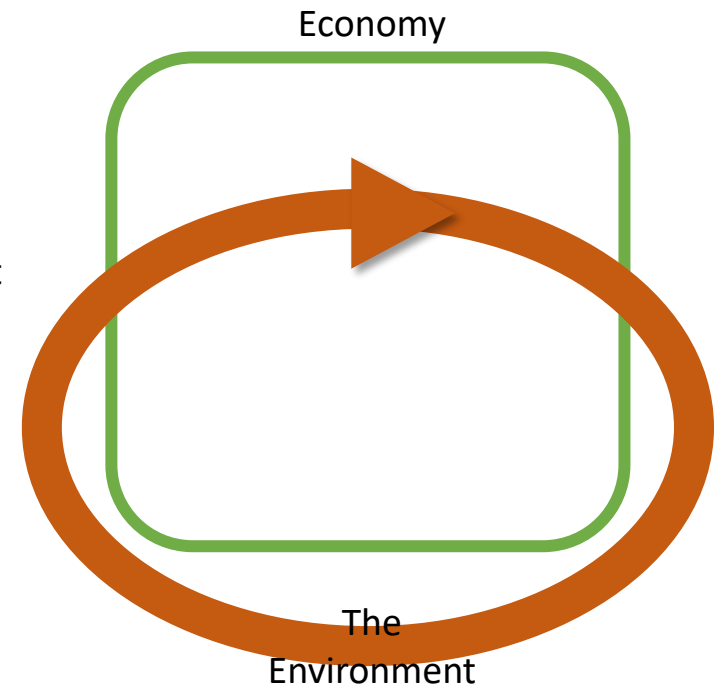
European Commission, “A sustainable Bioeconomy for Europe: Strengthening the connection between economy, society and the environment” (2018)

Technical vs. biological materials in a Circular Economy

With technical materials (metals, ceramics, glass, cement/concrete, plastics, hazardous materials, etc.) we want the flow of materials looks like this:



With biological materials, we want the flow of materials looks like this:

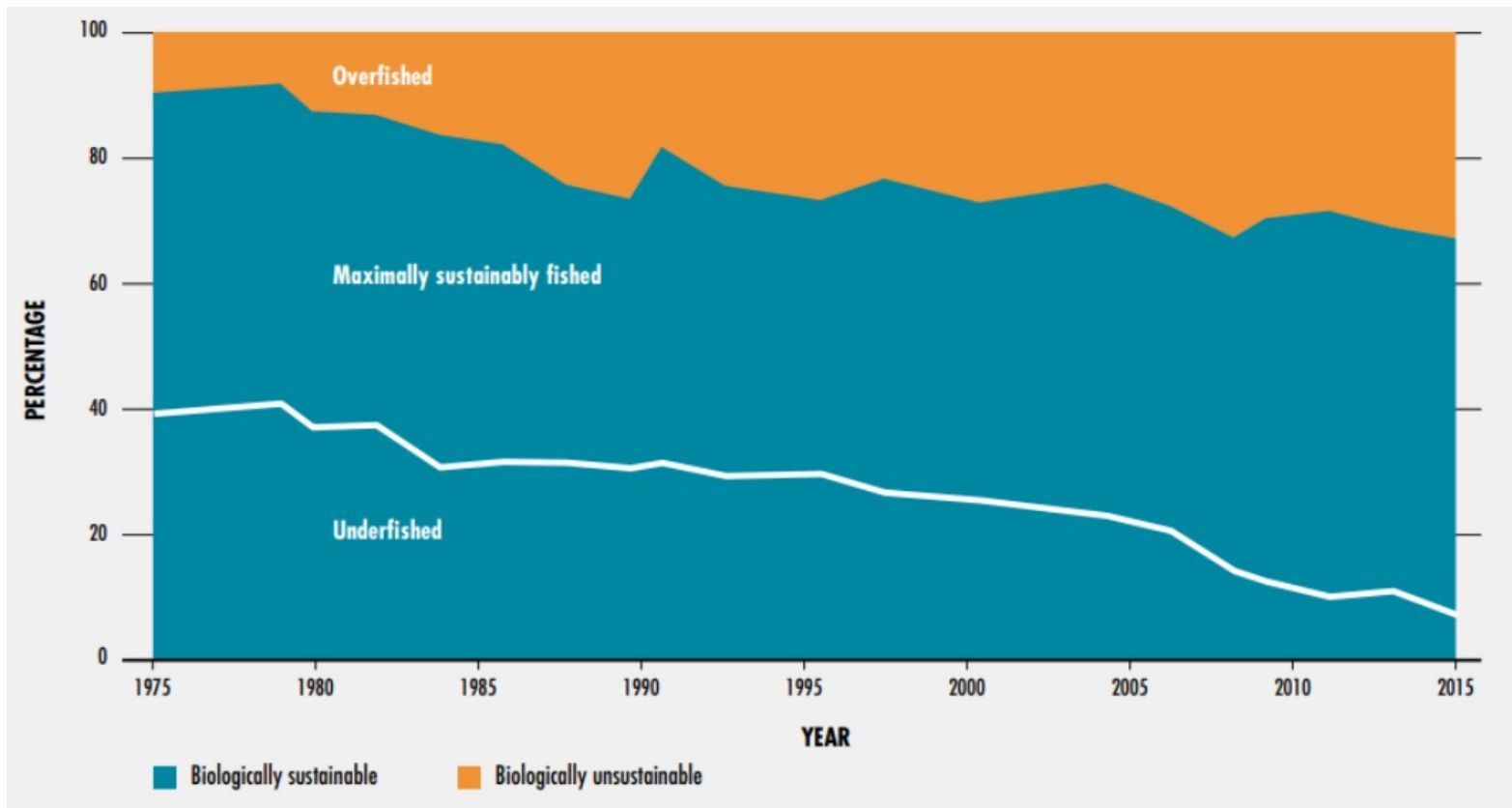


Principles for managing biological materials in a circular economy

- “Narrowing flows” and “Slowing down flows” are equally applicable to biological flows.
- “Closing the loops” for biological flows means deliberately using the Environment’s **natural recycling systems** to recycle the **carbon** and **nutrients** which make up our biological waste streams. We then **re-extract** that carbon and nutrients through newly-grown crops and plants as well as newly-born animals.
- For this loop closure to work:
 - We must not extract biological resources **too intensively**;
 - We must not overwhelm the natural recycling systems by dumping on them **more waste than they can handle**.
- If we don’t respect these two rules, the natural ecosystems will collapse!

Extracting biological resources too intensively – I

- Commercial fishing is the classic example.



Source: <http://www.fao.org/3/i9540en/i9540en.pdf>

Extracting biological resources too intensively – II

- But there are other examples:
 - Salinization of soils, through excessive irrigation
 - Loss of soil through erosion, caused by excessive cropping
 - Deforestation, through firewood production, mining, conversion to pasture or to agricultural land



Dumping too much waste

- Algal blooms from too much nutrients (N, P) being discharged to waterways is a typical example.

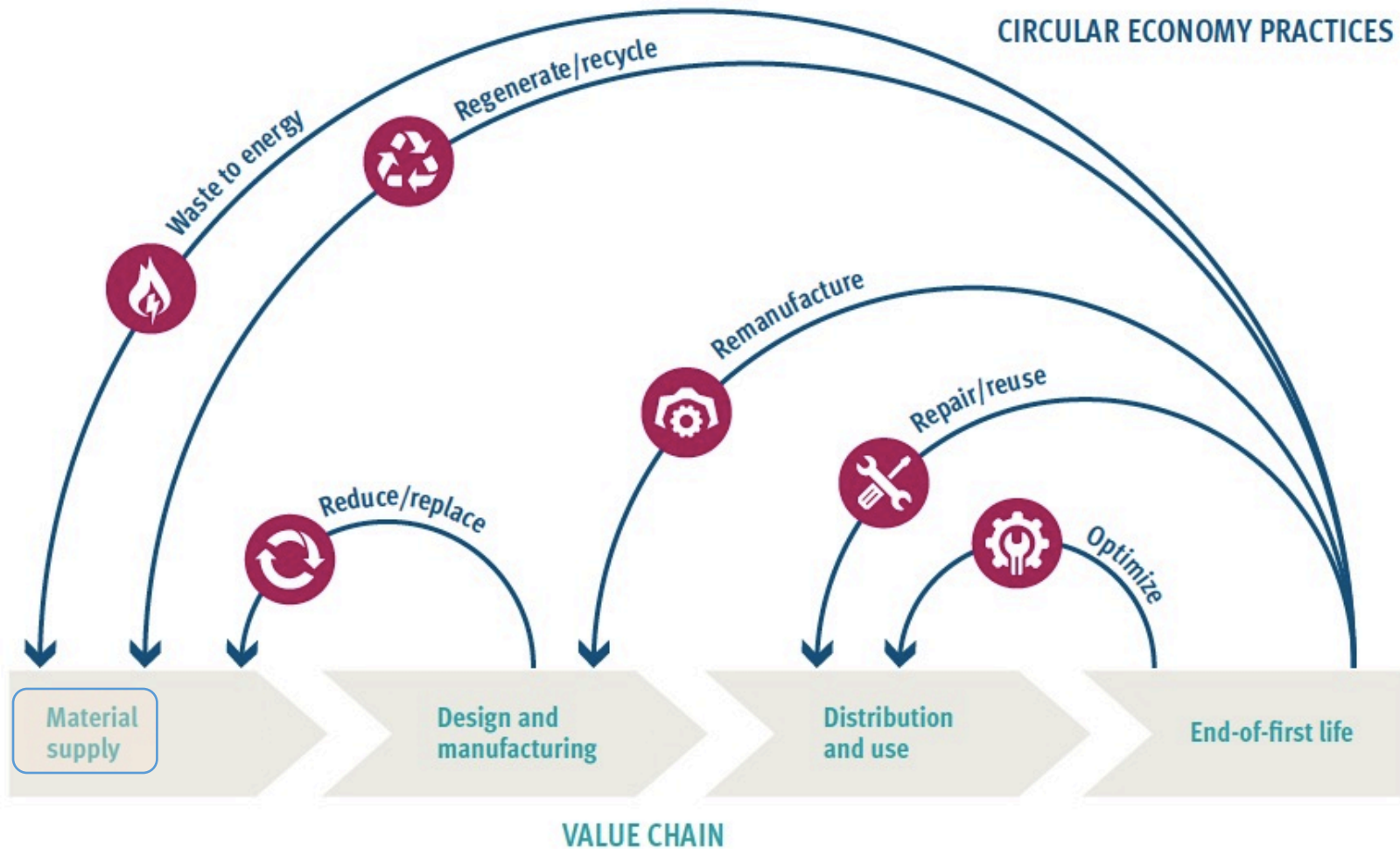


What types of biological resources enter our economies?

- Food and drink – including animal feed
 - plant-based
 - ❖ terrestrial plants
 - ❖ aquatic plants – seaweeds (“macroalgae”), sea grass
 - animal-based
 - ❖ terrestrial animals
 - ❖ aquatic animals – fish, molluscs, crustaceans
 - insect-based, e.g., honey from bees ... but also direct consumption of insects
- Wood and other lignocellulosic biomass – bamboo, other grasses, sedges, rushes, ...
- Fibre-producing biomass – cotton, hemp, flax ... but also silkworms
- Biomass offering other products – tobacco, medicinal plants, microalgae, ...
- Biomass offering services – work animals (horses, mules, donkeys), pollinators (bees, ...), microorganisms used in food production (various bacteria, fungi, yeasts)
- Biomass offering pleasure – flowers, garden plants, ... but also house pets

What types of biomass (potentially) leave our economies?

- Bio-based waste streams:
 - Crop residues
 - Animal waste (manure, etc.),
 - Waste from the industrial processing of plant, animal and woody biomass
 - Household bio-waste: food waste, gardening waste, used consumer products made with biomass, etc.
 - Human waste and wastewater treatment sludge
 - Animal carcasses



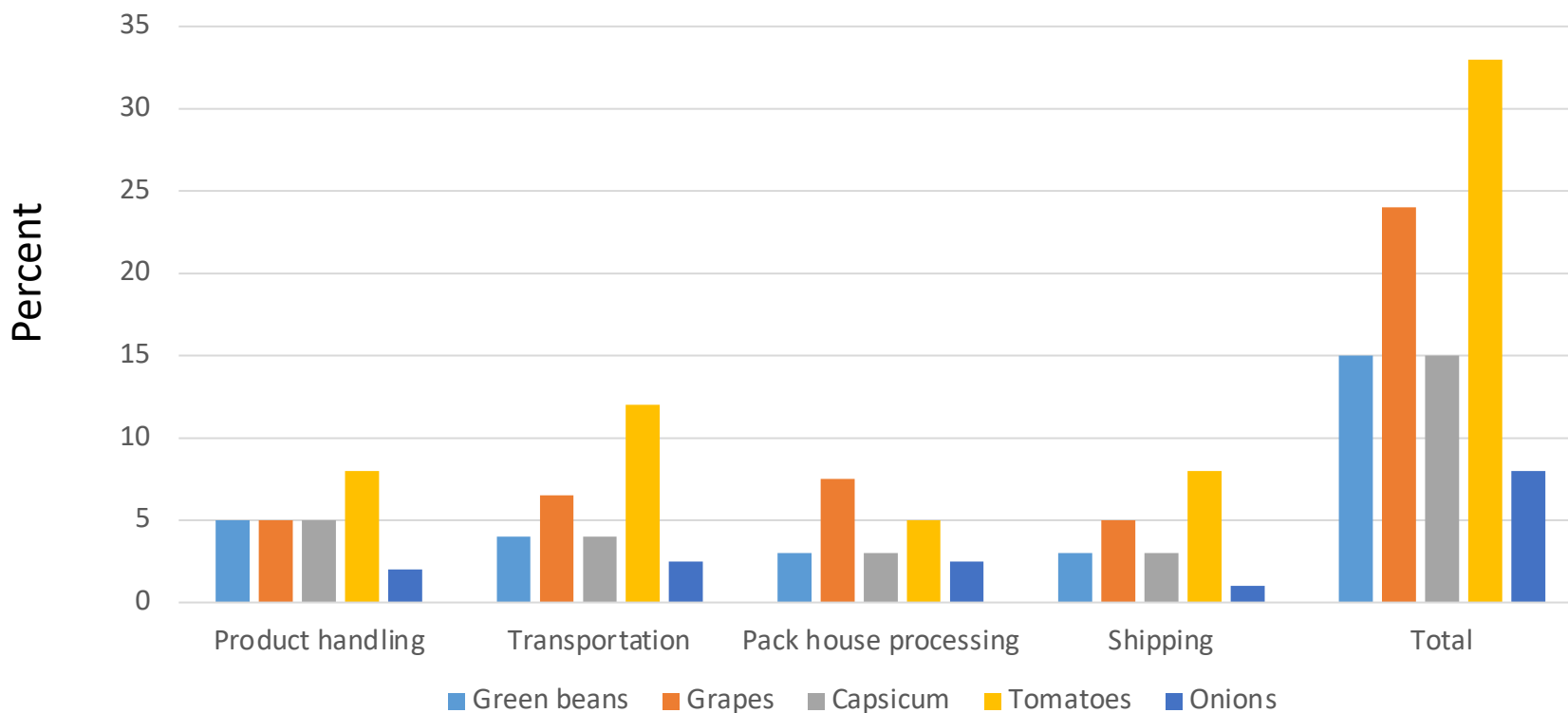


Circularity in primary production – I

- The whole point of the primary production segment is to extract biological resources from the environment (via farming, forestry, fishing, etc.), and deliver them to processing facilities (or directly to consumers) with the least amount of loss along the way.
- This is particularly true of foodstuffs.
- So “narrowing flows” by being as efficient as possible and minimizing losses as much as possible is a very important CE strategy in the primary production segment.
 - ✓ Harvesting losses
 - ✓ Post-harvest losses



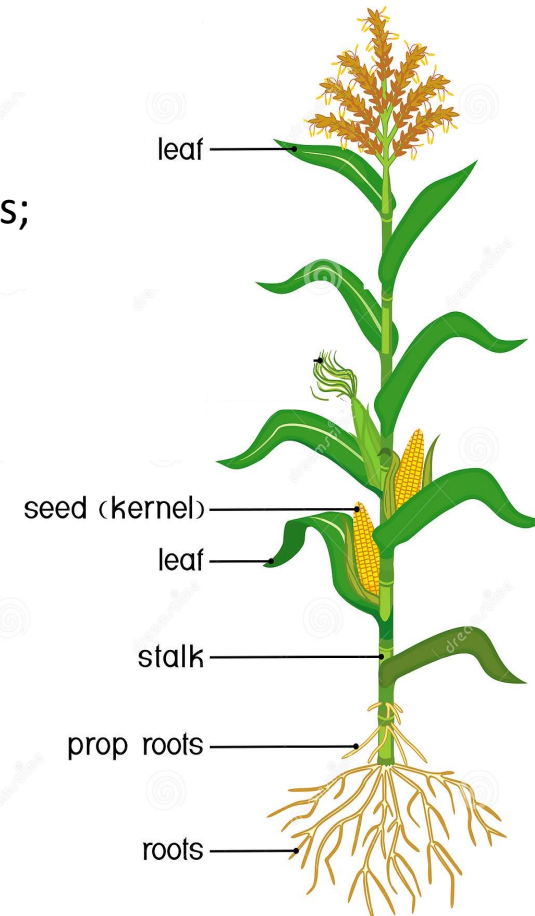
Post harvest losses, certain vegetables, Egypt



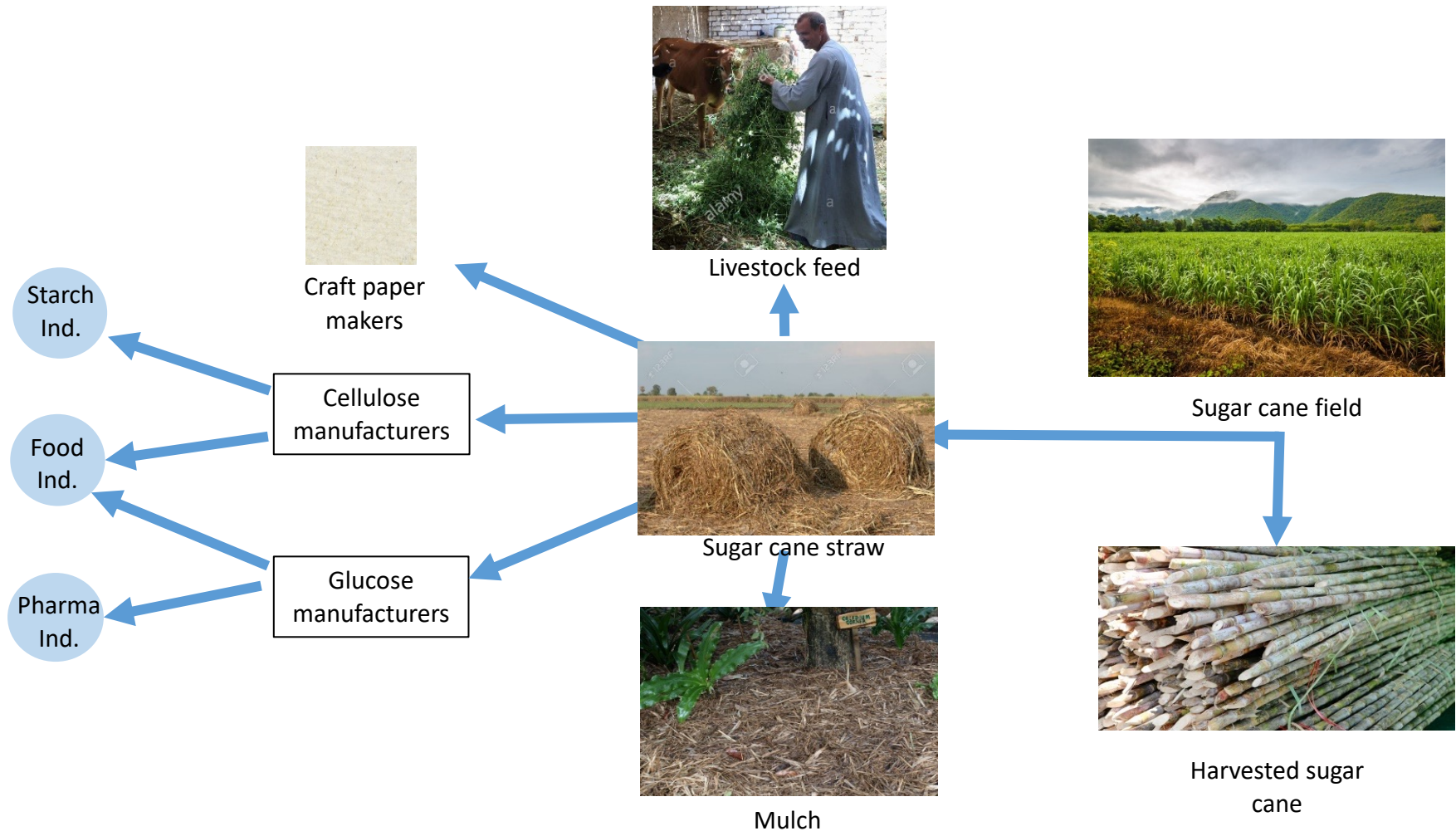
Source: Buck Consultants International, Assessment Report on Agri-logistics Losses (Green Beans, Onions, Tomatoes, Capsicum and Grapes), 2014

Circularity in primary production – II

- Biomass raw materials, and particularly foodstuffs, come with a lot of “unwanted stuff” (leaves, stalks, roots, shells, etc. in plants; bones, skin etc. in animals).
- You can “redesign” biomass (through selective breeding and, more recently, genetic engineering) to minimize the “unwanted stuff” (or maximize the wanted stuff) (“narrowing flows” strategy)
- You can also turn the “unwanted stuff” into “wanted stuff”, i.e. turn biomass residuals which are **potentially** waste into new products (“narrowing flows” strategy).



Example: turning sugar cane residuals into products





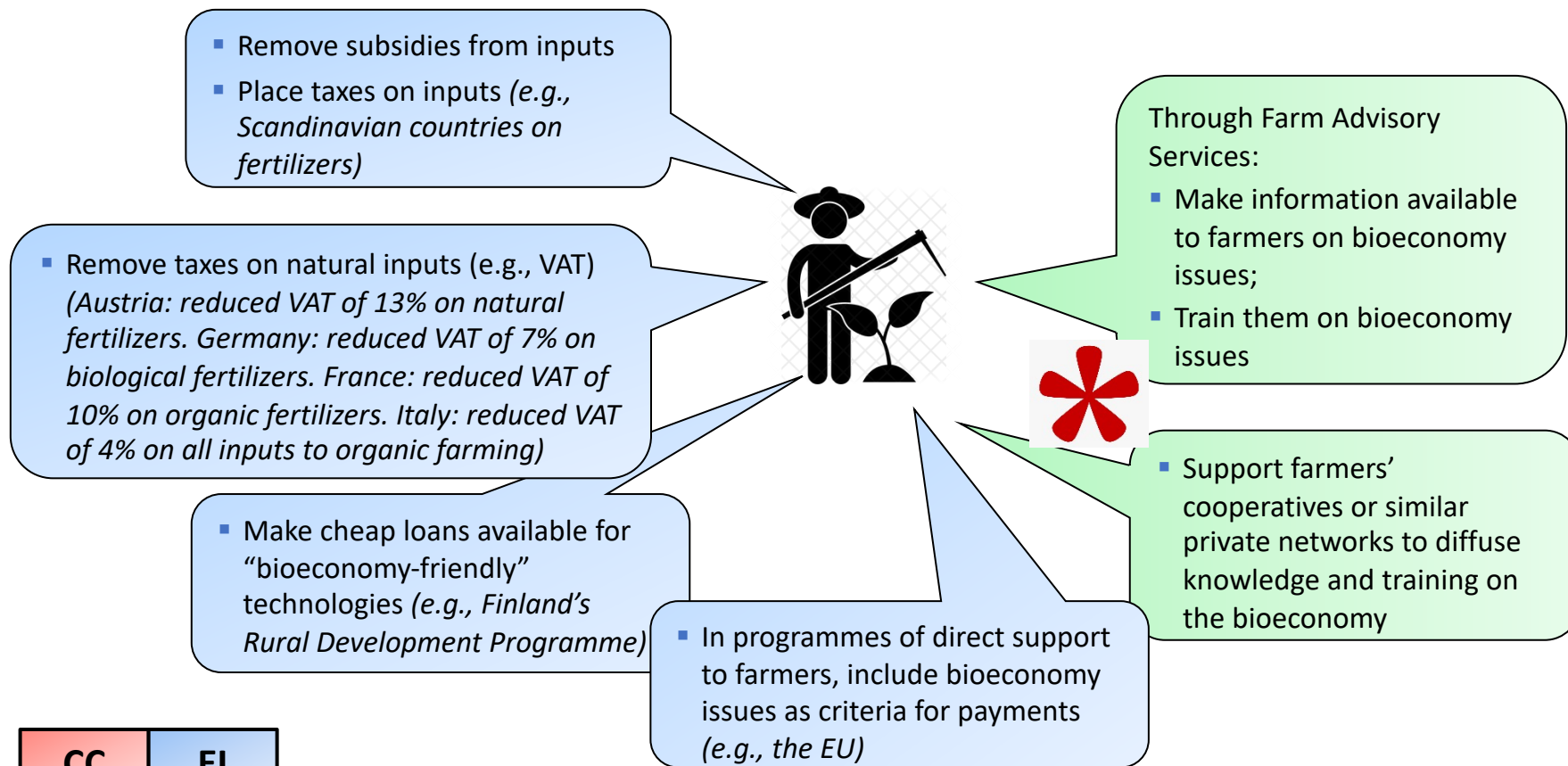
Circularity in primary production – III

Farmers and other primary producers should also be reducing the amount of **inputs** they use (“narrowing flows” strategy).

- Through greater efficiency, good management practices, and choice of good quality products, they can minimize their use of fertilizers, pesticides, water, fuel, etc.
- By changing their purchasing decisions, they can also reduce the amounts of inputs they use:
 - They can rent, not buy their machinery.
 - They can purchase natural fertilizers and pesticides rather than artificial fertilizers and pesticides.
 - They can use solar energy instead of fossil-fuel diesel (e.g., solar-powered pumps)



Policies to promote the bioeconomy in Agriculture – I



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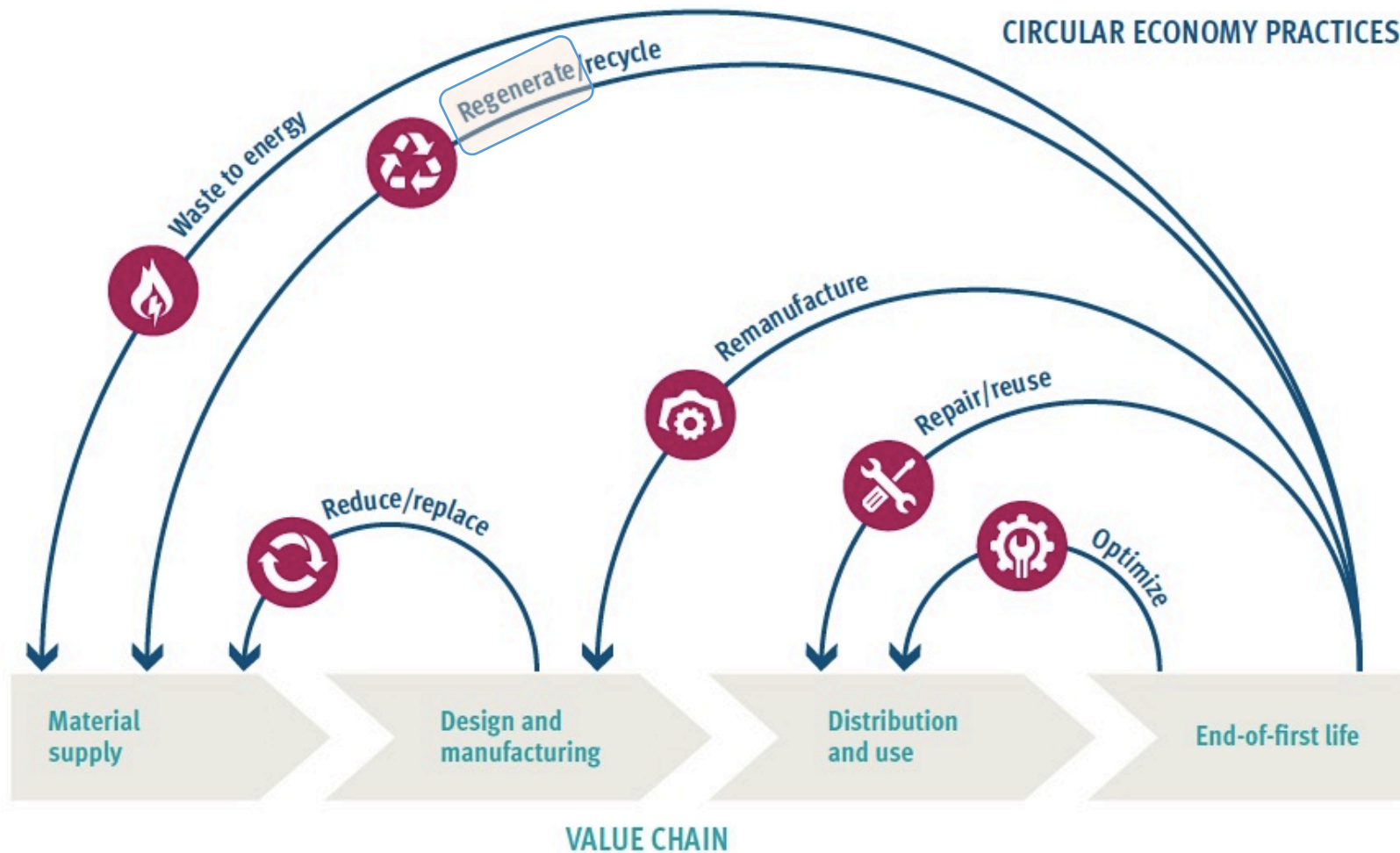
Policies to promote the bioeconomy in Agriculture – II

- Ban / severely restrict agricultural practices which discourage the valorization of biomass (*e.g., burning of straw in fields*)



- Regulate the use of fertilizers and pesticides (*many countries*)

- Ensure that under waste management laws / regs, agricultural residues are not defined as waste (*e.g., EU, partially*)



All practices and policies mentioned earlier for “Design and manufacturing” and “Distribution and use” apply equally well to biological products.

Regeneration

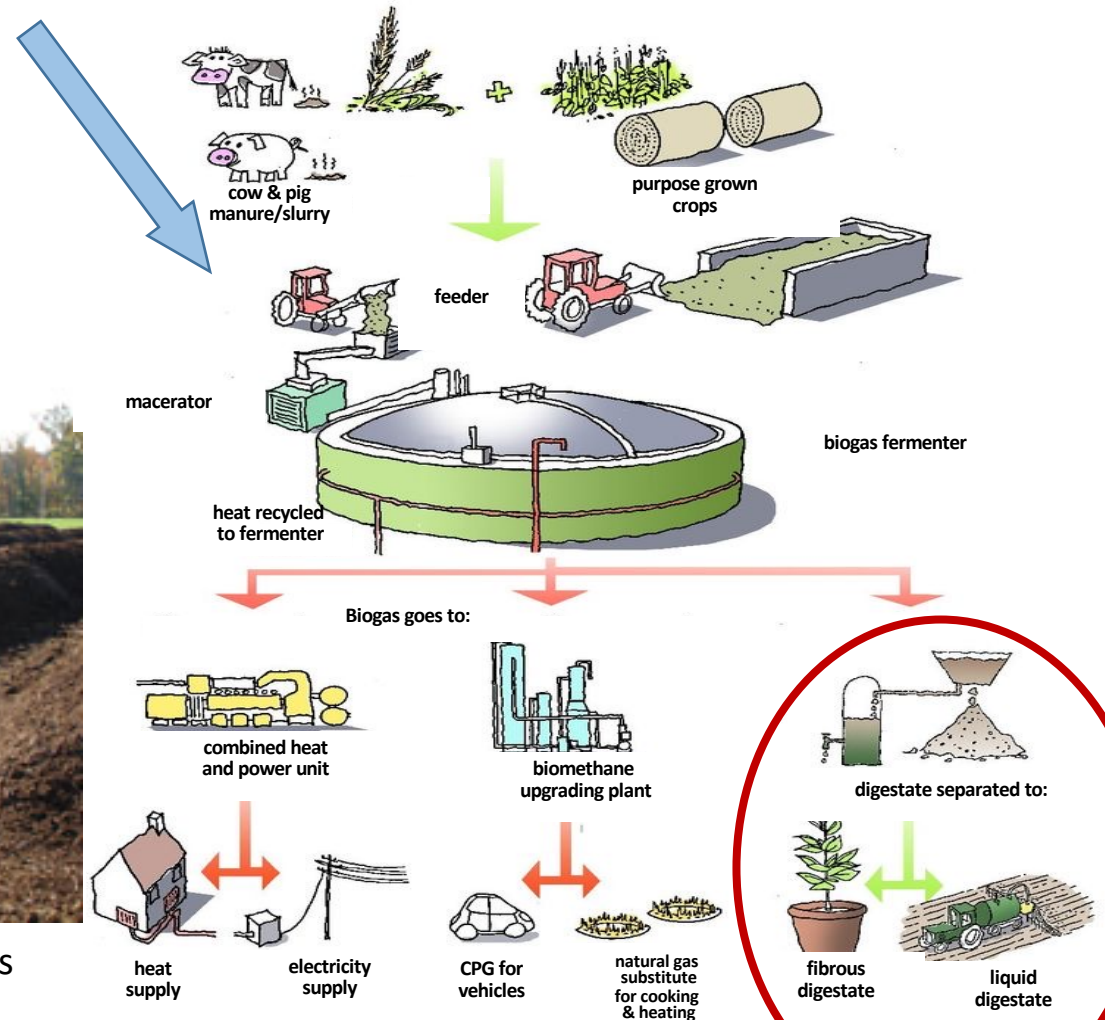
- Agriculture and forestry impoverish soils, extracting nutrients and soil carbon.
- On the other hand, much of our biomass wastes (food waste, other organic waste, wastewater treatment sludge) are poorly managed and create environmental and health problems.
- In modern times, we have maintained soil fertility by the massive use of artificial fertilizers. This is unsustainable.
- We need to maintain soil fertility and regenerate our soils naturally, by recycling our biomass wastes back to the land.
- We can do so by harnessing the Earth's natural recycling systems – bacteria, primarily – in operations which are run at **industrial scale**:
 - Composting
 - Anaerobic digestion

Anaerobic Digestion

Composting (Aerobic)



Production of uniform compost in windrows at a commercial composting facility.

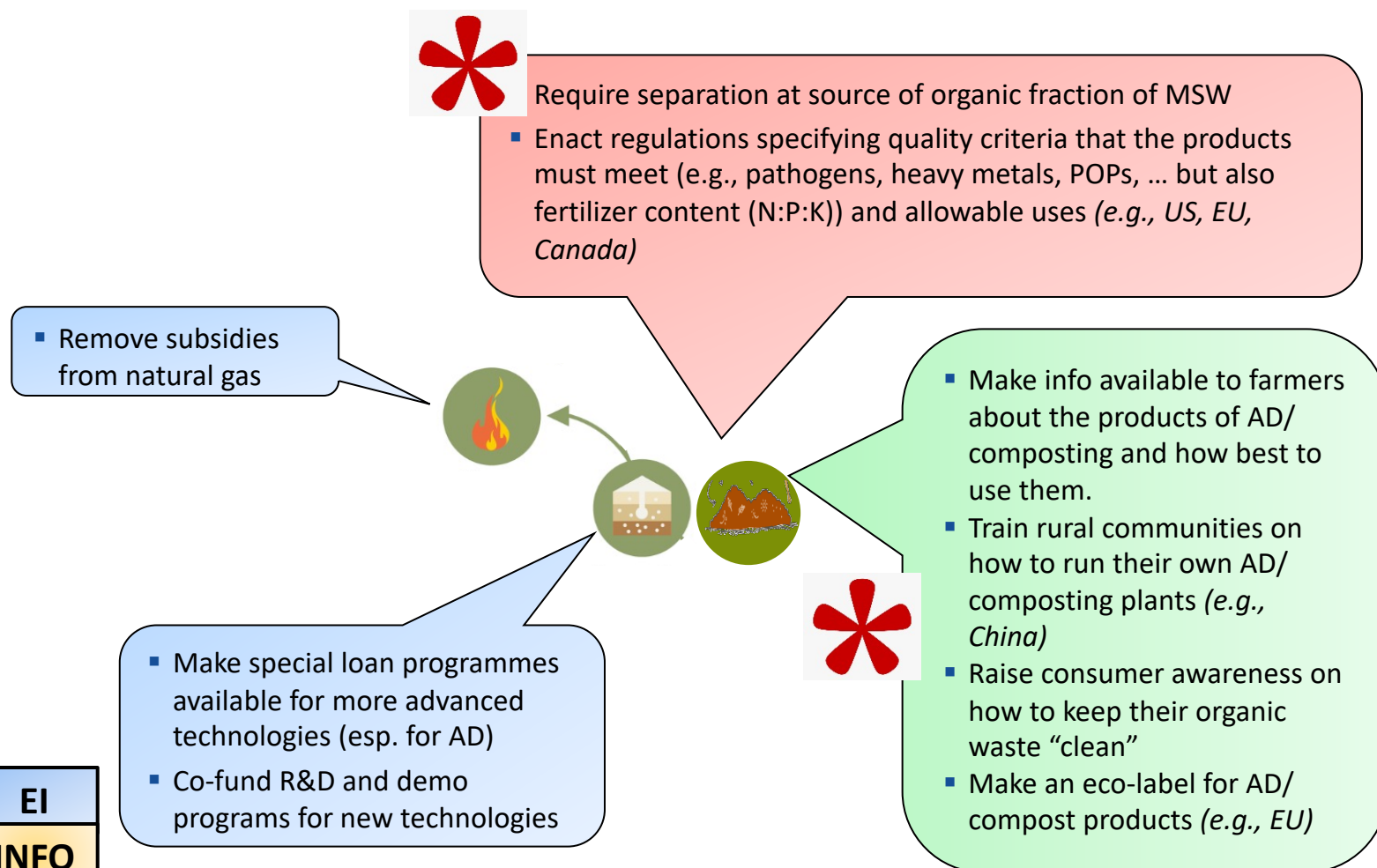


Restoring to the soil

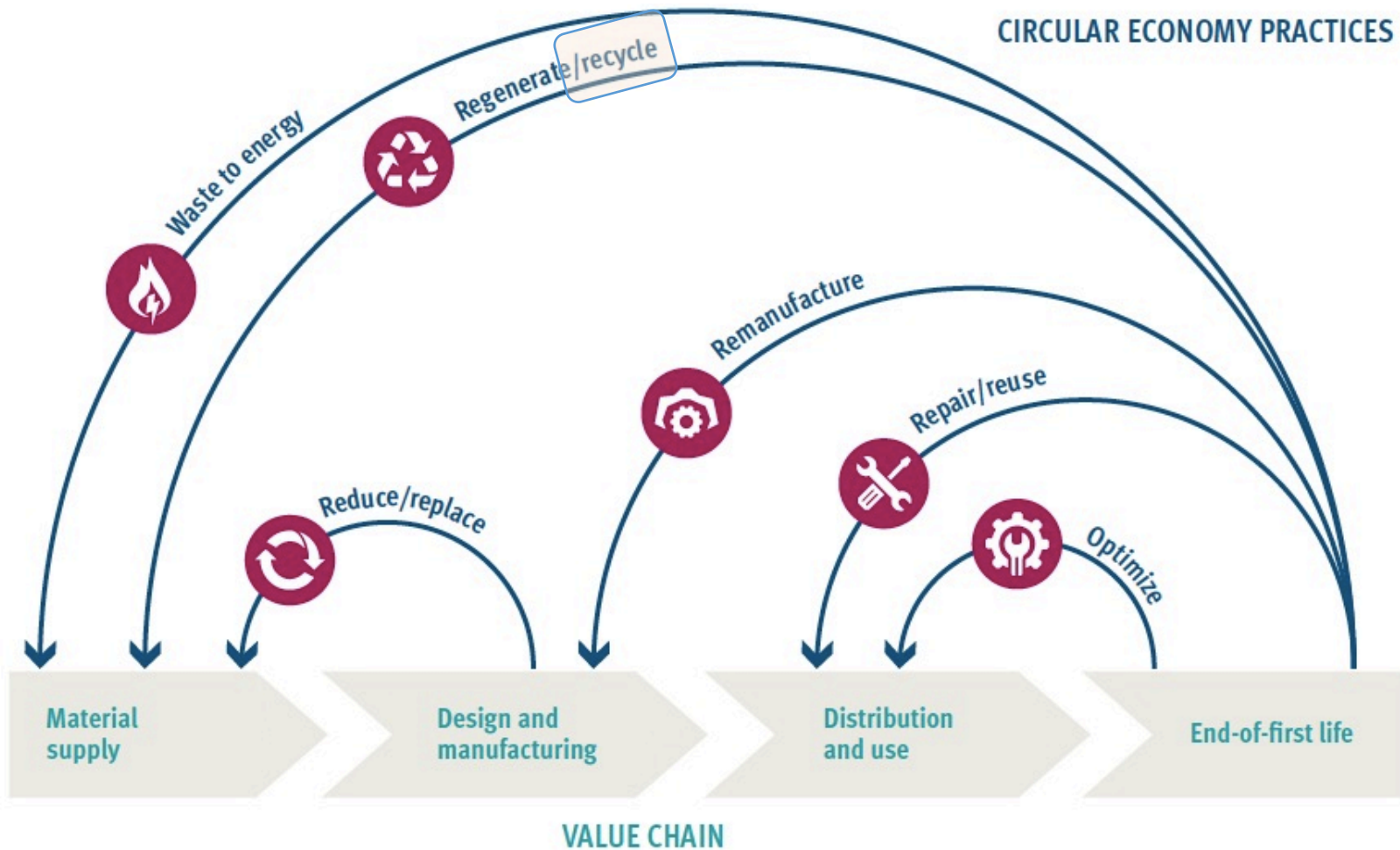
- Spread compost, fibrous digestate, liquid digestate on the land. They are good sources of nitrogen, phosphorus, potassium, magnesium, as well as carbon.



Policies to promote Composting and Anaerobic Digestion



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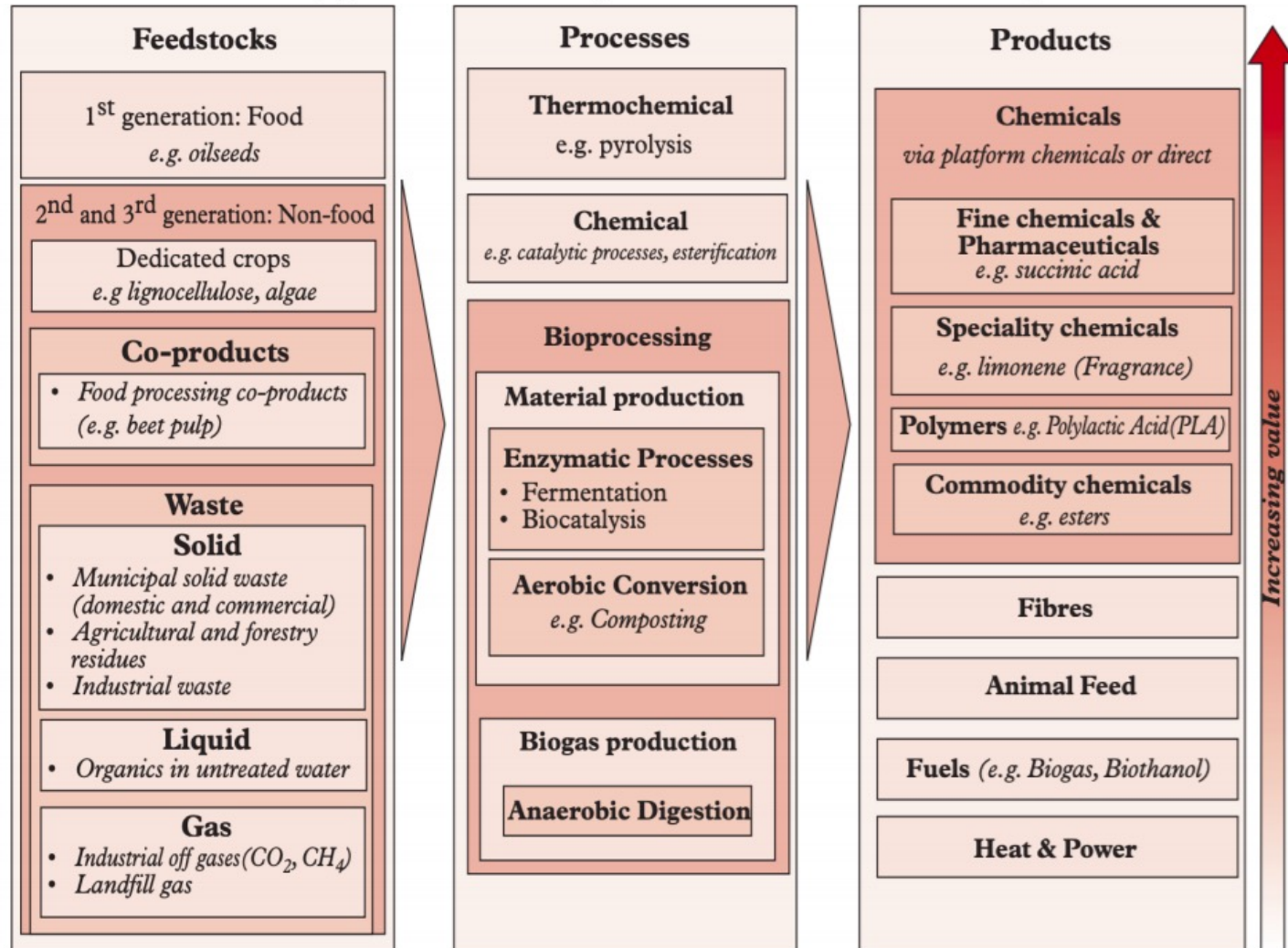




Use of biomass as a feedstock for the chemicals industry

- With the end to the use of fossil fuels, for climate change containment, we will need a new feedstock for the organic chemicals industry, to take the place of crude oil. Biomass can be that feedstock.
- Plants using biomass as feedstock are commonly called “biorefineries”.

Feedstocks, processes, and products in biorefining





Policies to promote extraction of biochemical feedstock

- Co-fund R&D on potential chemical pathways (*US, EU*)
- Co-fund demo programs of biorefinery designs (*proposed by Germany*)





Questions?

