

Food Waste

Definition of the challenge
and background information

Multicriteria

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1. What is Food Waste?

1.1 Definition

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1.1 What is Food Waste?

- Food waste and loss is any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed: food that is not eaten.
- It includes food wasted at any single level of the production process and also inedible parts of food (skin or bones).

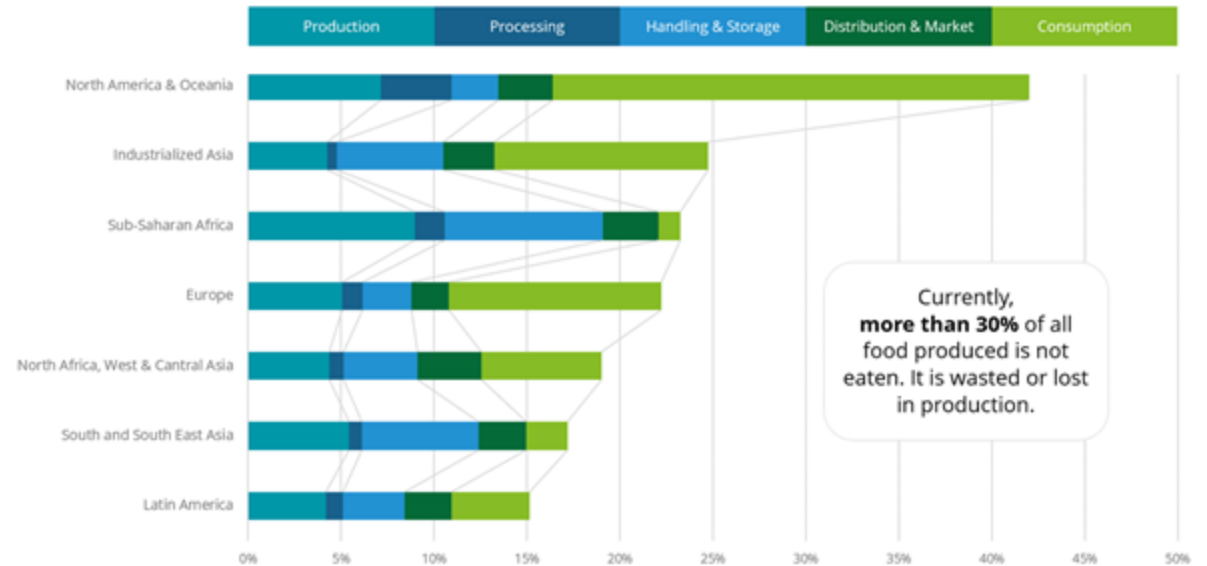


Source: Wikimedia Commons

1.2 Are Food Waste and Loss the same?

According to Food and Agriculture Organisation (FAO-UN)

- **Food loss** refers to a decrease in mass or quality of food that was originally intended for human consumption. It occurs from the start of food supply chain up to retail level.
- **Food waste** refers to food appropriate for human consumption being discarded at the retail and consumption level.
- **Food wastage** encompasses both food loss and food waste.





1.3 Some facts about Food Waste

57

Million tonnes of food waste are generated in the EU each year.

[Eurostat](#) (2020)

24%

Of water used in agriculture supplies food that will end wasted.

[European Environment Agency](#) (2020)

143.000.000.000€

Is the yearly bill of food waste in the EU.
[EU Food Safety](#) (2022)

45.7%

Of fruits and vegetables produced in Europe end up wasted.

[FAO](#) (2011)

17%

Of the produced food in the world is estimated to be wasted.

[UNEP](#) (2021)

127 kg

Of food are wasted annually per each European consumer.

[Eurostat](#) (2020)

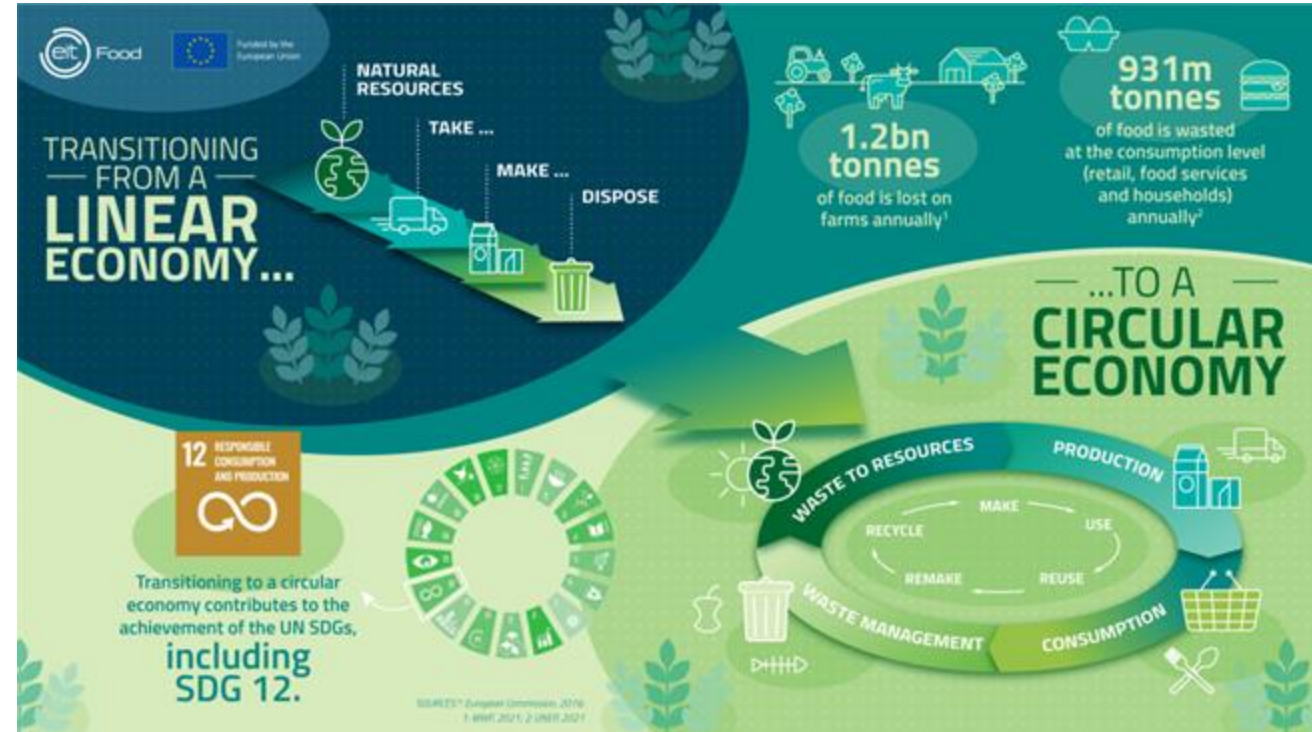
6%

Of the greenhouse emissions are emitted by food that ends wasted in the EU.

[EU Food Loss and Waste Hub](#)

1.4 What is a food system?

- The food system is a complex web of activities involving the production, processing, transport, and consumption of food.
- Our current linear model of 'make, use, and dispose' is inefficient, wasteful and unsustainable. We need to move from this to a circular food system where we use resources more efficiently and re-use side and waste streams.



Source: [EIT Food](#)

2. Circular Economy for Food

2.1 What is circular economy?

2.2 How does circular economy relate to food?

2.1 What is circular economy?

The circular economy is an economic model that aims to avoid waste and to preserve the value of resources (raw materials, energy and water) for as long as possible.

Circular economy is based on three principles:



**DESIGN OUT
WASTE AND
POLLUTION**



**KEEP PRODUCTS
AND MATERIALS
IN USE**



**REGENERATE
NATURAL
SYSTEMS**

Circular economy encourages **innovation**, from designing **products** that are **easy to fix** and **last longer**, to creating new business models where we can **share or rent items** instead of buying new ones.

2.1 What is circular economy? What are possible business models?



Materials recovery and recycling

Such as sorting and processing of recycled materials.



Green technologies and services

Production and maintenance of green technologies.



**Environmental clean-up,
monitoring, maintenance and re-
naturalization of the environment.**



Product design and repair

Products that are designed to be easily repaired, reused or repurposed will require more skilled labour to design and manufacture and in repair and maintenance services.



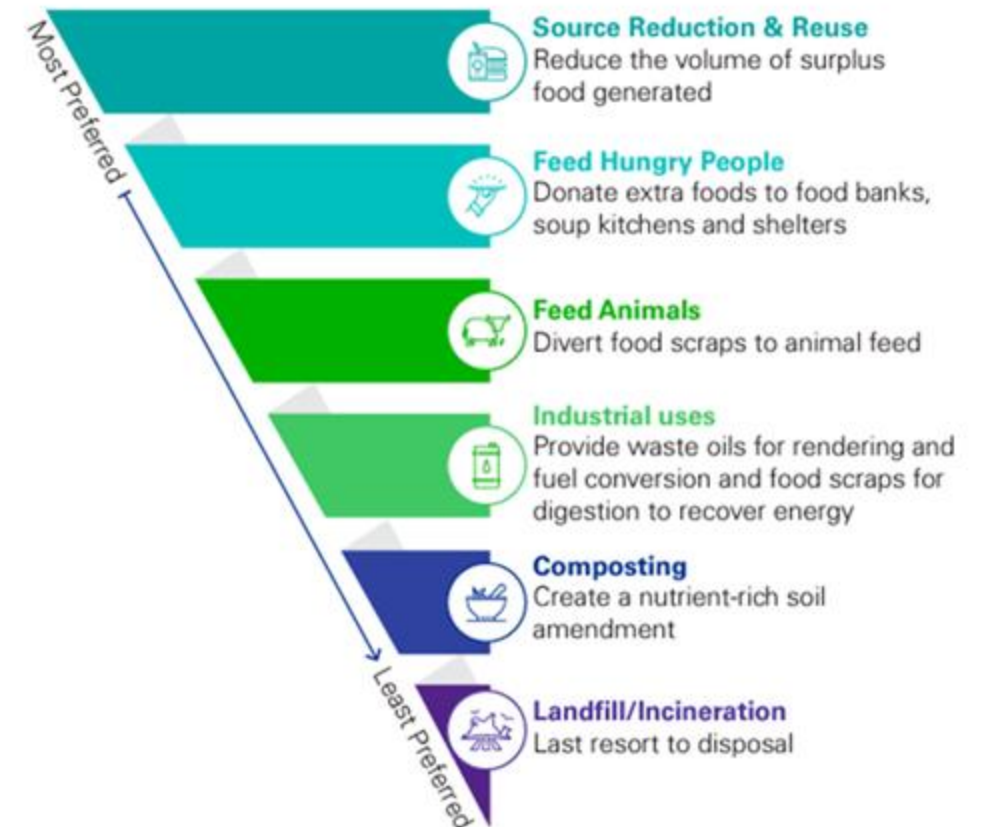
New business models

Such as product-as-a-service, remanufacturing, product-life extension, and using inedible food by-products as inputs for new products which can lead to the creation of new jobs in areas such as product design, marketing, sales, and customer service.

2.2 How does circular economy relate to Food?

- A **circular economy for food mimics natural systems** of regeneration so that waste does not exist, but is instead feedstock for another cycle.
- In a circular economy, food by-products like peels, leaves, or seeds can be put to good use! Instead of being thrown away, they can be repurposed and transformed into things like organic fertilizer for gardens and farms. Plus, some by-products can be used to create new food items, clothing and construction materials, or even energy.

Food recovery hierarchy



2.2 How does circular economy relate to Food?

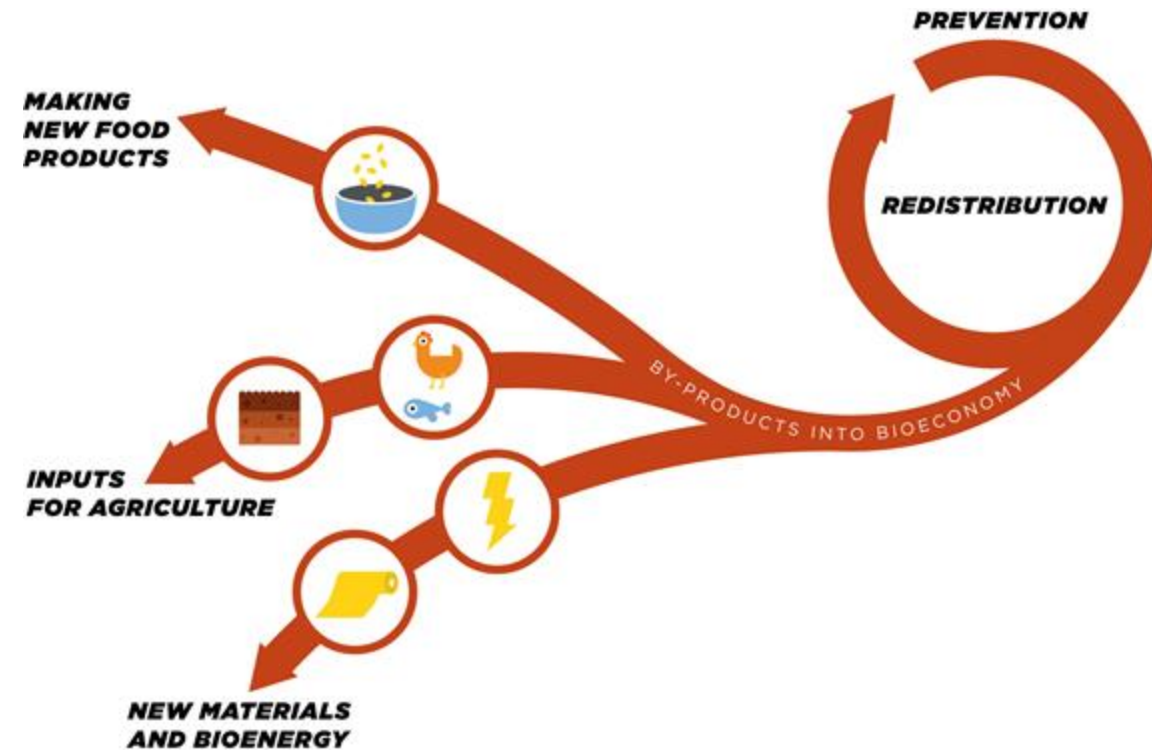
- **Reconnects communities with local food production and changes the way we grow food**
 - Beneficial for society and the environment
 - Cuts down CO₂ & returns carbon to the soil
- **Regenerative food production**
 - Healthy and stable soils
 - Improved local biodiversity
 - Air and water quality
- **Practices in local contexts**
 - Diverse crop varieties and cover crops
 - Rotational grazing
 - Agroforestry: provides a habitat for organisms.
 - Reusing organic waste flows as fertilisers



Source: <https://ellenmacarthurfoundation.org/>

After the production stage, the challenge against food waste persists. There are measures such as:

- Consumption of regional products
 - Resilient supply chain
 - Support local communities
 - Reinforcement of peri-urban green areas
 - Savings in transportations
- Redistribution of food surplus to people who may need it
- Reuse of inedible food and human waste as a base for new products.
 - Organic fertilisers for local producers
 - Construction materials



Source: <https://ellenmacarthurfoundation.org/>

3. Why do we care about Food Wastage?

The effects of Food Wastage: from production to consumption

Biodiversity

- Wasted food harms wildlife biodiversity.
- Attracts wildlife to other ecosystems or even cities.
- It alters trophic chain.

Air Quality & Greenhouse Gases

- Global food loss and waste equal to 8–10% of total anthropogenic GHG emissions.
- Trees are cut down to plant agricultural fields.

[Mbow et al](#) (2019)
[WWF](#)

Water Quality

- Agricultural irrigation accounts for 70% of water use worldwide.
- 24% of this water is wasted via food waste.
- Intensive animal farming can pollute water via infiltration.
- 8% of the total fish catch is discarded and returned to the sea (up to 15% in industrialized countries).

[FAO](#) (2017)
[EEA](#) (2020)
[FAIRR](#) (2019)
[FAO](#) (2011)

Energy Use

- Food systems consume 30% of global energy
- 70% out of it is used in the distribution chain
- 38% of the energy is wasted (food waste)

[FAO](#) (2014)
[FAO](#) (2015)

Human Health

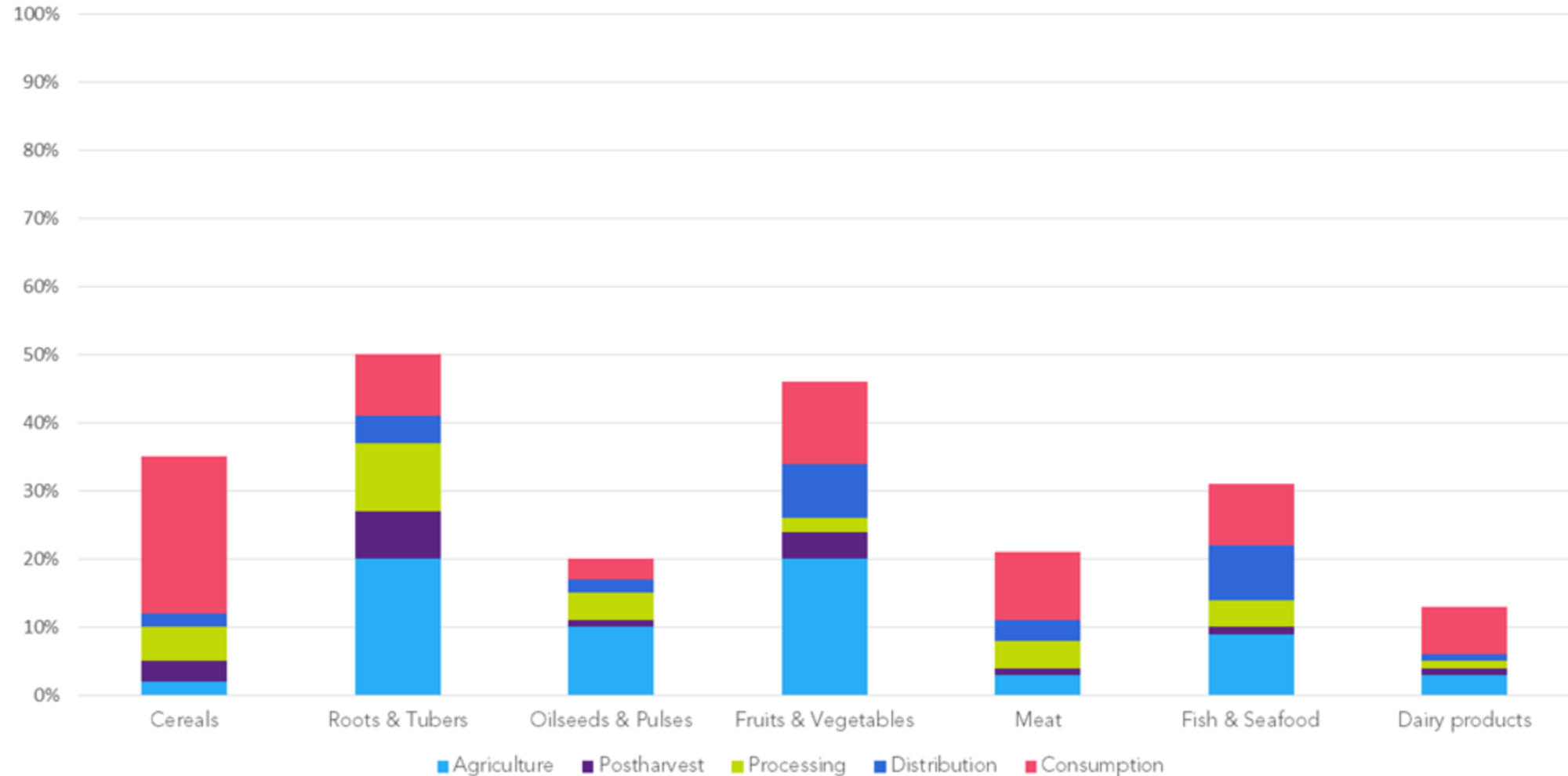
- Over half of the adult population in Europe are overweight
- 33 million people in Europe cannot afford a quality meal every second day
- 17% of global food goes to waste

[EUROSTAT](#) (2021)
[FEEDBACK_EU](#) (2022)
[UNEP](#) (2021)



*Unequal effect on territories and society,
depending on their degree of vulnerability*

Food Wastage per commodity groups in Europe



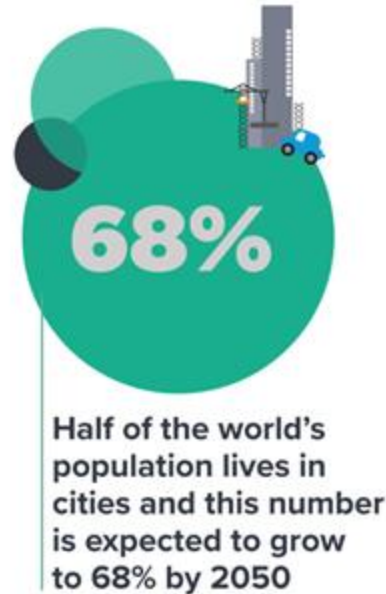
4. Why are cities so important for creating change?

4.1 How cities can be catalyst in changing the food system?

4.2 How the food system may be redesigned?

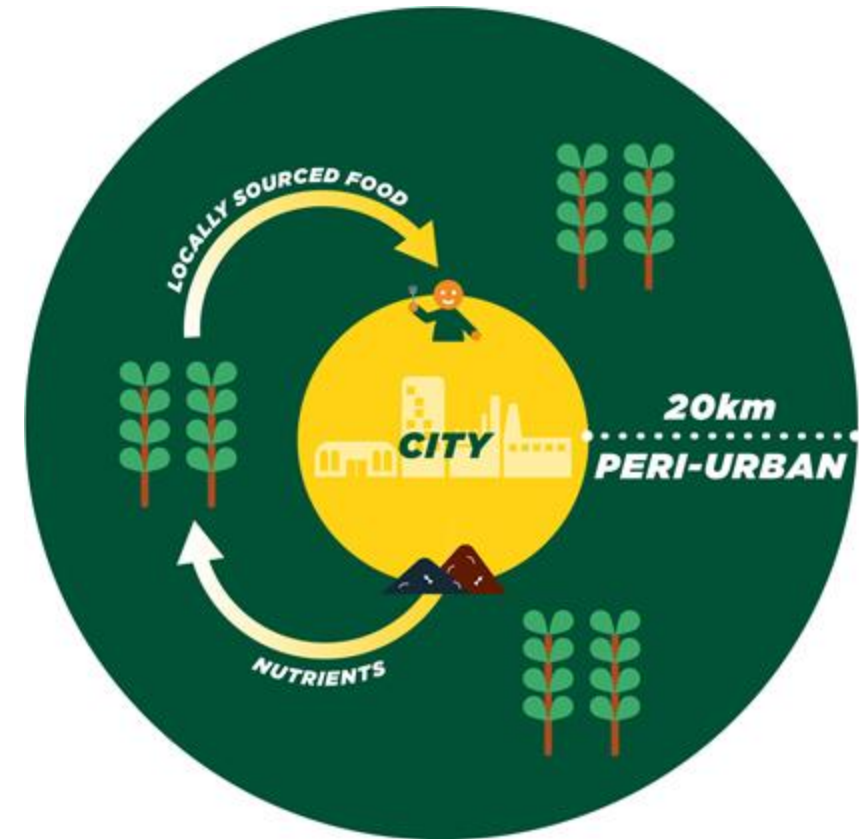
4 Why are cities so important for creating change?

- Demand power, due to the sheer volumes of food eaten, means that city businesses and governments are ideally placed to influence the type of food that enters a city, and how and where it is produced.
- The close proximity of citizens, retailers, and service providers (40% of cropland is within 20km of cities), makes new business models possible.



4.1 How cities can be catalyst in changing the food system?

- Sourcing food grown regeneratively, that employ techniques that replenish and improve the overall health of the local ecosystem.
- Demand food that is not only grown regeneratively, but also locally - when it makes sense - and support diversification of crops by selecting varieties best fitting local conditions, thereby building resilience.
- Reconnecting cities with food and farmers, supporting regenerative practices that benefit local environments.
- Use the principles of the circular economy and apply them across all dimensions of food design, from product concept, through ingredient selection and sourcing, to packaging.



4.2 How the food system may be redesigned?

DESIGNING PRODUCT CONCEPTS FOR NATURE

Design product concepts that enable nature to thrive and embedding nature-positive targets in the product brief can provide clear incentives for product development teams to design for regenerative outcomes.

PACKAGING

Three strategies can be used to help businesses achieve their circular economy goals for packaging: elimination, reuse, and material circulation.

CIRCULAR DESIGN FOR FOOD



INGREDIENT SELECTION AND SOURCING

Focus on achieving the best outcomes by taking into account which ingredients are included in formulations, how they are produced, and importantly, what role they play in regenerating the landscapes they are produced in.

4.2 How the food system may be redesigned?

Food architecture trends often follow similar patterns as those in traditional architecture



During the mid-20th century, there was a trend towards brutalist concrete structures, at the same time, there was a proliferation of brutalist processed foods



At the end of the 20th century, architects inspired by postmodernism created unique buildings that defied our expectations of form and function. Around the same time, food architects were inspired by molecular gastronomy.



The global economic recession in 2008 had an impact on both food and architecture, as there was a shift towards more sustainable, locally-sourced, and organic products in both areas.

5. Food Waste Mitigation Strategies & Initiatives

5.1 Strategies for food waste reduction

5.2 Case: Meat waste and its water footprint

5.3 Future Scenarios for Food Waste

5.4 Legal Barriers to Food Waste Circularity

5.5 Start-ups and initiatives

5.1 Strategies to Reduce Food Waste



Increasing awareness

There is growing awareness of the problem of food waste, and more people are taking steps to reduce their own food waste at home.



Government action

Many governments around the world are taking action to reduce food waste, such as by implementing food waste reduction targets or by establishing food waste reduction programs.



Technology

There are many new technologies that are being developed to help reduce food waste, such as sensors that can detect when food is going to expire and apps that can help people plan their meals more efficiently.



Business action

Many businesses, particularly in the food and hospitality sectors, are taking steps to reduce food waste, such as by implementing "first in, first out" systems to ensure that older products are used before they expire.



Collaboration

There is increasing collaboration between different sectors, such as government, business, and civil society, to address food waste.

Overall, there is growing recognition of the problem of food waste and a number of efforts underway to address it.

Food waste mitigation initiatives at different stages



Primary production

- Short supply chains and regionalisation of food production.
- Storage improvements
- Use of by-products for animal feed production.
- Taxation policies on food waste disposal
- Access to modern equipment and techniques
- Fishing: A policy reform and use of selective fishing gear.



Food processing and packaging

- Policies for resale/use of 'sub-standard' products
- Application of date marks (more accurate date labelling)



Wholesale and logistics

- Electronic ordering systems and automatic storage management systems
- Advanced packaging (improve conservation and transport techniques)
- Improve distribution (and redistribution to food banks) logistics
- Financial incentives to reduce disposal and increase redistribution
- Development of new business models around imperfect produce

Food waste mitigation initiatives



Retail and markets

- Food redistribution programmes
- Reduce prices on sell before /best before date products
- Alternative use of products
- Limits to price promotions with discounts on volumes
- Purchase per weight of fruit and vegetables
- Improve and guarantee food safety standards
- Improve refrigeration techniques
- Consumer awareness



Food Services

- Encourage consumption of leftovers and use of doggie bags
- Reduction of menu variety
- Improve demand forecasting and ordering systems
- Menu quantities based on hunger / size / healthy habits



Households

- Improve waste collection infrastructure
- Education programme on diet and cooking

5.2 Case: Meat waste and its water footprint

Meat production is a resource-intensive process, requiring significant amounts of land, water, and energy to raise and process animals. Is a major contributor to greenhouse gas emissions, having significant environmental impacts. Meat waste occurs at various stages of the food supply chain:

PRODUCTION

significant amount of waste is generated by culling and sorting animals, as well as by mortalities.

PROCESSING

Waste can be generated by trimming and processing meat cuts.

DISTRIBUTION

Waste is provided from spoilage and damage to meat products during transportation.

RETAIL

Waste can be generated by overstocking and stock rotation

CONSUMER

Waste can be generated by purchasing too much meat and not using it before it spoils.

The water footprint of meat production can be reduced by improving the efficiency of water use in feed production, using more sustainable production methods, such as regenerative agriculture, and reducing meat consumption.

The consumption of meat is a major contributor to food waste: a large proportion of the food produced globally is used to feed animals raised for meat, rather than being directly consumed by humans.



5.3 Future Scenarios for Food Waste

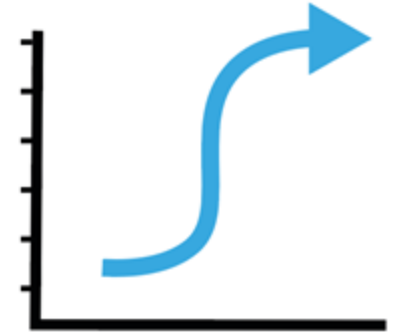
Continued progress

If current trends continue, it is possible that food waste will continue to be reduced as awareness of the issue grows and more people and businesses take steps to reduce their own food waste.



Radical change

It is also possible that technological innovations or major shifts in societal values could lead to radical changes in the way food is produced, distributed, and consumed, resulting in significant reductions in food waste.



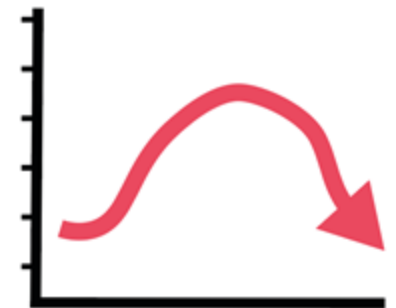
Plateau

It is possible that progress in reducing food waste may plateau at some point, as it becomes more difficult to make further gains. This could be due to a lack of incentives or technological limitations.



Reversal

If efforts to reduce food waste are not sustained or if there is a significant increase in the global population, extreme weather events, or economic downturns it is possible that food waste could increase in the future.



5.4 Legal Barriers to Food Waste Circularity

Food Safety Regulations

Some of them can make it difficult to create novel food, repurpose or donate food that is past its expiration date, even if it is still safe to eat. Businesses may be hesitant to donate or repurpose food due to concerns about liability in the event of food-borne illness. Regulations on food labelling and packaging can be very strict for novel food and can make it difficult to repurpose food that is mislabelled or packaged in a way that does not meet regulations.

Zoning Regulations

These regulations can limit the use of land for certain activities, such as composting or anaerobic digestion, and may make it difficult to process food waste on-site. Zoning regulations vary by country and region, therefore it is worth to consider:

Air quality regulations.

Noise regulations.

Waste management regulations.

Water quality regulations.

Building codes.

Fire safety regulations.

Barriers to tech pilots

There are several legal barriers to deploying tech pilots in European cities and rural communities. These include:

Privacy and data protection laws.

Regulatory barriers.

Liability and safety concerns.

Procurement laws.

Interoperability.

Waste Management Regulations

EU directives that aim to reduce the amount of waste generated and promote recycling and recovery of waste materials.

Waste Framework.

Landfills.

Batteries.

Packaging and Packaging Waste.

Vehicles End-of-Life.

Waste Electrical and Electronic Equipment.

Circular Economy Package.

5.5 Start-ups and initiatives

Es im-perfect (Barcelona):
[Fight food waste while giving job opportunities to everyone](#)



- Cook and sell jelly, pate, sauce or compote made from discarded food either at production stage or coming from excedents.
- Social project employing vulnerable people in risk of social exclusion.



Ottan Studio (Turkey):
[Upcycling food waste](#)



- Green waste upcycling into high-quality materials to be used in interior design and industrial design products.
- They create furniture, decoration, light beams or wall panels.



Start-ups and initiatives

Too Good To Go (Denmark → Worldwide):
[Lets customers buy and collect Surprise Bags of food](#)



- Through their app, everyone can check if their neighbour restaurants, cafes or shops have leftovers and pick them up at a great price.
- +150.000 businesses around the world are selling surprise bags through this app.



RePlate (US):
[Food donation management](#)



- Manage the food donations: They take them to a nearby non-profit that works with people experiencing food insecurity.
- They create furniture, decoration, light beams or wall panels.



Start-ups and initiatives

Kebony (Norway)
Modified wood manufacturers

ke
bo
ny

Natural wood
Made to last

- They modify food waste to mirror the behaviour and characteristics of tropical hardwood, which is typically harder, stronger, and more durable.
- They can prevent deforestation and save tons of greenhouse gas emissions.



BIO2CHP (Greece):
Energy production from residual biomass

BIO₂CHP
ON-SITE ENERGY PRODUCTION

- They use fruit waste, coffee grounds, and olive kernels for small-scale, on-site electricity production.
- It converts waste into additional revenue while reducing the footprint of the end user.

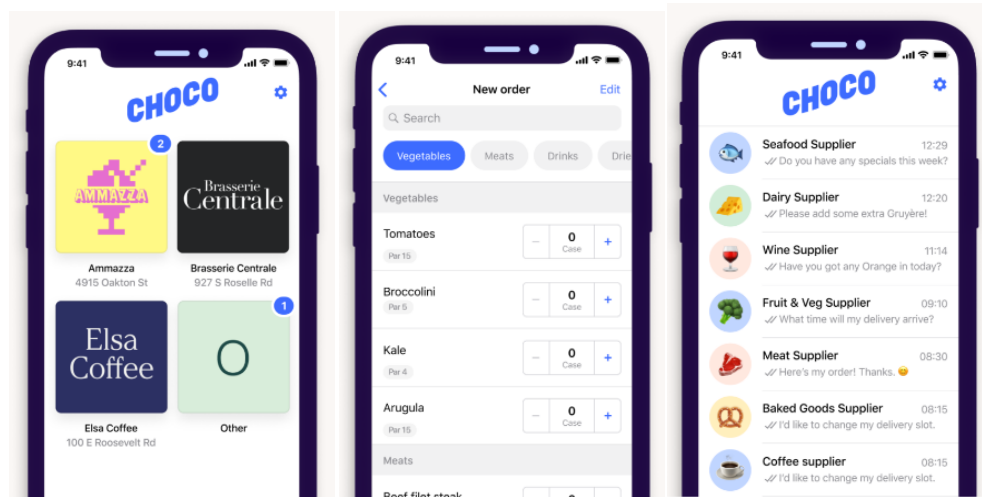


Start-ups and initiatives

Choco (Germany) [Digitalised order system for restaurants](#)



- They facilitate decision making on restaurants ordering their ingredients with their novel digital platform.
- They have linked over 10.000 suppliers with 15.000 chefs to improve order accuracy and avoid food loss at this stage.



HUT und STIEL (Austria) & PermaFungi (Belgium) [Oyster mushrooms growing from coffee grounds \(1\)](#) [\(2\)](#)

- This two startups collect coffee disposals from their towns and use them to grow oyster mushrooms.
- They sell kits for home production and even PermaFungi creates lampshades from a myco material.



Sustainable Business Model Categories

Groupings Archetypes Examples



Technological

Maximalise material and energy efficiency

Low carbon manufacturing / solutions
Lean manufacturing
Additive manufacturing
De-materialisation of products / packaging
Increased functionality to reduce total number of products required

Create value from waste

Circular economy, closed loop
Cradle 2 Cradle
Industrial Symbiosis
Reuse, recycle, re-manufacture
Take back management
Use excess capacity
Sharing assets, ownership and collaborative consumption
Extended producer responsibility

Substitute with renewables and natural processes

Move from non-renewable to renewable energy sources
Solar and wind based energy innovations
Zero emission initiative
Blue economy
Biomimicry
The Natural Step
Slow manufacturing
Green Chemistry

Social

Deliver functionality rather than ownership

Product oriented PSS - maintenance, extended warranty.
Use oriented PSS - rental, lease, shared
Result-oriented PSS - Pay per use
Private Finance Initiative (PFI)
Design, Build, Finance, Operate (DBFO)
Chemical Management Services (CMS)

Adopt a stewardship role

Biodiversity protection
Consumer care: promote consumer health and well-being
Ethical (fair) trade
Choice editing by retailers
Radical transparency about environmental / societal impacts
Resource stewardship

Encourage sufficiency

Consumer education models; communication and awareness
Demand management, including cap & trade
Slow fashion
Product longevity
Premium branding / limited availability
Frugal business
Responsible distribution / promotion

Organisational

Repurpose for society / environment

Not for profit
Hybrid businesses, social enterprise for profit
Alternative ownership: cooperative, mutual, farmers collectives
Social and biodiversity regeneration initiatives: Net positive
Base of pyramid solutions
Localisation
Home based, flexible working

Develop scale up solutions

Collaborative approaches: sourcing, production, lobbying
Incubators and entrepreneur support models
Licensing, franchising
Open innovation platforms
Crowd sourcing / funding
Patient / slow capital collaborations

Data: [Bocken et al. 2014](#)
Chart: Multicriteria





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