Food waste accounting: ongoing research at the Joint Research Centre

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Directorate D – Sustainable Resources

Bio-Economy Unit (D1)

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Joint Research Centre
the European Commission's
in-house science service

European Commission – Joint Research Centre

JRC is the science and knowledge service of the European Commission.

JRC's mission is to support EU policies with independent evidence throughout the whole policy cycle."

- 6 locations in 5 Member States
- 3 000 total staff
- 83% of core research staff with PhDs
- 42 large scale research facilities, more than 110 online databases
- More than 100 economic, bio-physical and nuclear models

Directorate D – Sustainable Resources

Creating, managing and making sense of scientific knowledge for EU policies related to the sustainable use of resources, encompassing environmental, economic and social dimensions.

Workshop
Food waste accounting: methodologies, challenges and opportunities

- Share experiences and perspectives on food waste quantification at the European scale, highlighting opportunities and challenges in order to **improve food waste quantification** and **ensure better decision support** in relation to food waste reduction and valorization

- **Food waste quantification from the macro scale down to single stages** of the food waste generation as basis for discussing a way to improve estimations.

Contents

- The policy context: waste framework directive, circular economy and bioeconomy

- Focus on food waste accounting
  - Quantification
  - Valorisation

- Sustainability assessment of prevention and valorisation options

- Open challenges and conclusions

The policy context

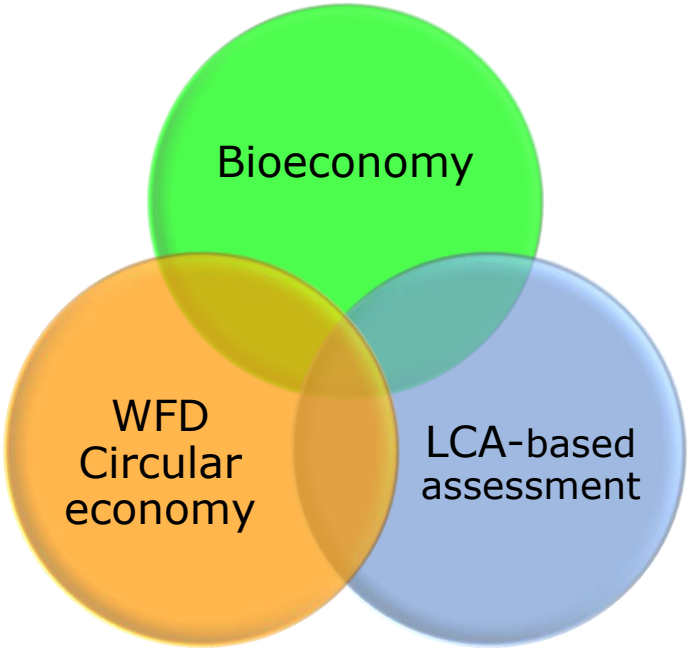
Waste Directive 2008/98/EC amend proposal (2015), obligatory monitoring and reporting on food waste

EU Circular economy action plan (2015), food waste one of the priority areas

'The **bioeconomy**[…] encompasses the production of renewable biological resources and the conversion of these **resources** and **waste streams** into value-added products, such as food, feed, bio-based products and bioenergy'

'....the bioeconomy strategy supports the development of an agreed methodology for the calculation of environmental footprints, e.g. **using life cycle assessments** (LCAs)'

EU Bioeconomy strategy 2012



Life Cycle Thinking and Assessment

core concept for Sustainability Assessment of Goods, Services, Organisations and Regions

- Assess the performance of **good, services, systems, technologies, innovations, infrastructures, waste management options, regions**
- Help identifying the **most important burdens** and the **most relevant life cycle stages** contributing to environmental impacts (material extraction, manufacturing, use phase etc.)

LCA for environmental integrated assessment

Avoiding burden shifting

- **over impact categories** (increasing impact in an impact category while reducing the impact on another)
- **over life cycles stages** (e.g. increasing impact in the end of life while reducing the impact in the use phase)

Goal and scope

e.g. LCA of a car of typology X, assuming a use for Y years, produced in country Z, ect.

LCI - Life Cycle Inventory

For each stage of a product life cycle (e.g. resource extraction, manufacturing, use, etc.) data on **emissions into the environment** (e.g. CO_2, benzene, organic chemicals) and **resources used** (e.g. metals, crude oil) are collected in an inventory.

Each emission in the environment and resource used are then characterised in term of potential impact in the LCIA, covering a number of impact categories.

LCIA - Life Cycle Impact Assessment

CLIMATE CHANGE

EUTROPHICATION

LAND USE

RESOURCE DEPLETION

ACIDIFICATION

OZONE DEPLETION

ECOTOXICITY

IONISING RADIATION

PHOTOCHEMICAL OZONE FORMATION

WATER DEPLETION

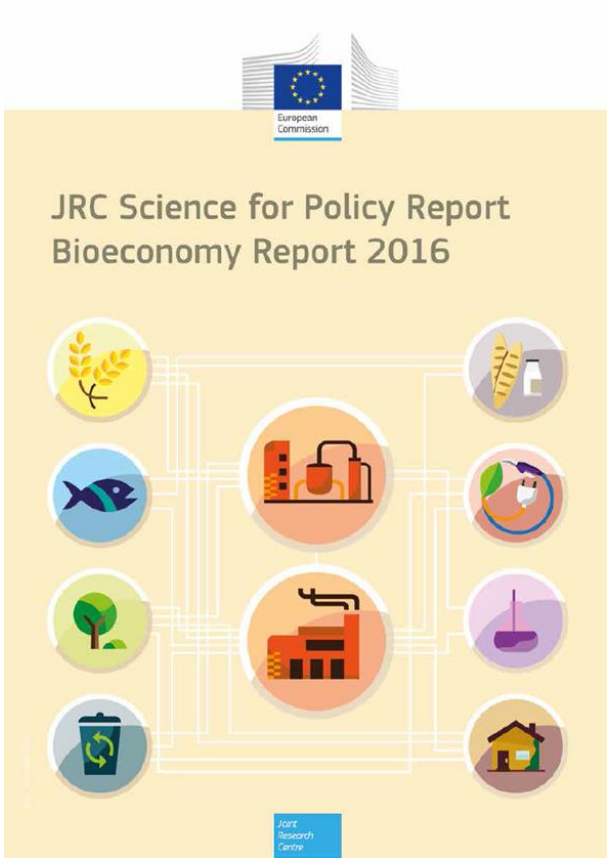
HUMAN TOXICITY

Areas of protection

- Human health
- Ecosystem health
- Natural resources

Interpretation

Bioeconomy and circular economy



- 36% of biomass produced in EU is used for bio-based material and bioenergy
- Most important sectors (*with turnover increase between 2008 and 2014*):
  - liquid biofules (+25% turnover),
  - bio-based chemicals, pharmaceuticals, plastics and rubber (+22%),
  - forestry sector (+ 21%)
- Bio-based by-products and waste from agricultural, forestry and food (e.g. 20 % of the total food produced is food waste (FUSIONS,2016))
- Several options for valorisation of bio-based by-products and waste, *still little exploited*
- Bioeconomy Knowledge Centre https://biobs.jrc.ec.europa.eu/

The biomass mandate

Mandate to JRC on global and EU biomass supply and demand on a long term basis

Overarching JRC study on biomass

Approved (2015) by 12 policy DGs at Directors level

RTD, SG, AGRI, CLIMA, DEVCO, ENER, ENV, GROW, MARE, MOVE, REGIO and TRADE

ISG Biomass chaired by RTD

Scope of the JRC biomass study

Assessment of EU and global biomass **supply, demand, flows and sustainability** (incl. gaps and uncertainties)

Scenarios and projections for biomass supply and demand and their respective impacts (2020-2030-2050)

Covering **all sources** of biomass and **all uses**

Addressing **impacts** linked with production and use of biomass, **competition and synergies** between sectors for biomass resources

Long-term institutional commitment

Bioeconomy and circular economy

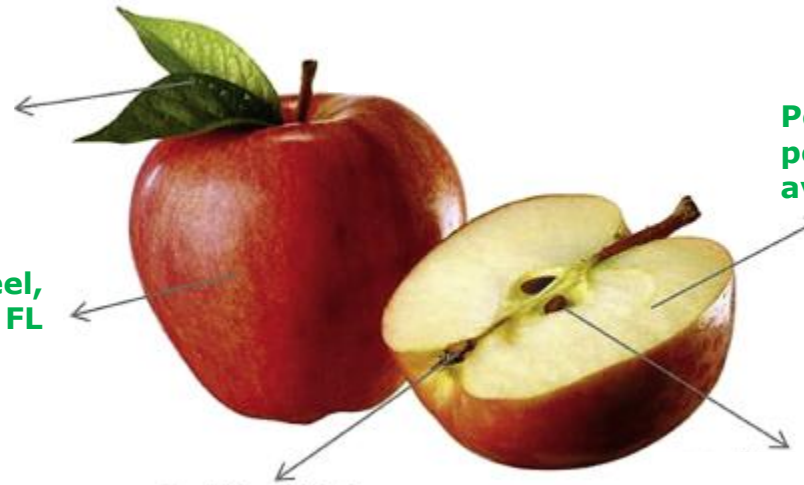
Focus on food waste

Key area of Bioeconomy

EU Circular economy action plan: food waste one of the priority areas

Huge potential for prevention and valorisation (as energy and materials)

Food waste related definitions



FAO

food loss, food waste

WRAP

avoidable, possibly avoidable and unavoidable food waste

Corrado S, Ardente F., Sala S, Saouter E (2017) **Modelling of food loss within life cycle assessment: From current practice towards a systematization**. Journal of Cleaner Production, 140(2): 847–859

Food waste related to different aspects..

- Physical
  - edible/unedible

- Cultural

South East Asia, banana peels are often used to make delicious curries and chutneys

- Behavioral

What type of "apple eater" are you?

- avoidable/unavoidable

Food waste quantification

Review of existing studies

Breakdown

Geographical scale	Total	FSC stage	Commodity group and FSC stage	Product per FSC
Global	Overall FW generation at global scale	FW from one or more FSC stage(s) at global scale	FW from one or more food commodity group(s) per FSC stage(s) at global scale	
European	Overall FW generation at EU scale	FW from one or more FSC stage(s) at EU scale	FW from one or more food commodity group(s) per FSC stage(s) at EU scale	
National/ regional	Overall FW generation at national/regional scale	FW from one or more FSC stage(s) at national/regional scale	FW from one or more food commodity group(s) per FSC stage(s) at national/regional scale	FW from one or food product(s) per FSC stage(s) at national/regional scale
Representative case (producer, retailer…)		FW from one FSC stage considering data from a limited number of FSC actors (e.g. retailers, canteens)	FW from one or more food commodity group(s) per a FSC considering data from a limited number of FSC actors (e.g. retailers, canteens)	FW from one or food product(s) per FSC stage(s) considering data from a limited number of FSC actors (e.g. retailers, canteens)

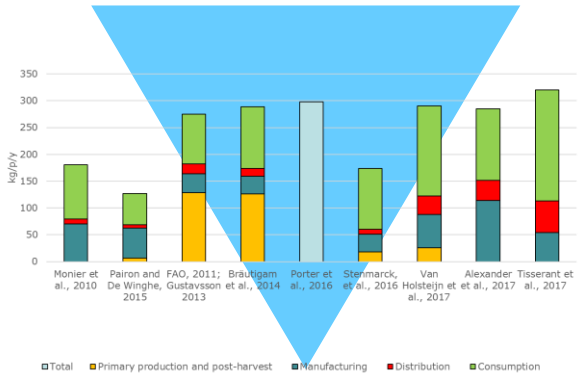
Matrix for food waste accounting, considering the different geographical scales and the level of breakdown in LCA stages in the Food Supply Chain (FSC)

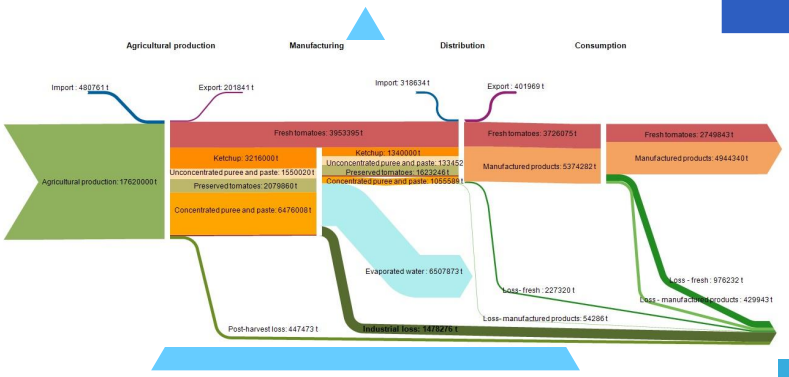
Sala S, Corrado S, (2018) **Bioeconomy contribution to circular economy.** In: Designing Sustainable Technologies, Products and Policies. From science to innovation. Eds. Benetto E., Gericke K., Springer, ISBN: 978-3-319-66980-9. (*LCM Book upcoming*)

Food waste quantification

Approaches adopted

Top-down





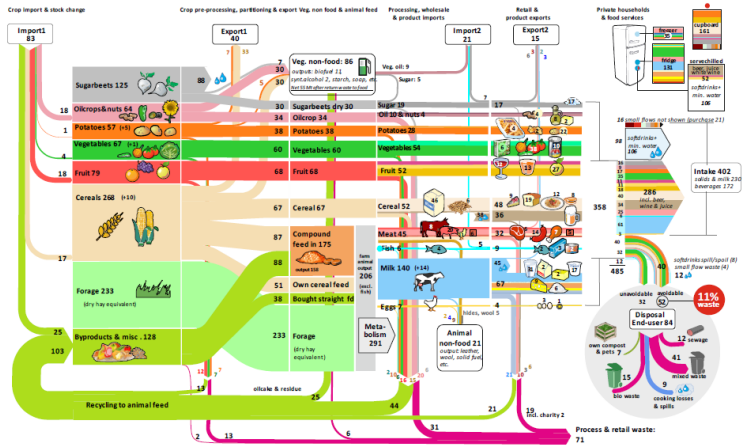
Bottom-up

Our objective

Detailed estimation of food loss and waste in EU

Identification of priority sectors

Evaluation of prevention and valorisation options



van Holsteijn et al., 2017

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Food waste quantification at EU scale

Review of studies on food loss and waste generation in Europe – top down

Different quantification approaches

Direct measurements (first-hand data) vs indirect measurements/secondary data

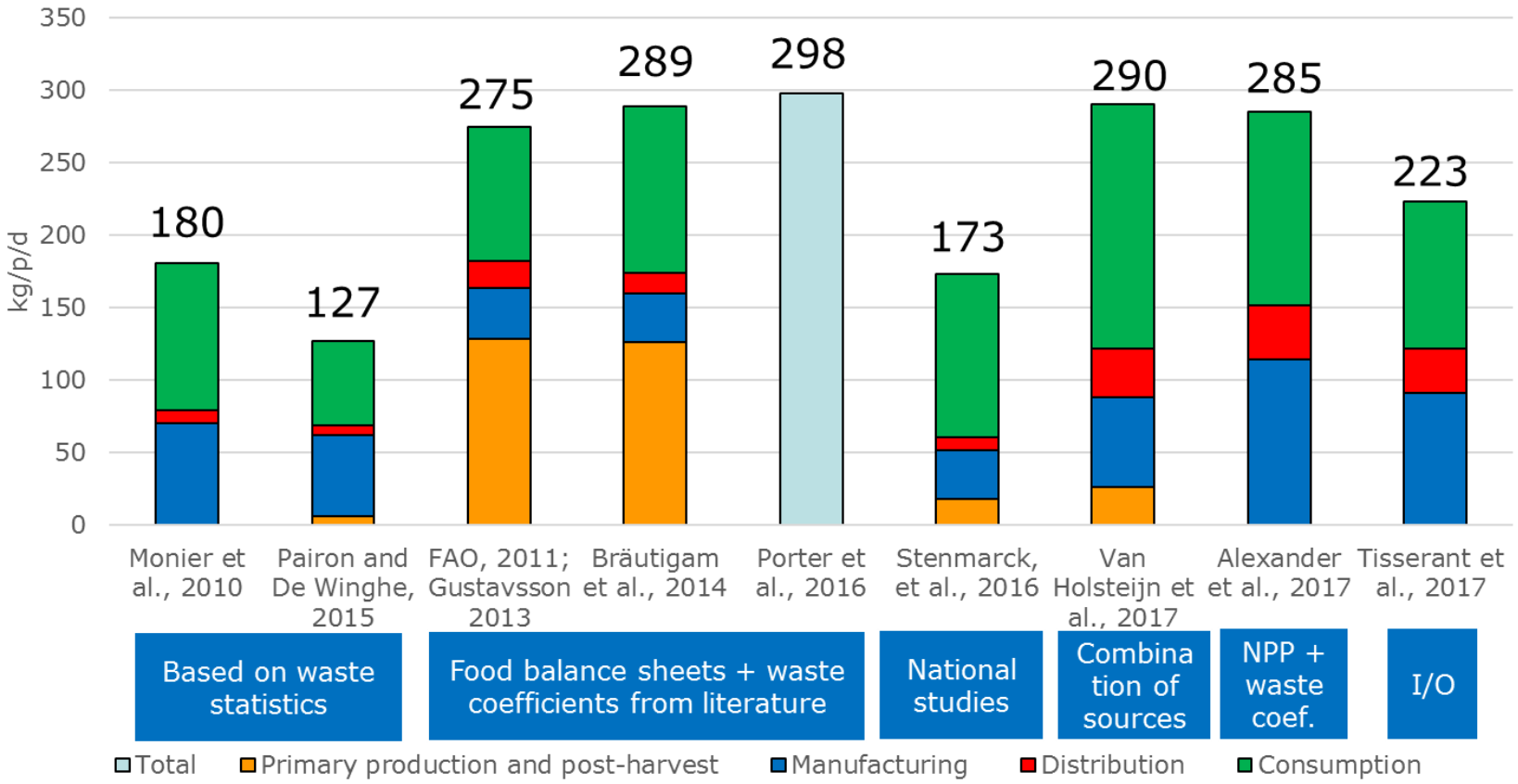
Types of material included

- Edible/Inedible

Sources of data

- Food balance sheets + waste coefficients from literature
- Waste statistics
- Statistics (FAO, Eurostat…) + literature
- National studies scaled up at EU scale
- Net primary production + waste coefficients from literature
- Multi-regional environmentally extended supply and use table database

Food waste quantification at EU scale, top down



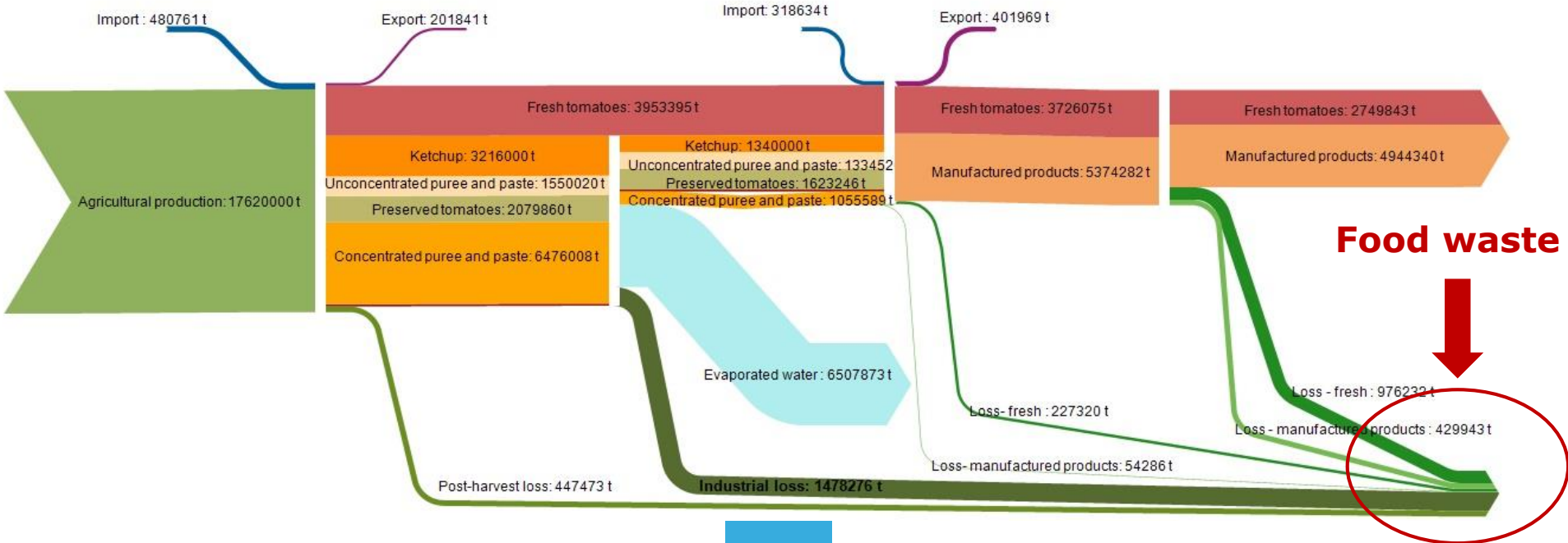
Corrado S. and Sala S. (2017) **Food waste accounting along food supply chains: state of the art and outlook.** Submitted to Waste Management

Food waste quantification: the example of tomatoes, bottom-up

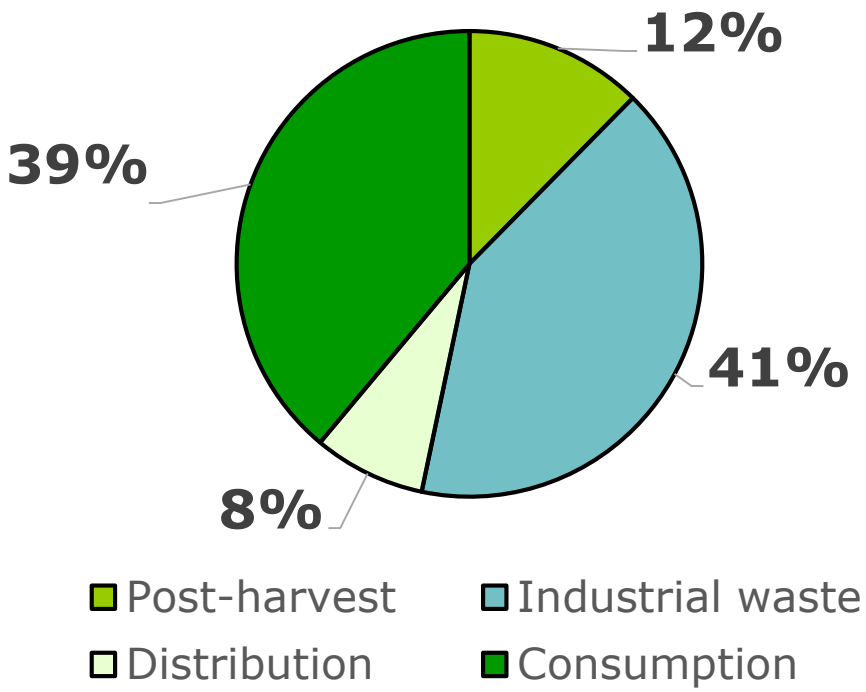
Production and trade
EU statistics

Scientific literature

Agricultural Production | **Manufacturing** | **Distribution** | **Consumption**

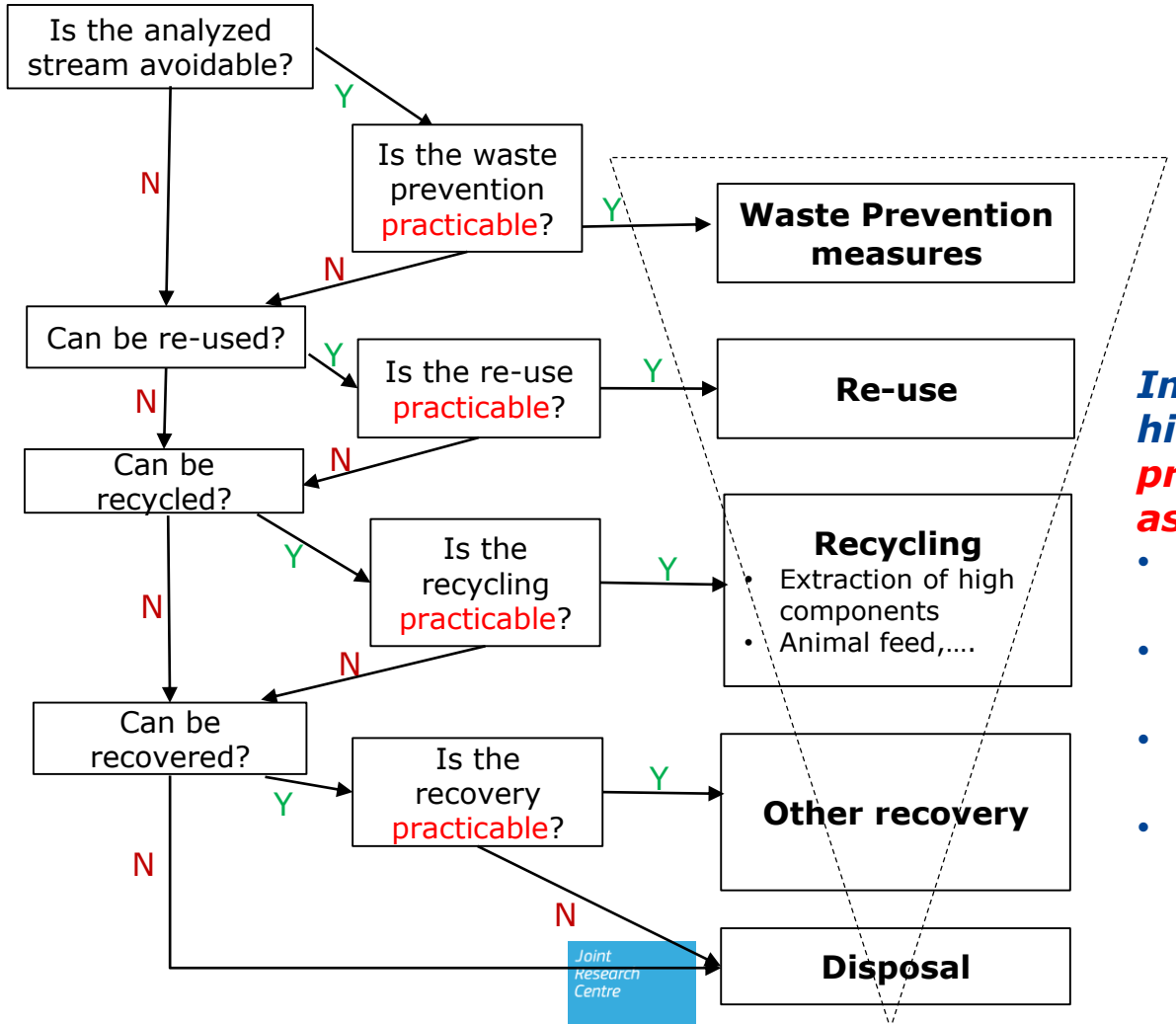


Distribution of food waste along supply chain of a specific product - tomato



Food Waste reduction and valorization: a conceptual framework

Food waste



Improved waste hierarchy including practicability assessment:

- ***environmentally preferable***
- ***technically feasible***
- ***economically profitable***
- ***legislation compliant***

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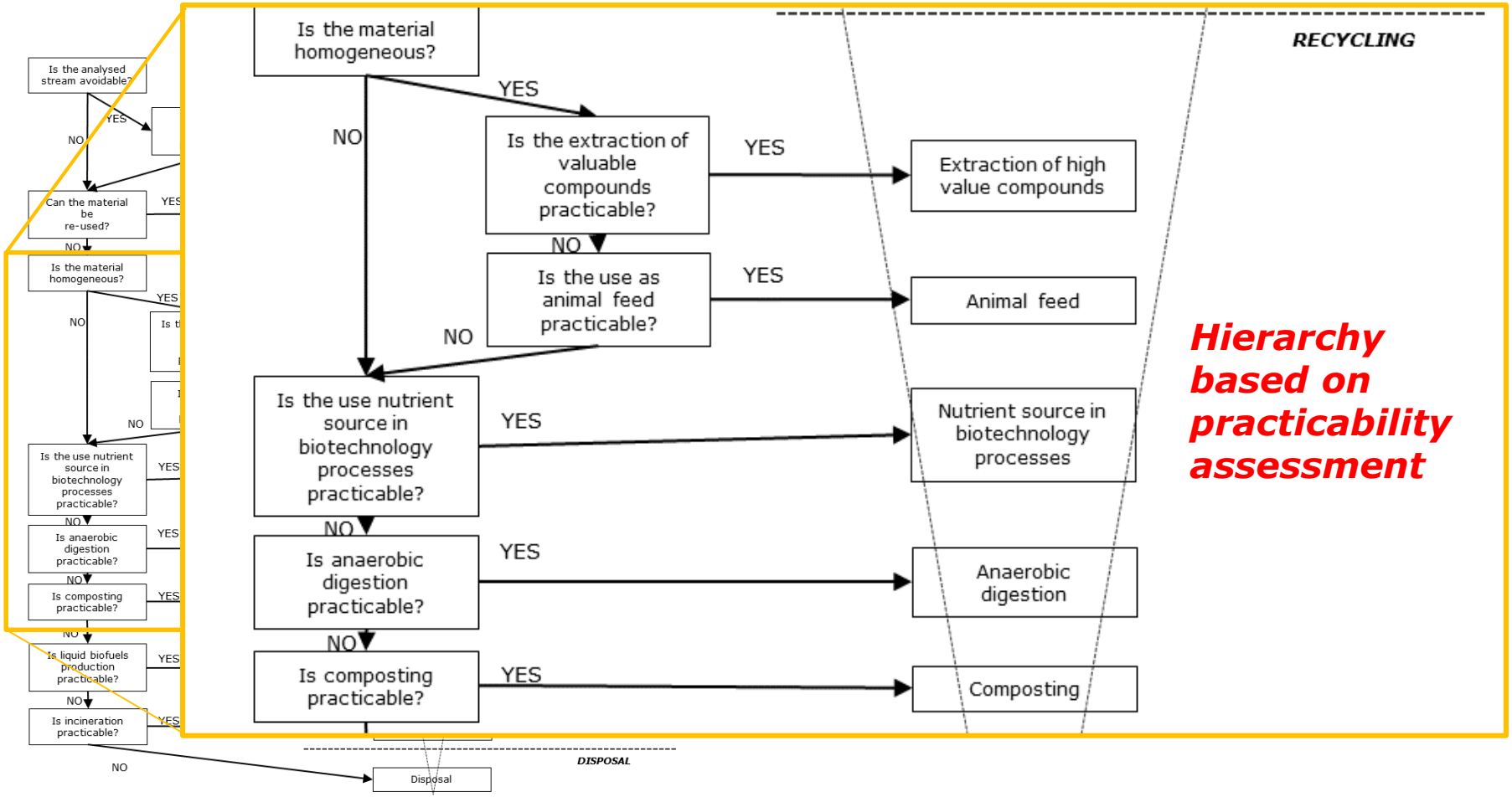
Food Waste reduction and valorization: a conceptual framework



Hierarchy based on practicability assessment

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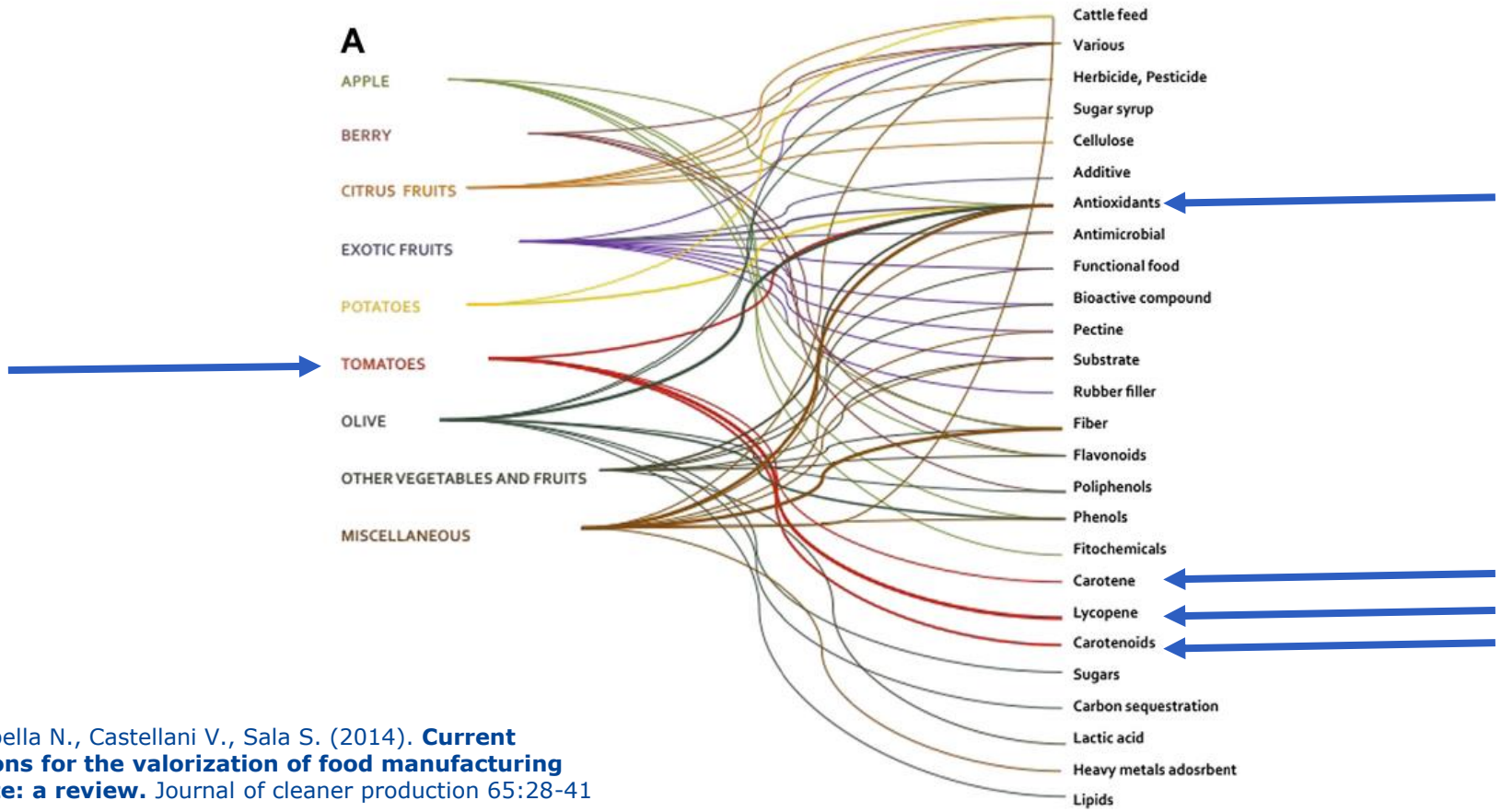
Food waste valorisation options

Assessing potential routes of valorisation for the most relevant food loss and waste streams, considering both consolidated and innovatives practices



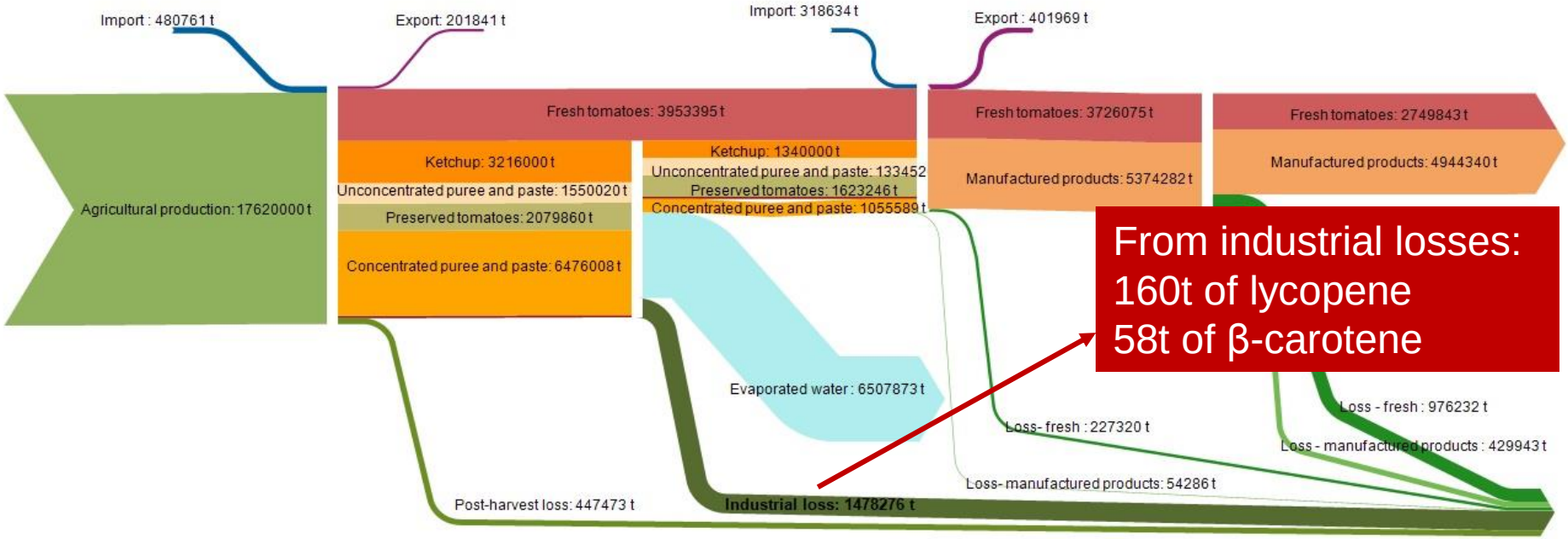
Mirabella N., Castellani V., Sala S. (2014). **Current options for the valorization of food manufacturing waste: a review.** Journal of cleaner production 65:28-41

Food waste valorisation: the example of tomatoes

Production and trade
EU statistics

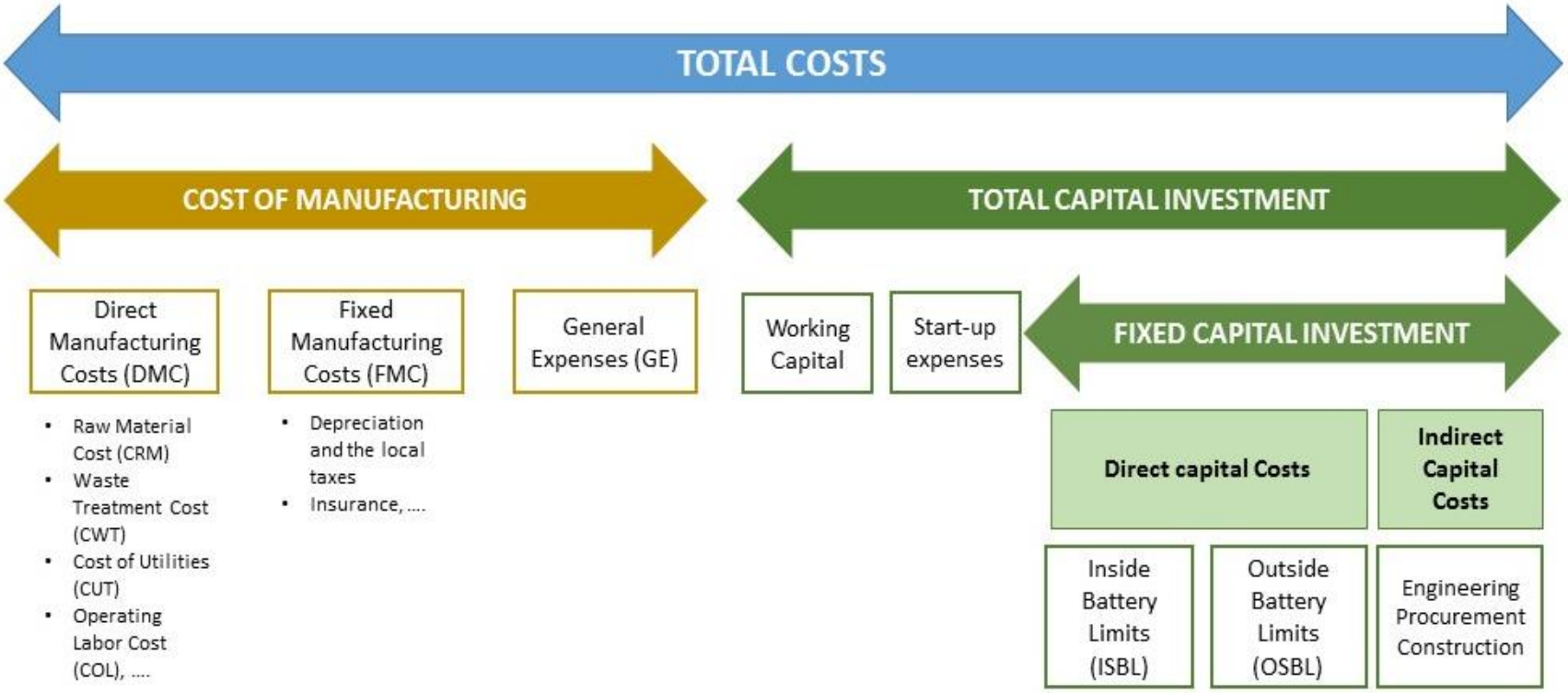
Scientific literature

Agricultural Production | **Manufacturing** | **Distribuition** | **Consumption**



From industrial losses:
160t of lycopene
58t of β-carotene

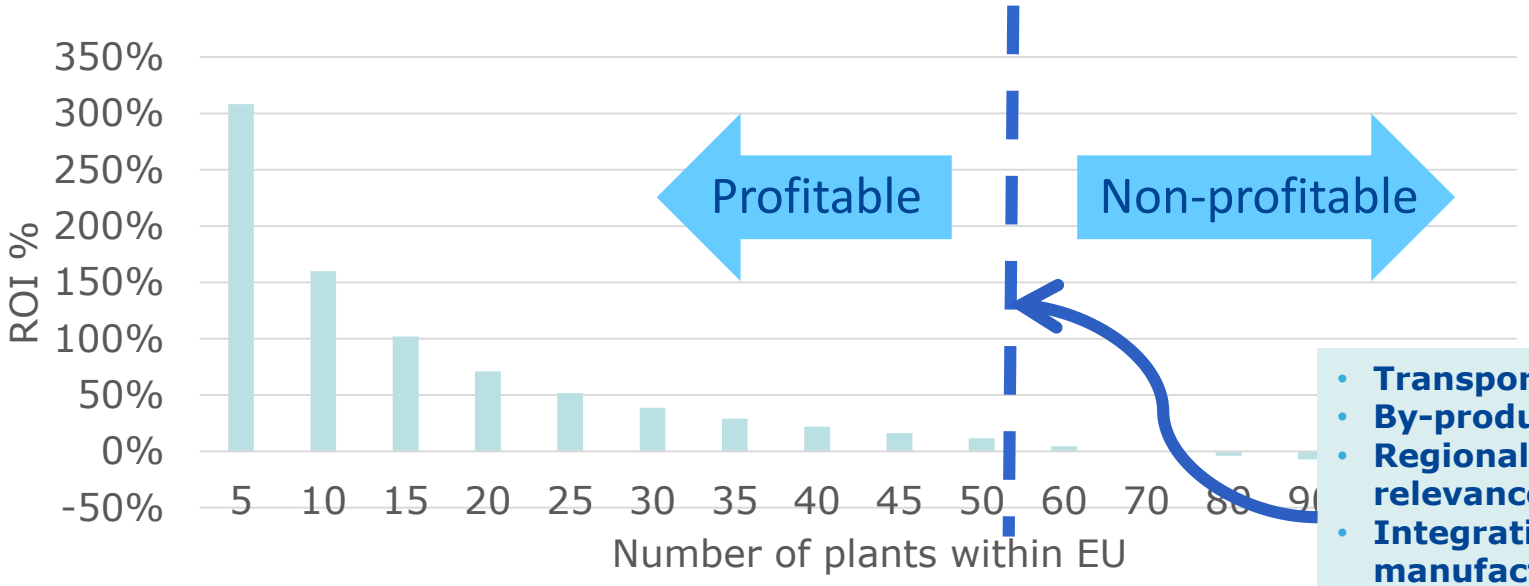
Preliminary economic assessment of valorisation options



Preliminary economic assessment of valorisation options

Calculations done for unavoidable waste at manufacturing stage (homogeneous stream) for the extraction of lycopene and β-carotene

$$\text{ROI (return on investment)} = \frac{\text{Annual net profit}}{\text{Capital costs}} \ [\%]$$



- **Transport costs**
- **By-product costs**
- **Regional relevance**
- **Integration with manufacturing**
- **Multi-output processes**

Environmental assessment of valorisation options

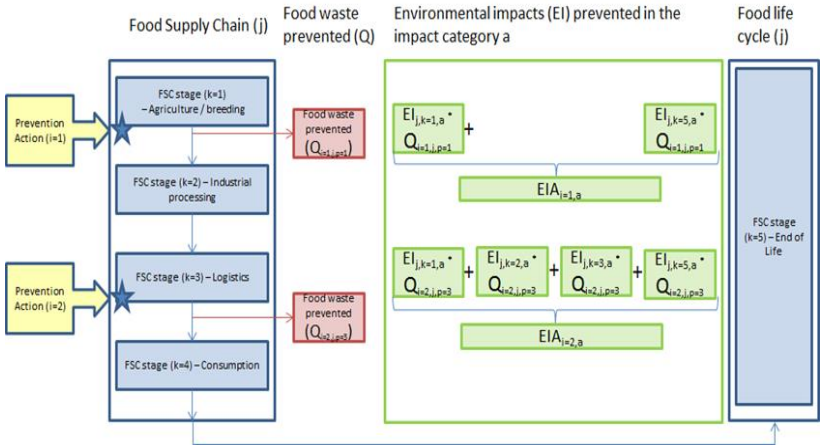
Life cycle thinking (LCT) and life cycle assessment (LCA) suitable for the purpose:

- Comparison between alternatives
- Avoid burdens shifting

Food waste prevention measures

UN SDG: -50% food waste at retail and consumer levels and reduce food losses along the supply chain by 2030

- LCA for assessing burden and benefits of prevention actions
- Type of scenarios applied:
  - Prevention of food waste at household and consequent reduction of the quantity of food bought
  - Prevention of food waste and losses at stages before consumption



Optimization analysis

Prioritization of interventions and action could be based on **economic constraints** and **maximisation of environmental benefits**.

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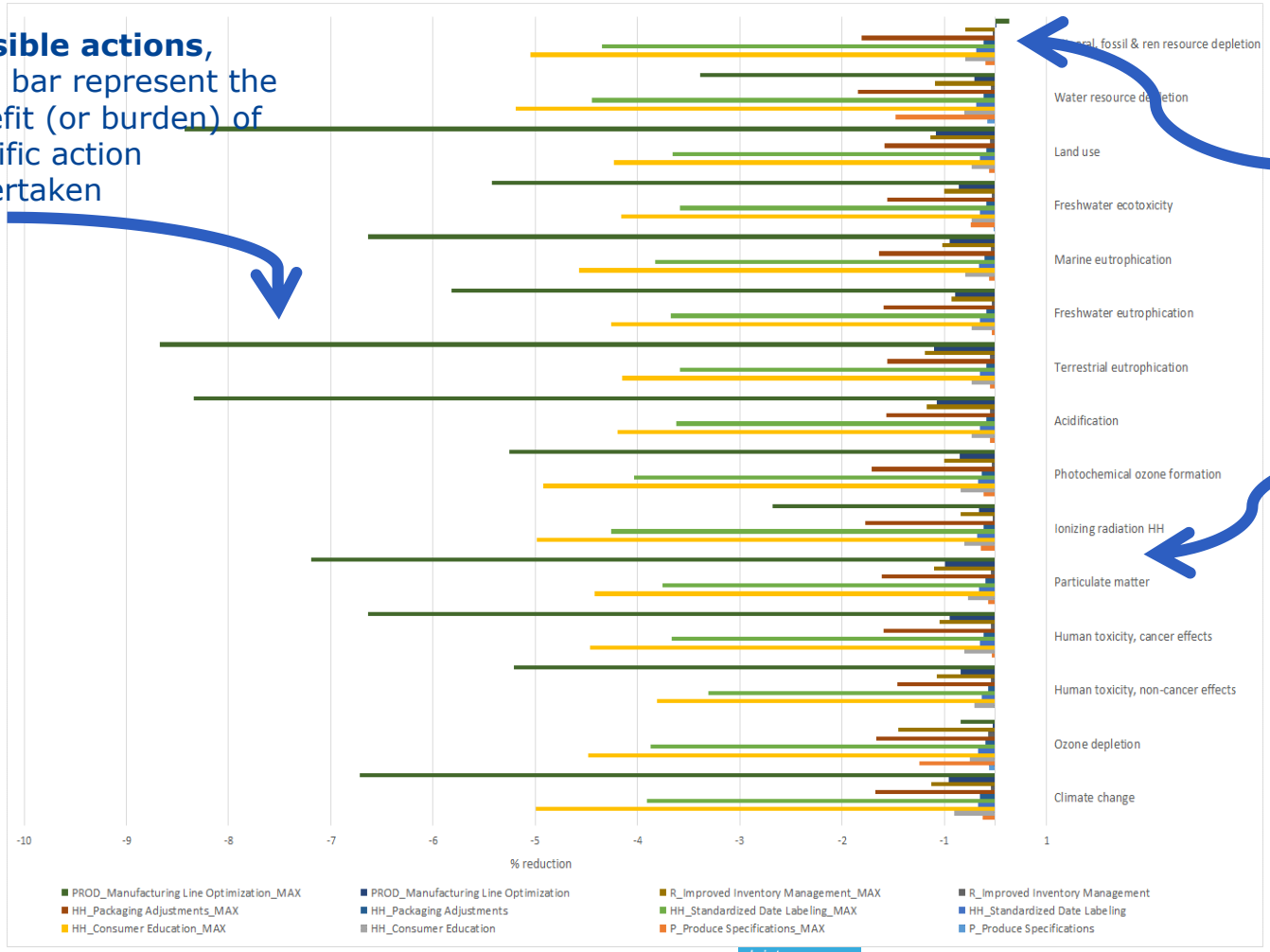
Cristobal J., Castellani V., Manfredi S., Sala S. (2017) **Prioritizing and optimizing sustainable measures for food waste prevention and management**. Waste management

Efficacy of prevention actions Environmental

Possible actions, each bar represent the benefit (or burden) of specific action undertaken



Baseline scenario (0), representing the impact due to the food consumption of an average EU citizen

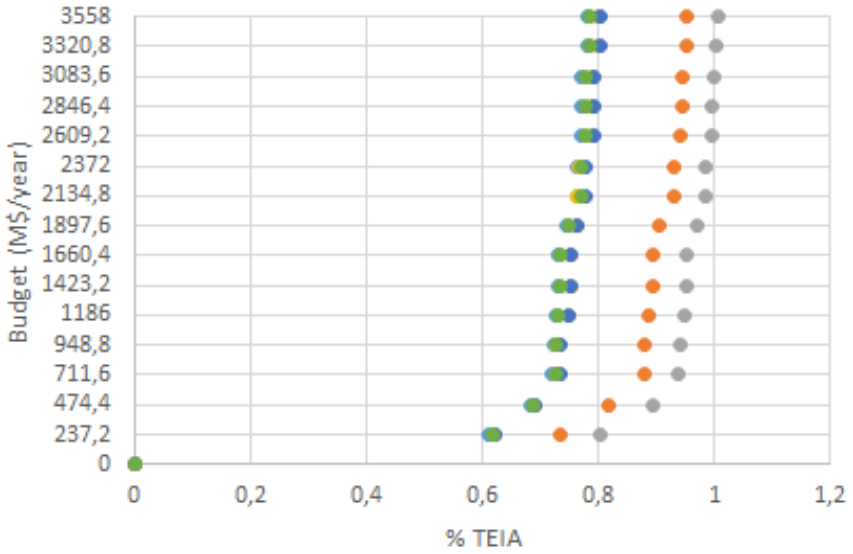
15 different typologies of environmental impacts are assessed, based on models used in Life Cycle Assessment

Cristobal et al 2017

Efficacy of prevention actions

Environmental and Economic trade offs

Budget:budget allocated (constraint)



Different sets of weighting factors for the environmental impact categories

Example of results: around 80% of the **TEIA** (**total environmental benefit objectives**) is achieved within the first step of budgeting (i.e. the lowest budget).

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Cristobal et al 2017

Food waste quantification to policies

Policy Focus

PREVENTION

MANAGEMENT

VALORIZATION

Accounting Methodology

- Life Cycle Stages
- Edible vs Inedible
- Avoidable vs Unavoidable
- Characteristics of FW streams

Conclusions

- Combining top-down and bottom-up food waste accounting approaches allows the characterization of food waste generated a the European level
- The proposed framework can help in the identification of preferable prevention/valorisation pathways for bio-based by-products and waste based on their practicability and hierarchy . LCT and LCA are proper approaches to identify possible environmental trade-offs and to compare alternatives
- **Definitions:** Distinction between avoidable/unavoidable and edible/unedible is key to improve quantification of food waste
- **Quantification:** Reliability and granularity of food waste data need to be enhanced to disclose their potential contribution to circular economy
- **Prevention**: Steer actions towards avoidable food waste and specific actors, life cycle stages
- **Valorisation:** Several options for food waste valorisation are reported in literature, but often practicable considerations on their feasibility are missing, e.g. profitability
- **Different accounting methodology** may be needed depending on the **specific policies** to be addresses: Prevention, Management and Valorization of food waste

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