UNIVERSITÀ DEGLI STUDI DELL'INSUBRIA

Organic Fraction of Municipal Solid Waste Treatment with Black Soldier Fly Larvae: A Life Cycle Assessment Perspective

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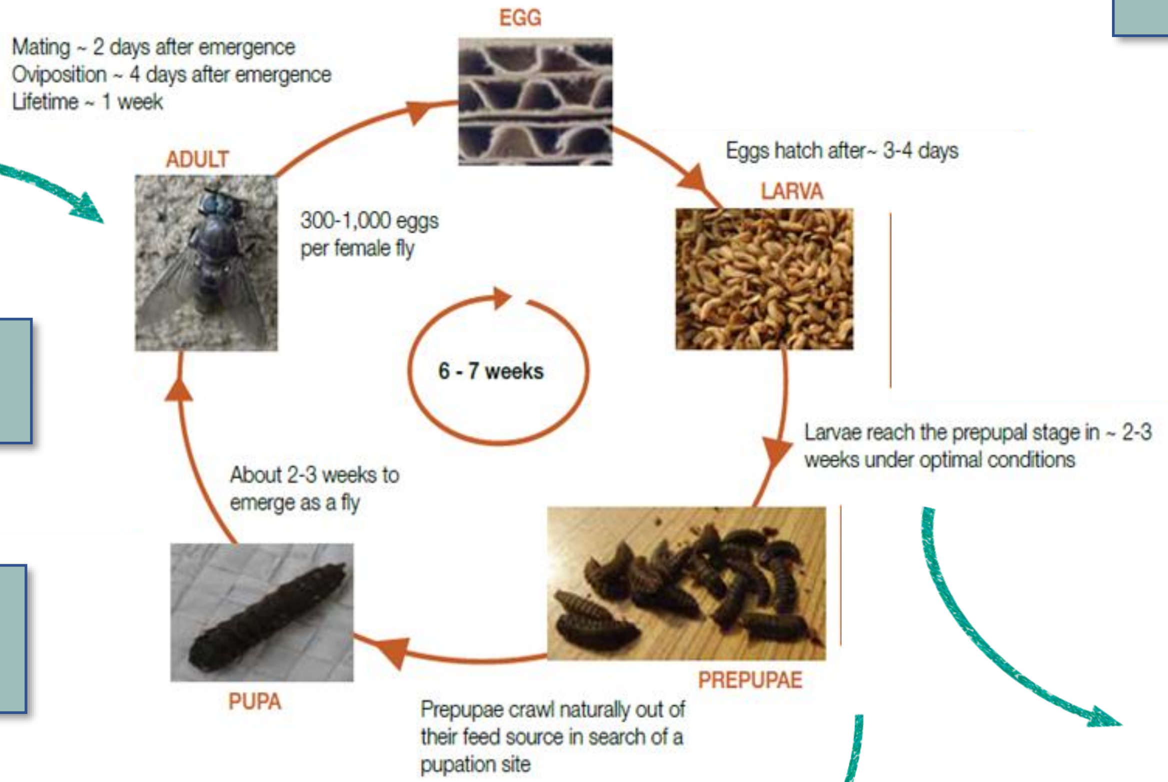
Outline

- Introduction
- The RICH project
- Methods
- LCA Results
- Concluding remarks

Introduction

OFMSW

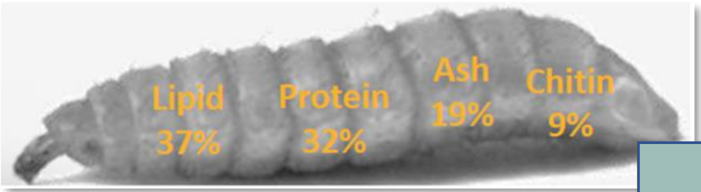
Joly and Nikiema, 2019



BSF

Compost

Bioplastics (mulch sheets)



Leni et al., 2018

Prepupae

Fishmeal

The RICH project

Turning Rubbish Into biobased materials: a sustainable CHain for the full valorization of organic waste.

OBJECTIVES:

- Development of a bioconversion system of OFMSW through an **innovative approach by BSF larvae**
- Development of an environmentally friendly process for the **extraction of proteins and lipids** from BSF prepupae
- Development of an innovative and reliable process to **produce protein-based materials** (bioplastics)

RICH

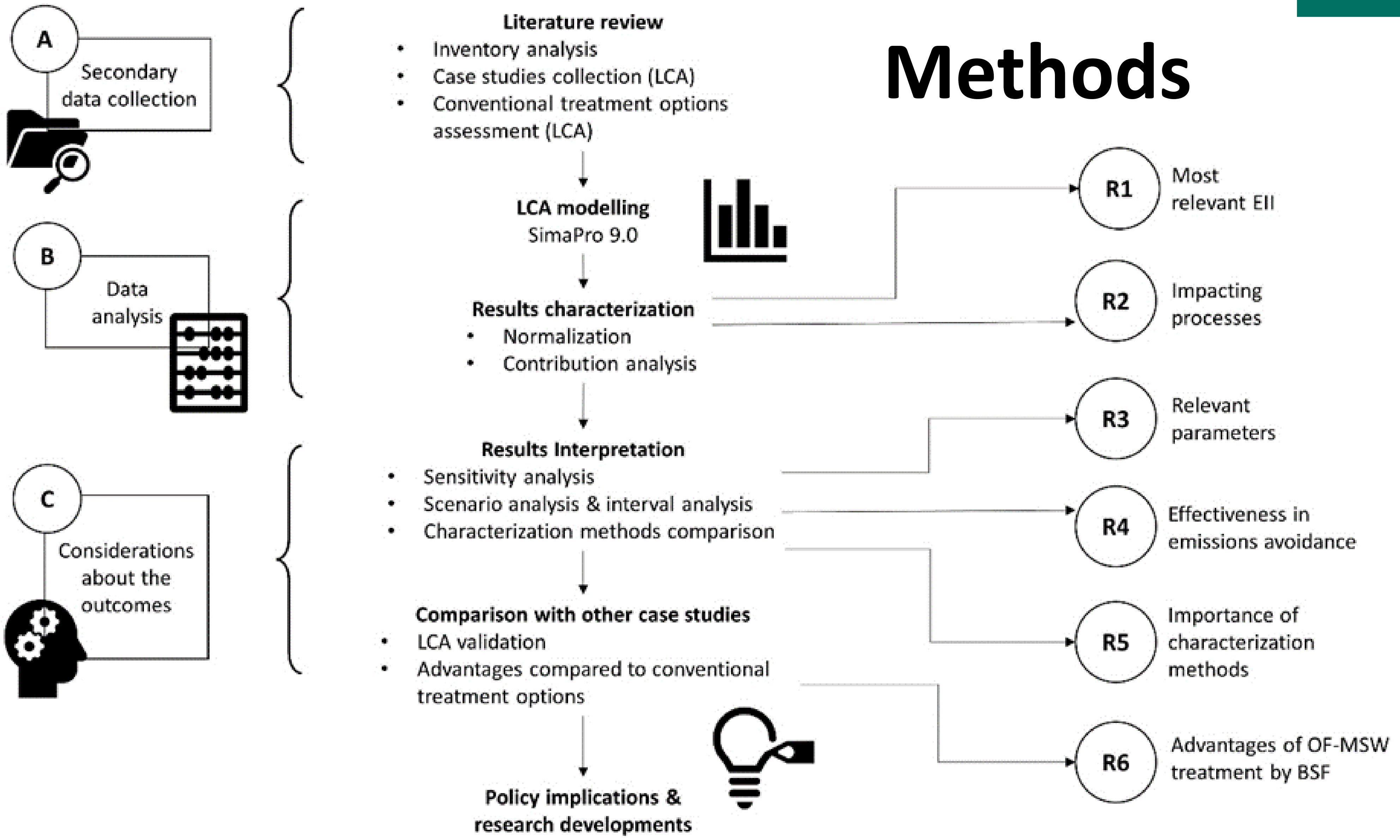
PARTNERS:

- University of Insubria (Varese, Italy): **Department of Biotechnology and Life Sciences**, Department of Theoretical and Applied Sciences, Department of Economy.
- University of Milan (Italy): Department of Biosciences
- Polytechnic of Milan (Italy): Department of Chemistry, Materials and Chemical Engineering
- Deutsche Institut für Kautschuktechnologie (Germany)

Methods

The **aim** of the research is to provide a comprehensive study related to the **environmental impacts generated by a BSF treatment process** compared to composting and anaerobic digestion.

Novelty: define the most relevant indicators in terms of optimistic and pessimistic scenarios for comparing the BSF treatment system with conventional treatment options



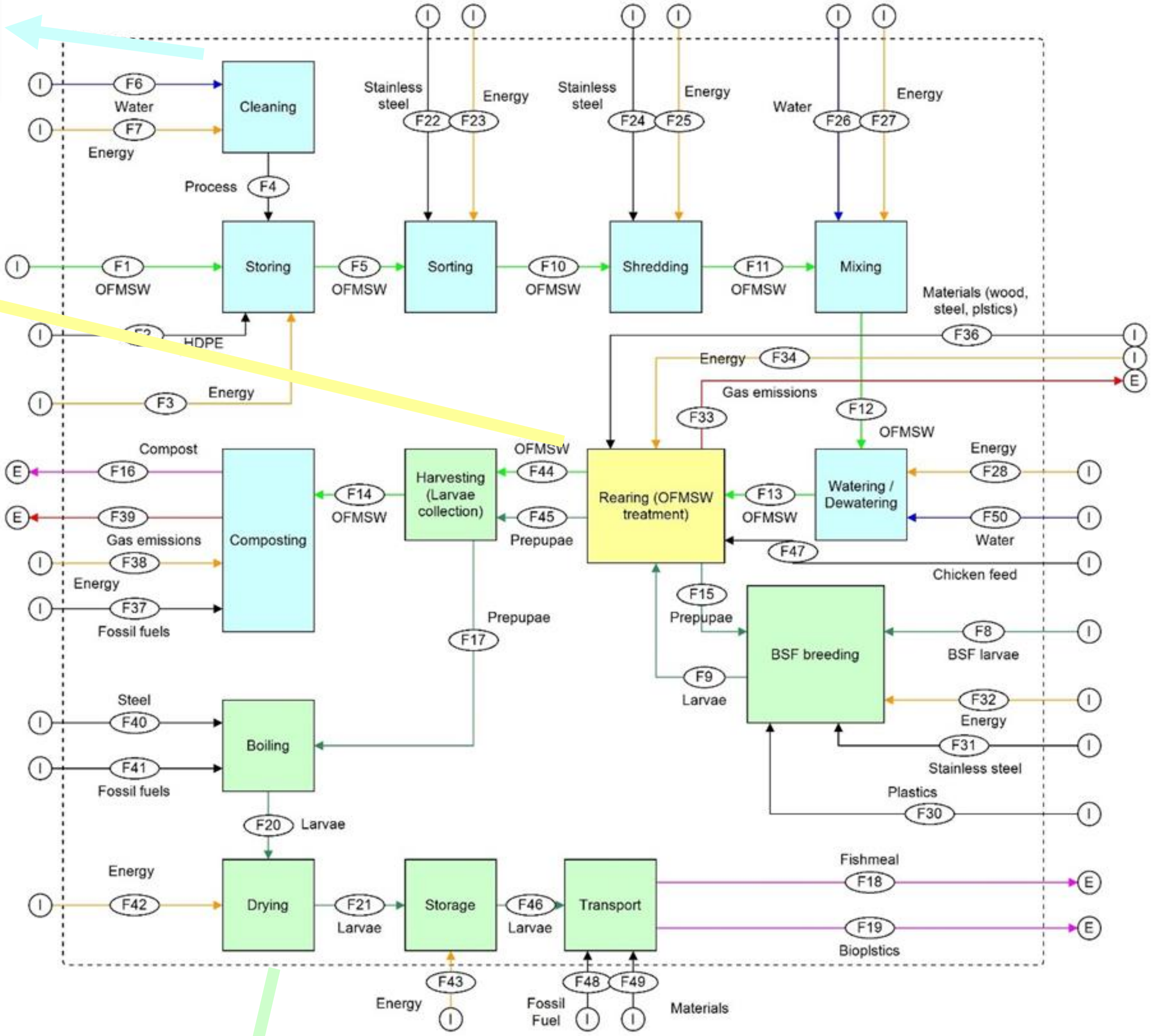
Environmental LCA

OFMSW pre and post treatment

OFMSW Treatment process

Inventory analysis

Authors	Country	Document
(Smetana et al., 2019)	Germany	Scientific article
(Dortmans et al., 2017)	Switzerland	Handbook
(Mertenat et al., 2019)	Switzerland	Scientific article
(Salomone et al., 2017)	Italy	Scientific article



BSF breeding and post treatment

System boundaries (prepupae post treatment non included)

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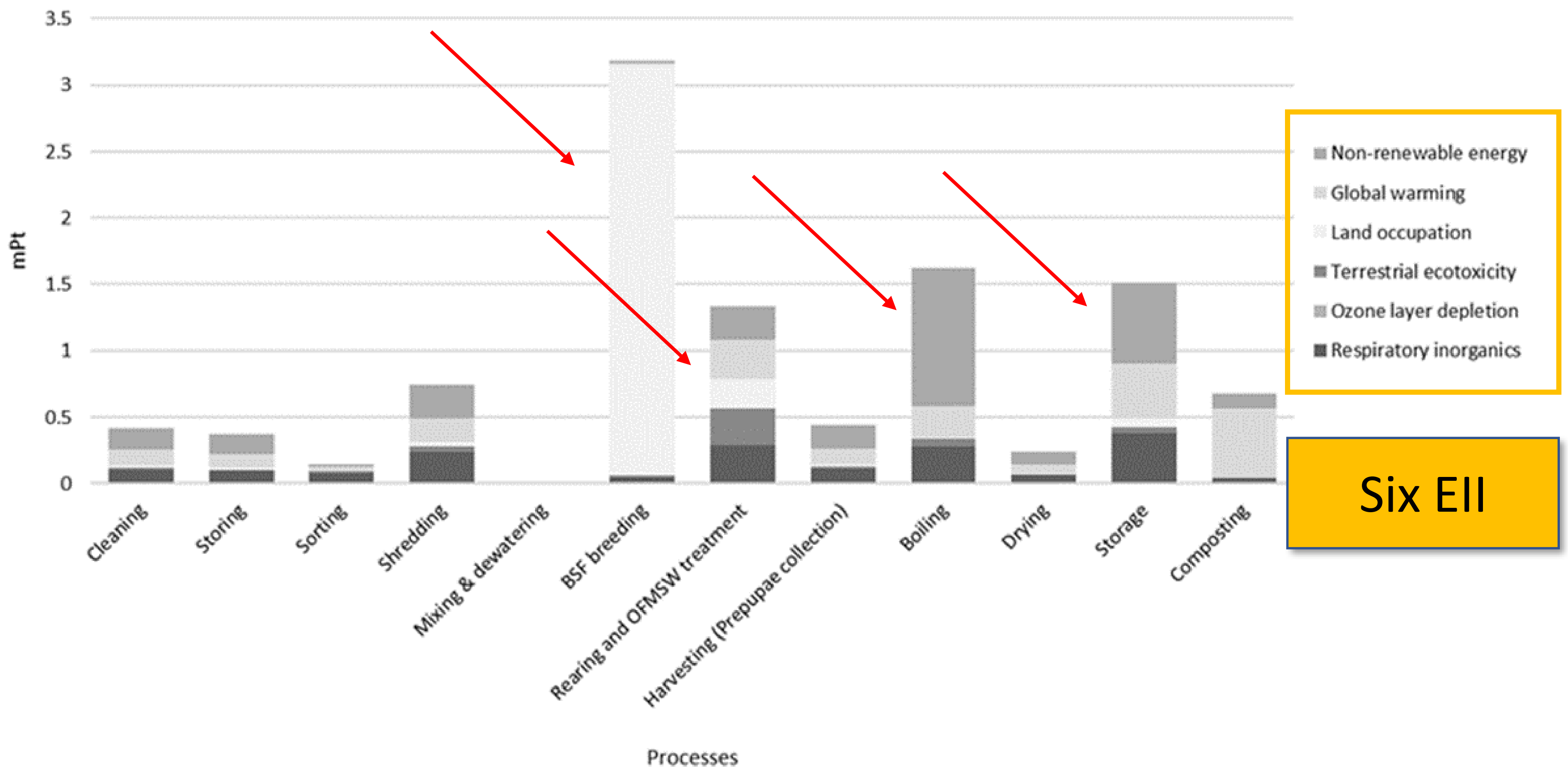
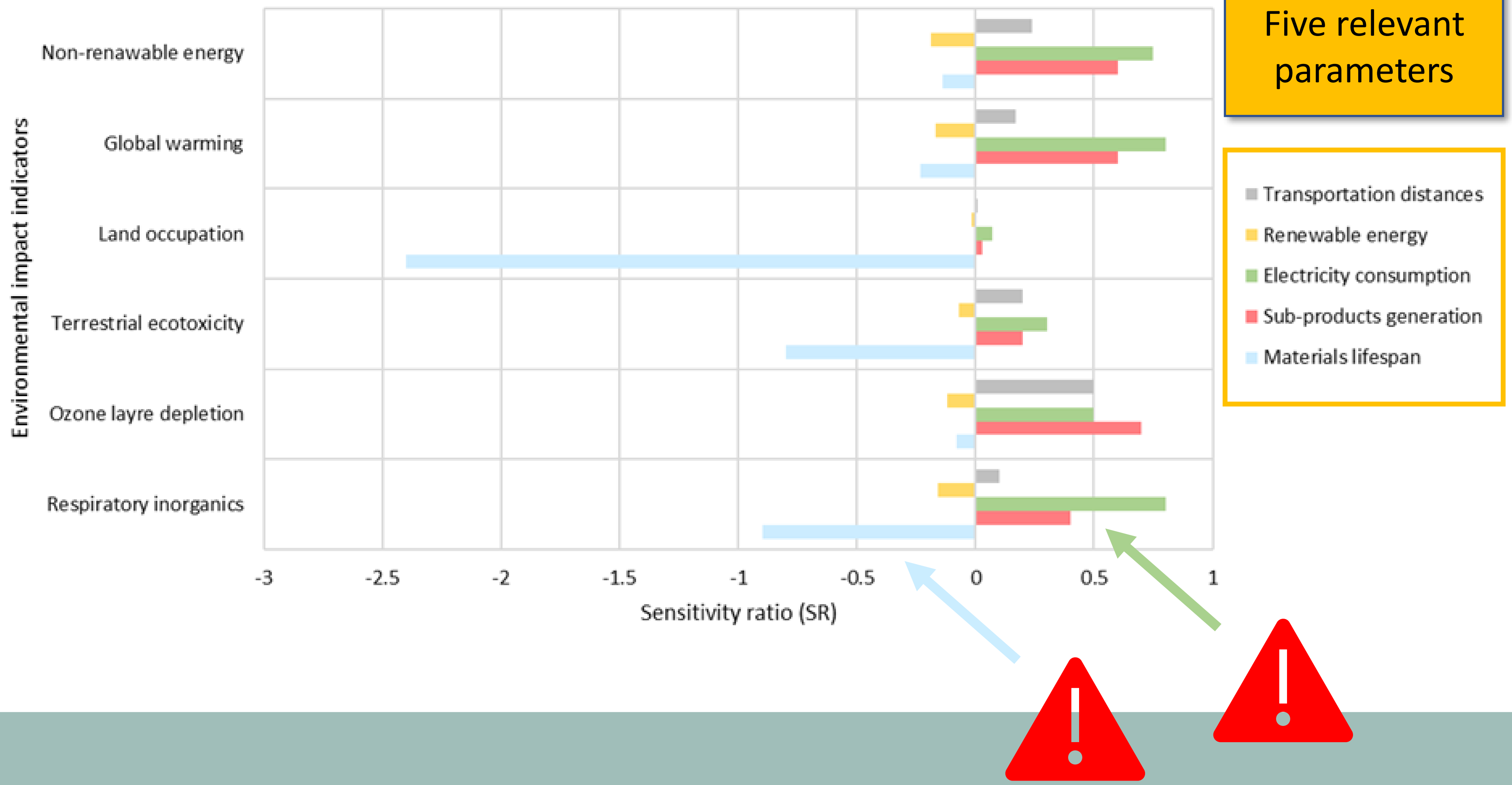
Results - Most relevant EII and impacting processes



Six EII

Results - Relevant parameters to be assessed



Five relevant parameters

Results - Effectiveness in emissions avoidance

Avoiding fishmeal production and transportation

Scenarios	Respiratory inorganics	Ozone layer depletion	Terrestrial ecotoxicity	Land occupation	Global warming	Non-renewable energy
	kg PM2.5-eq	kg CFC-11-eq	kg TEG soil	m^2 org. arable	kg CO_2-eq	MJ primary
S0	0.0174	3.50E-06	879	44	20.62	439
Fishmeal avoided 0 km	0.0137 (-21.3%)	7.63E-07 (-78.2%)	738 (-16.0%)	43.7 (-0.7%)	17.9 (-13.2%)	202 (-54.0%)
Fishmeal avoided 1,000 km (transportation trucks)	-0.006 (-134.4%)	-5.11E-06 (-246%)	-1117 (-227.1%)	38.8 (-11.8%)	-15.5 (-175.2%)	-331 (-175.4%)
Fishmeal avoided 10,000 km (ships transportation)	-0.0144 (-182.8%)	-8.12E-07 (-123.2%)	454 (-48.4%)	43 (-2.3%)	8.43 (-59.1%)	64.6 (-85.3%)

Avoiding plastics and bioplastics production

Scenarios	Respiratory inorganics	Ozone layer depletion	Terrestrial ecotoxicity	Land occupation	Global warming	Non-renewable energy
	kg PM2.5-eq	kg CFC-11-eq	kg TEG soil	m^2 org. arable	kg CO_2-eq	MJ primary
S0	0.0174	3.50E-06	879	44	20.62	439
Avoidance of bioplastics production	0.0171 (-1.7%)	3.45E-06 (-1.4%)	875 (-0.5%)	41.3 (-6.1%)	20.4 (-1.1%)	432 (-1.6%)
Avoidance of recycled polyethylene production	0.0174 -	3.49E-06 (-0.3%)	872 (-0.8%)	43.9 (-0.2%)	20.5 (-0.6%)	438 (-0.2%)

Advantages of OFMSW treatment with BSF larvae compared to conventional options

	Unit	Sanitary landfill	Composting	Anaerobic digestion	BSF	
					Min	Max
Global warming	kg CO_2eq	1182	60	30	-32.39	41.42
Ozone layer depletion	kg CFC-11eq	304E-05	7.75E-06	5.03E-06	-6.7E-06	5.5E-06
Non-renewable energy	MJ	1543	6874	982	-797	629.24

Concluding remarks

- **BSF treatment environmental impacts are always lower than final disposal and composting**, while it seems to have better performances than AD, although not in the worst process conditions.
- **If renewable energy is employed and low electricity consumption is achieved**, BSF larvae can be a good alternative to support sustainable OFMSW treatment.

Primary data about proteins extraction and bioplastics production are required giving to the LCA more relevant and reliable information.

Produce high values bioplastics: importance in avoiding virgin materials use

Effective impacts related to the chemical processes (primary data assessment)

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Thank you!

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Fondazione CARIPLO

This research has been supported by:

The CARIPLO Foundation

Grant number 2020-0900