Current issues of waste across the food chain

By-products, co-products and waste utilisation

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Definitions

**Food Loss:** The decrease in edible food mass at production, postharvest, processing, and distribution in value chains directed to human consumption.

**Food Waste:** Food fit for human consumption being discarded at the retail or consumer level.

**Food Wastage:** Encompasses “food loss” and “food waste.

**By-product:** Something produced in the making of something else or a secondary result.
Definitions

• What proofs are relevant for *prima facie* evidence of a product/by-product?
  • Economic value
  • Produced intentionally
  • Subject to product/use regulations
  • Use is permitted
  • Use for purpose intended

• In the case of a product the presumption is that they are not waste until proven otherwise.
What is waste?

Around one third of the food produced globally is lost or wasted.
Per capita food losses and waste, at consumption and pre-consumption stages, in different regions

Food waste in Europe

89 million tonnes/year in EU

123 kg per capita/year or 16% reaching consumers

Almost 80% is avoidable as it is edible

By 2020: 126 million tonnes/year expected

Food chain

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Food Supply Chain

1. Plant production
2. Animal production & aquaculture
3. Fisheries

Primary production

Primary production ready for post-harvest
1. Plant production
2. Animal production & aquaculture
3. Fisheries

Processing and Manufacturing

Wholesale, retail & marketing
1. Wholesale
2. Retail
3. Redistribution

Food preparation & consumption
1. At home
2. Out of home

Food chain vs waste

Food and inedible parts removed from the food supply chain

Valorisation & conversion
Animal feed
Biobased materials & biochemical processing

Food waste
Composting
Anaerobic digestion
Plough in
Bio-energy
Incineration
Landfill
Discards
Co-generation

Non food production chain
Biobased production chains (e.g. bio-materials, biofuels, pet food)
Types of losses

Waste during storage
Surplus cooking
Spoiled food
Food preparation waste
Plate scraping
Loss Across the Value Chain

- **Agricultural Production Loss:** Spilled or damaged agricultural output during harvest, sorting, and handling.

- **Postharvest Handling and Storage Losses:** Losses due to spillage and degradation during handling, storage, and transportation off the farm.

- **Processing Losses:** Losses due to spillage and degradation during industrial or domestic processing, including crops sorted out or lost during process interruptions.

- **Distribution Losses:** Losses experienced while in the market system, e.g., in wholesale markets, supermarkets, retailers, and wet markets.

- **Consumption Waste:** Waste incurred at the household level, typically due to discards.
Where food waste occurs

- Agriculture
- Post-harvest
- Consumption
- Distribution
- Processing

Food losses
Where food waste occurs

20 %  30 %  40 %  45 %  35 %  20 %  20 %
20% Oilseeds & Pulses Food Losses
Every year, 22% of the global production of oilseeds and pulses is lost or wasted.

30% Cereals Food Losses
In industrialized countries, consumers throw away 285 million tonnes of cereal products.

45% Roots & Tubers Food Losses
In North America & Oceania alone, 5,814,000 tonnes of roots and tubers are wasted at the consumption stage alone.

45% Fruit & Vegetables Food Losses
Along with roots and tubers, fruit and vegetables have the highest wastage rates of any food products; almost half of all the fruit and vegetables produced are wasted.

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20% MEAT FOOD LOSSES
Of the 263 million tonnes of meat produced globally, over 20% is lost or wasted.
This is equivalent to 75 million cows.

35% FISH & SEAFOOD FOOD LOSSES
8% of fish caught globally is thrown back into the sea. In most cases they are dead, dying or badly damaged.
This is equal to almost 3 billion Atlantic salmon.

20% DAIRY FOOD LOSSES
In Europe alone, 29 million tonnes of dairy products are lost or wasted every year.
This is the same as 574 billion eggs.

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Impact of food waste

Environmental impact of food waste in North America and Europe. BCFN 2013.
Waste utilisation

• Not just the disposal costs – but there are other costs to consider
  • Costs to buy
  • Costs to cook & manage on site
  • Cost of disposal

It has been estimated that each tonne of food waste can cost between €3,000 - €4,000
Food waste – possible solutions

Preventing food waste = 1st priority

• Awareness raising, information & education
• Food redistribution programmes
• Logistical improvements
• Role of food packaging

Transforming unavoidable food waste into a resource

• Feed & energy recovery → separate collection of food waste necessary
What food is being throwing out?

**60% Avoidable:**
- plate scrapings
- leftovers
- gone off fruit and veg etables
- Best before date items
- damaged stock which cannot be used due to H&S, etc.

**20% Potentially Avoidable**
- bread crusts or heels made into bread crumbs
- vegetable trimmings used for stock and soups
- meat and fish bones used for stock
- discarded butter for cooking
- old fruit for jams and smoothies, etc.

**20% Unavoidable**
- banana skins
- animal bones (before or after used to make stock),
- unusable prep waste (e.g. potato peels with soil on them), etc.
Business challenges

• Raw materials availability (volumes, seasonality)
• Logistics
• Market potential of products (volumes, value)
• Investment – Reducing risk
• Business models
• Economic and environmental impact
Research challenges

• Detailed compositional data of food waste materials
• Implementation of green processing technologies
• Integration of processing with technologies
• Process scalability & process economics
• Functionalisation of molecules to suit market applications/Consumer
Possible solutions

- Reduce waste
- Utilise waste for valuable compounds
- ‘Design out’ waste involving innovation throughout the value chain

Targets by 2030
- Reduce material input by 17-24%
- Saving potential €630 bn
- Reduce total GHG emissions

Towards a circular economy: A zero waste programme for Europe, European Commission, 2014 value chain
# Bakery waste composition (per 100 g)

<table>
<thead>
<tr>
<th>Content</th>
<th>Pastry</th>
<th>Cake</th>
<th>Wheat bran</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>34.5 g</td>
<td>45.0 g</td>
<td>N/A</td>
</tr>
<tr>
<td>Starch (dry basis)</td>
<td>44.6 g</td>
<td>12.6 g</td>
<td>N/A</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>33.5 g</td>
<td>62.0 g</td>
<td>15.0 g</td>
</tr>
<tr>
<td>Lipids</td>
<td>35.2 g</td>
<td>19.0 g</td>
<td>6 g</td>
</tr>
<tr>
<td>Sucrose</td>
<td>4.5 g</td>
<td>22.7 g</td>
<td>N/A</td>
</tr>
<tr>
<td>Fructose</td>
<td>2.3 g</td>
<td>11.9 g</td>
<td>N/A</td>
</tr>
<tr>
<td>Free sugar</td>
<td>N/A</td>
<td>N/A</td>
<td>1.5 g</td>
</tr>
<tr>
<td>Fiber</td>
<td>N/A</td>
<td>N/A</td>
<td>50 g</td>
</tr>
<tr>
<td>Protein (TN × 5.7) (dry basis)</td>
<td>7.1 g</td>
<td>17.0 g</td>
<td>14.0 g</td>
</tr>
<tr>
<td>Total phosphorus (dry basis)</td>
<td>1.7 g</td>
<td>1.5 g</td>
<td>N/A</td>
</tr>
<tr>
<td>Ash (dry basis)</td>
<td>2.5 g</td>
<td>1.6 g</td>
<td>N/A</td>
</tr>
</tbody>
</table>

1. N/A, data not available.

Zhang et al., 2013. Green Chem. 15:690–695. 62
DISCLAIMER:
The FOODstars project receives funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 692276. This presentation reflects only the opinion of authors and not the opinion of European Commission.

NAPOMENA:
Projekat FOODstars se finansira iz fondova Evropske Unije, iz programa Horizont 2020 za istraživanja i inovacije (broj ugovora 692276). Sadržina ove prezentacije odražava samo mišljenje autora, a ne mišljenje Evropske komisije.
By-product/Waste utilisation
Feedstocks, processes and products in a bioeconomy

<table>
<thead>
<tr>
<th>Feedstocks</th>
<th>Processes</th>
<th>Products</th>
</tr>
</thead>
</table>
| 1st generation: Food  
  e.g. oilseeds | Thermochemical  
  e.g. pyrolysis | Chemicals  
  via platform chemicals or direct |
| 2nd and 3rd generation: Non-food  
  Dedicated crops  
  e.g lignocellulose, algae | Chemical  
  e.g. catalytic processes, esterification | Fine chemicals & Pharmaceuticals  
  e.g. succinic acid |
| Co-products  
  • Food processing co-products  
  (e.g. beet pulp) | Bioprocessing  
  Material production  
  Enzymatic Processes  
  • Fermentation  
  • Biocatalysis  
  Aerobic Conversion  
  e.g. Composting | Speciality chemicals  
  e.g. limonene (Fragrance) |
| Waste  
  Solid  
  • Municipal solid waste  
  (domestic and commercial)  
  • Agricultural and forestry residues  
  • Industrial waste | Biogas production  
  Anaerobic Digestion | Polymers  
  e.g. Polylactic Acid (PLA) |
| Liquid  
  • Organics in untreated water | | Commodity chemicals  
  e.g. esters |
| Gas  
  • Industrial off gases (CO₂, CH₄)  
  • Landfill gas | | Fibres |
| | | Animal Feed |
| | | Fuels (e.g. Biogas, Bioethanol) |
| | | Heat & Power |
Carrot (Harvested)

PRE - HARVEST

Location & Environmental Conditions

Agronomic Practice

- Convention grown
- Organic grown
- Irrigation
- Harvest delay

- Soil Types
- Climatic Conditions (Rainfall & Temperature)

POST - HARVEST

Storage Conditions (days & temperature)

Transport & Pre-cleaning

Grading - root size

Processing

FOOD PROCESSING

Minimal processing

Domestic processing

Peeling, Washing, Cutting & storage

Blanching (time & temperature)

Boiling (time & temperature)

Carrot based products [peeled or cuts (disk / baton / cube / shreds), blanched – salad & boiled - stew]

Human Consumption

Losses in terms of peel
Food processing by-product valorisation

By-products

- Agro industry
- Food industry

Bioenergy

- Carbohydrates
- Proteins
- Fats
- Carotenoids
- Alkaloids
- Polyphenols

Feed

www.resfood.eu
Extraction

Sample

Freeze-drying, Air drying, Oven drying, Grinding, Homogenization

Clean up

Solid-liquid extraction
Conventional
Percolation
Modern
UAE, MAE, SFE, PLE,
Maceration
PHWE,
Soxhlet, Refluxing, Infusion

Extraction

Clean-up - Isolation

CC-fractionation, Filtration, Evaporation,
LLE, SPE, SPME, SDME

Instrumental analysis

Others

FID, ECD, MS, MS/MS

UV, Electro.Chem., FLU, MS, MS/MS, NMR

ENVIRONMENTAL PROTECTION

GREEN PROCESSING TECHNOLOGIES

- Flow Technology
- Microwaves
- Pyrolysis/gasification
- Solid State Fermentation
- Microbial Digestion

High value chemicals

- Bioplastics
- Organic acids
- Furans
- Essential oils

Fuels

- Biodiesel
- Bio-alcohols
- Syngas/Biogas
- Biofuels from pyrolysis oils

WASTE VALORIZATION

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