Comparative assessment of different manure valorisation technologies from an environmental perspective

I. Noya, S. Feijoo, L. Lijó, S. González-García, G. Feijoo and M.T. Moreira

Department of Chemical Engineering, Institute of Technology,

University of Santiago de Compostela

SPAIN

This study was carried out within the framework of the European project **ManureEcoMine** (Project number: 603744)

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Group of Environmental Engineering and Bioprocesses (Biogroup)

University of Santiago de Compostela (USC)

- ✓ Nutrient removal using conventional and advanced biological processes
- ✓ Biological systems for wastewater treatment based on granules and biofilms
- ✓ Advanced monitoring and control of wastewater anaerobic treatment
- ✓ Enzymatic degradation of recalcitrant compounds
- ✓ **Life Cycle Assessment (LCA)**
- ✓ Environmental Risk Analysis

LCA methodology

- LCA → **comprehensive evaluation of the environmental consequences** that a product or service have on the environment throughout its life cycle.

- **LCA** method has been standardized by means of the following standards:
  - **ISO 14040** (2006): Life Cycle Assessment – Principles and Framework
  - **ISO 14044** (2006): Life Cycle Assessment – Requirements and Guidelines

Figure 1. Life Cycle Assessment perspective.

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LCA methodology

Goal and scope definition

Inventory data collection

Inputs from Technosphere		
Electricity	1000	kWh
Outputs to Environment		
CH_4	60	kg
N_2O	0.1	kg

Impact assessment

Environmental results			
Impact categories	A	B	C
Climate change	10	60	-1
Acidification	5	15	-5
Eutrophication	0.8	1	0

Interpretation

- Conclusions
- Recommendations
- Improvement options

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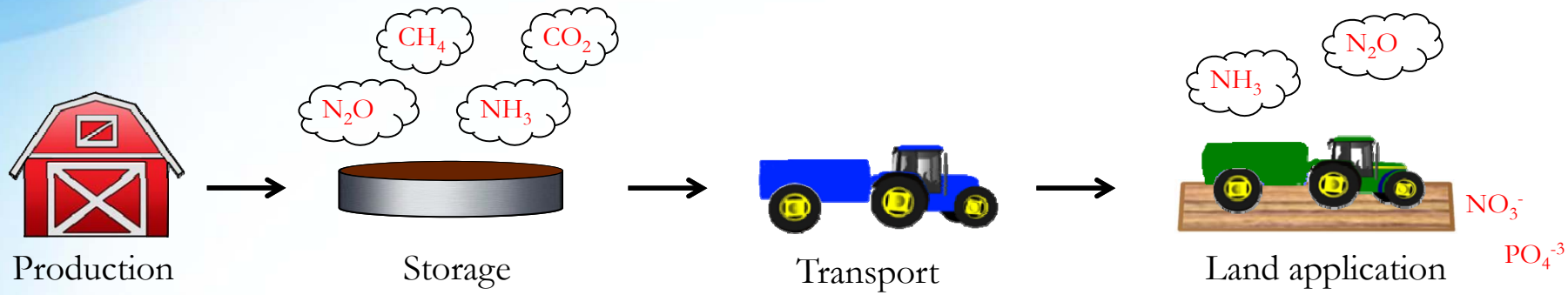
Livestock waste management

Sources of pollution:

- Manure storage
- Transport
- Manure application to land

Nitrates Directive
(91/676/CEE)



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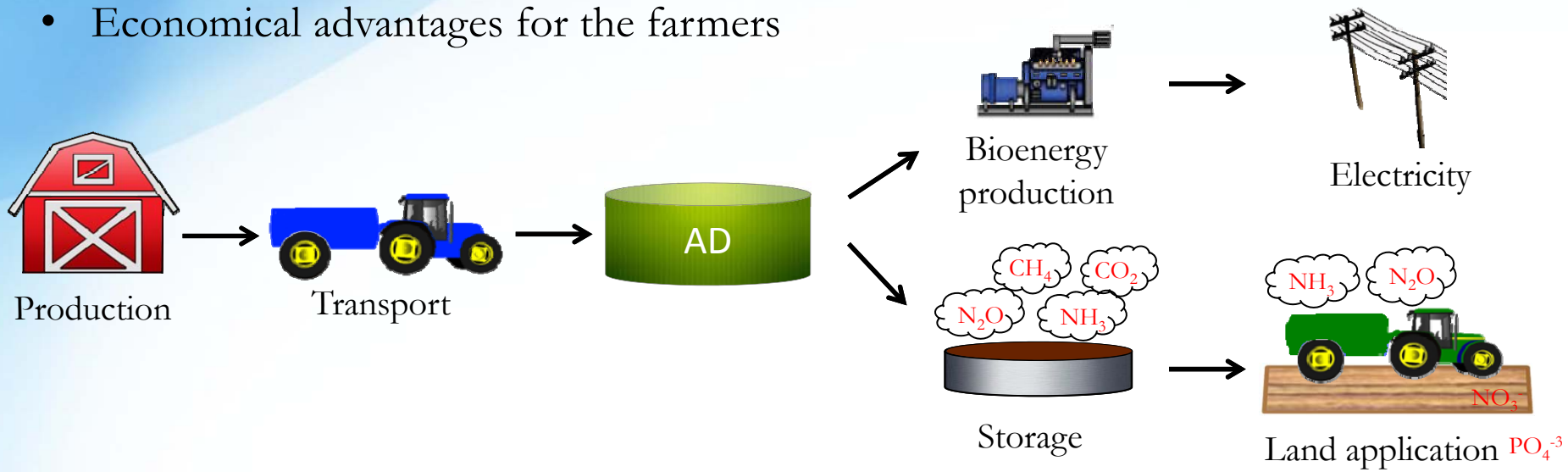
Livestock waste management

Biogas production from manure:

- Renewable energy production
- Lower greenhouse gas emissions
- Fertilisation value (avoiding mineral fertilisers)
- Less nuisance from odours and flies
- Economical advantages for the farmers



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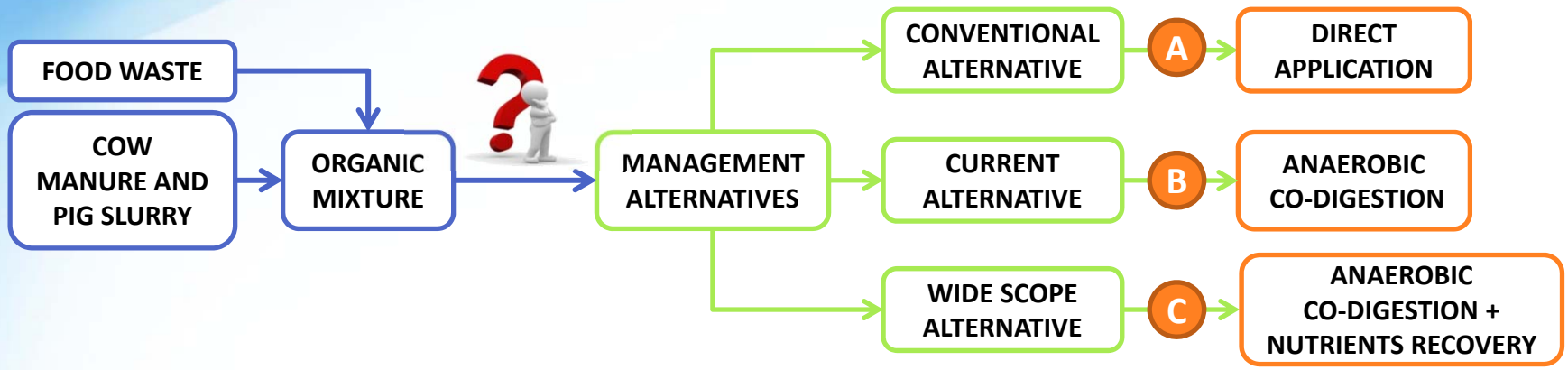
CASE STUDY: Manure management

GOAL

- **Comparative environmental assessment** of the impacts associated with different alternative scenarios focused on livestock manure management for energy production and nutrients valorization

SCOPE

- Gate-to-grave perspective
- Functional unit (**FU**): **1 ton of manure treated**



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System boundaries – Scenarios A/B

Energy production

Field application

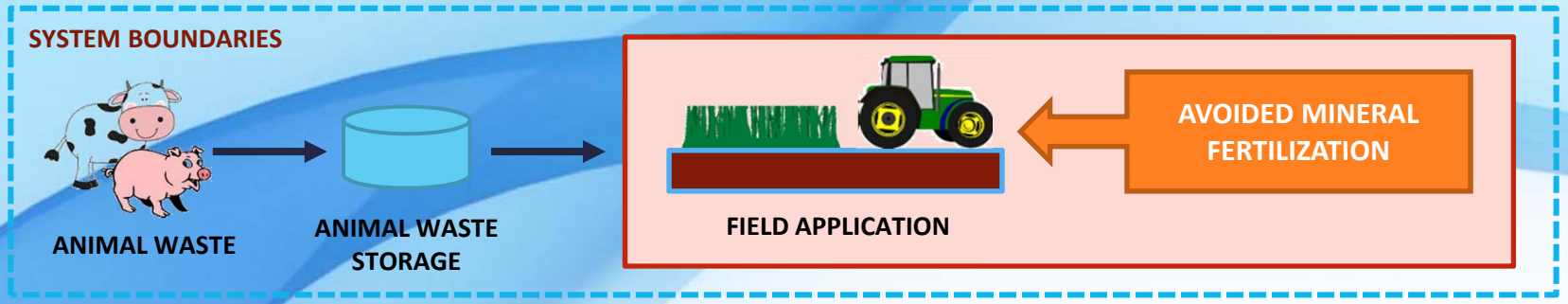

Figure 3. Flowchart of the processes involved in **Scenario A**.

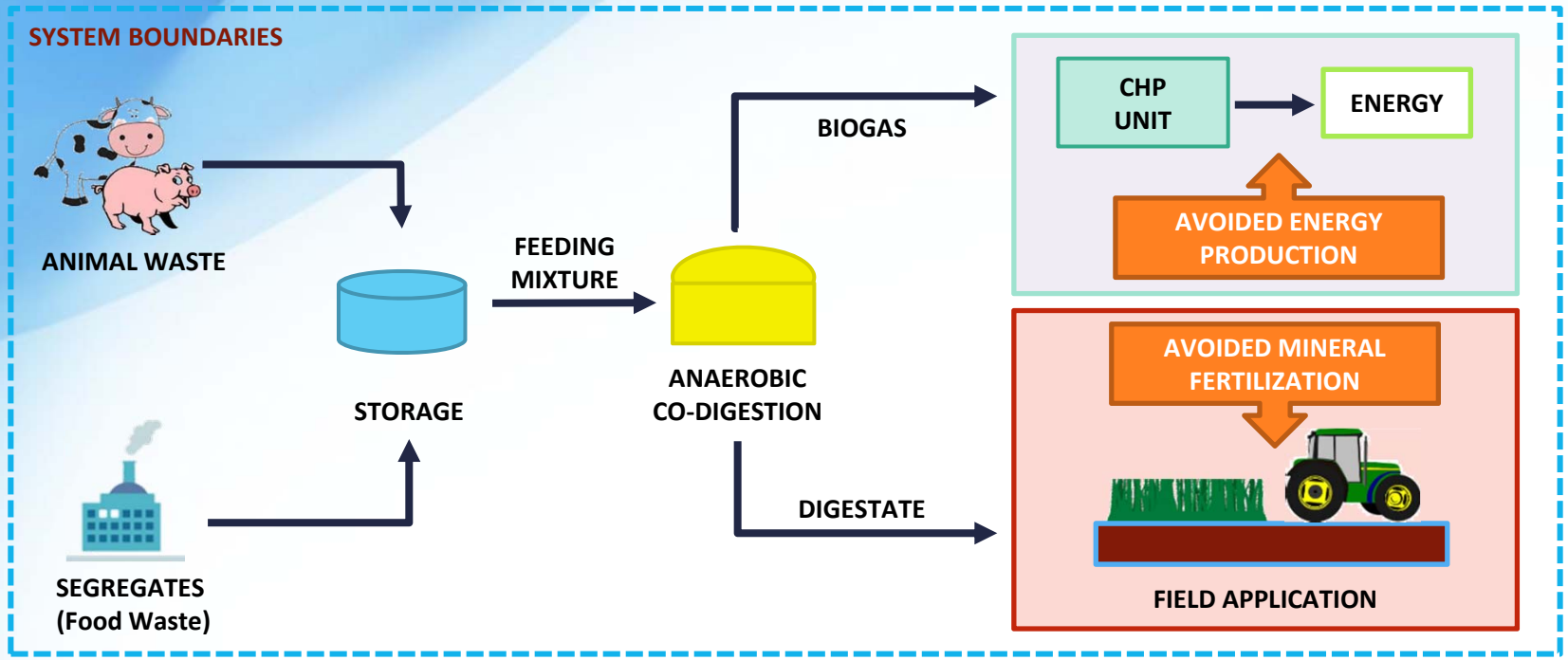

Figure 4. Flowchart of the processes involved in **Scenario B**.

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System boundaries – Scenario C

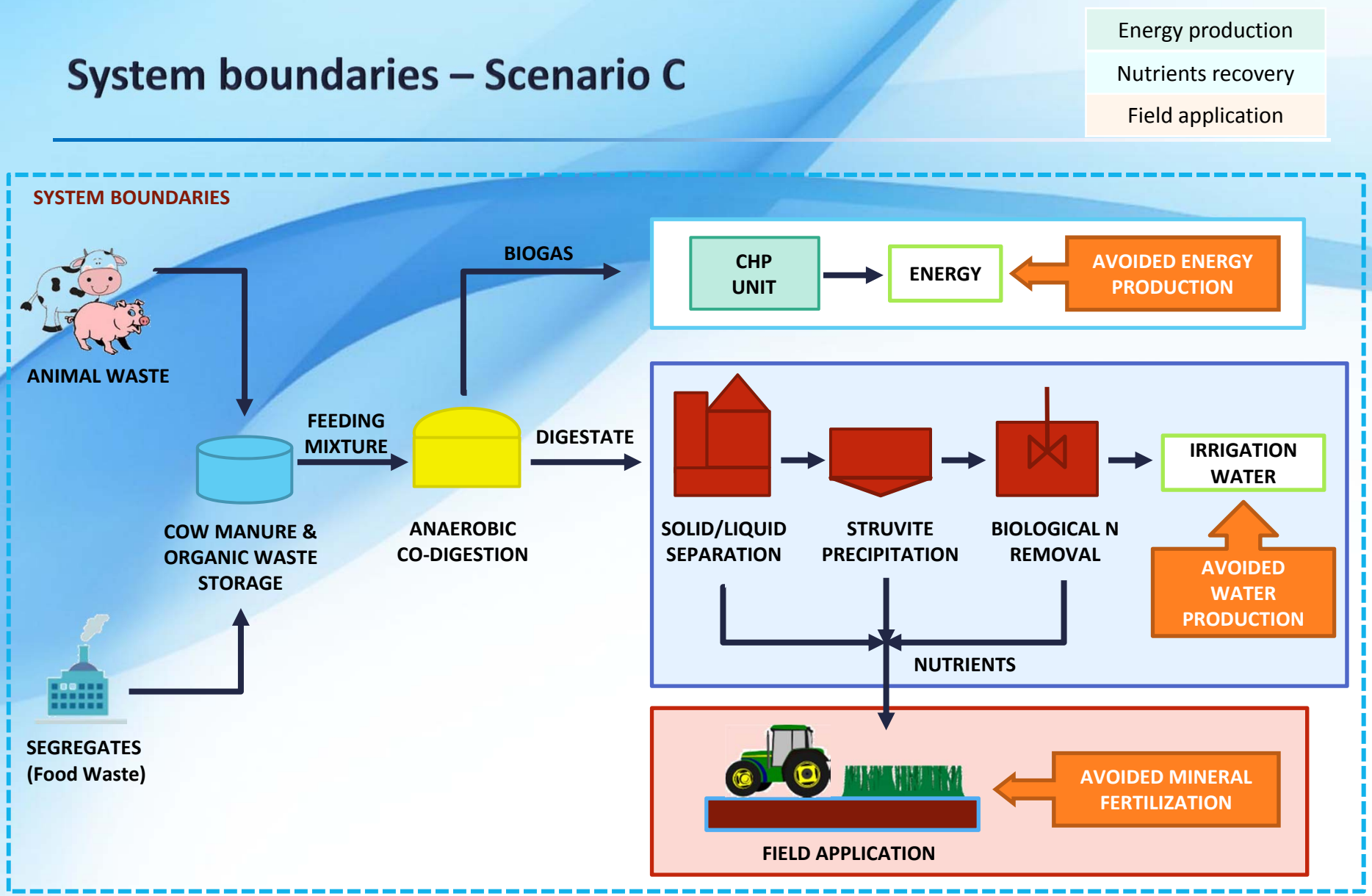

Figure 5. Flowchart of the processes involved in **Scenario C**.

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Life Cycle Impact Assessment – 6 Impact Categories

METHODOLOGY	**RECIPE MIDPOINT (H) 1.12**
SOFTWARE	**SIMAPRO 8.0.5.13**

Table 1. Impact categories selected for evaluation.

IMPACT CATEGORY	ACRONYM	UNIT
CLIMATE CHANGE	CC	kg CO_2 eq
TERRESTRIAL ACIDIFICATION	TA	kg SO_2 eq
FRESHWATER EUTROPHICATION	FE	kg P eq
MARINE EUTROPHICATION	ME	kg N eq
HUMAN TOXICITY	HT	kg 1,4-DB eq
FOSSIL DEPLETION	FD	kg oil eq

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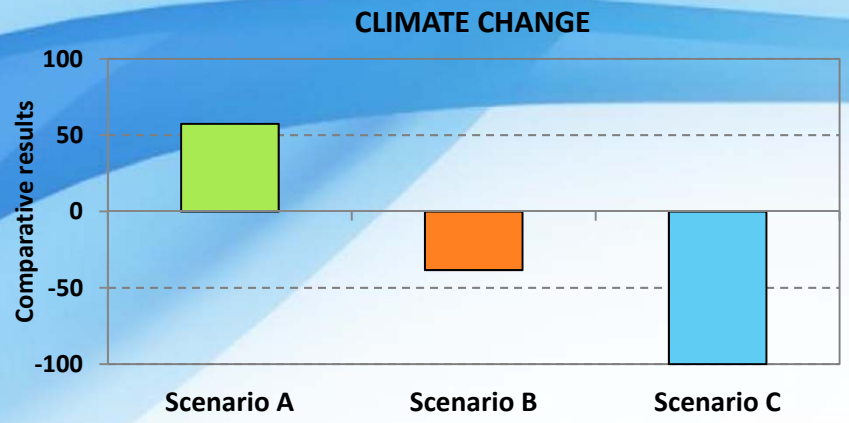
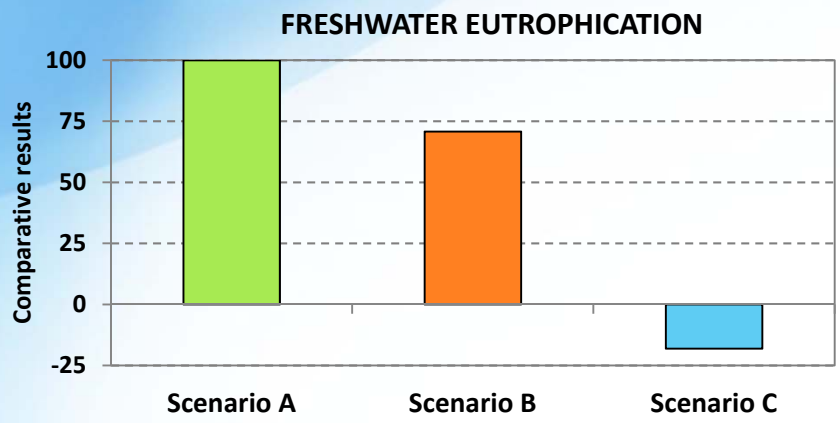
Comparative assessment – Characterization results (I)





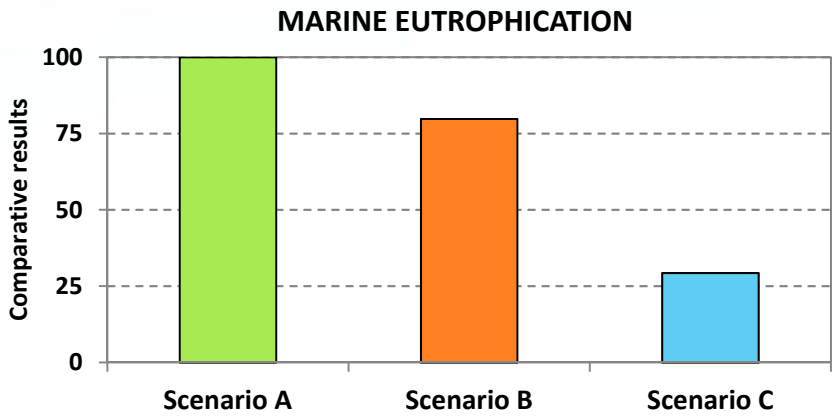
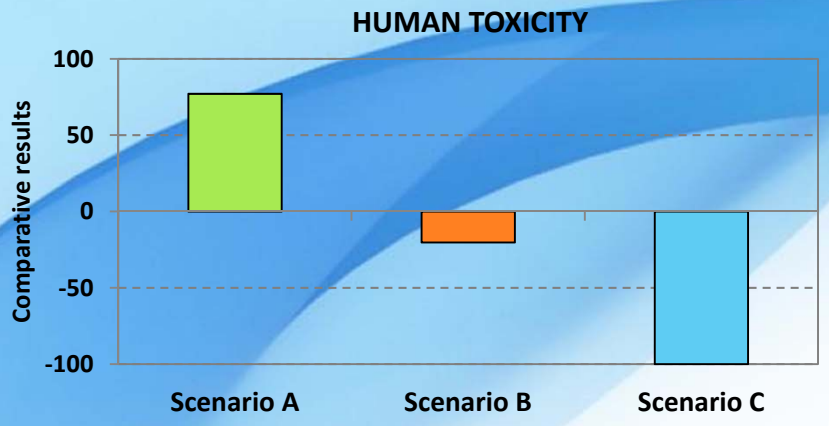
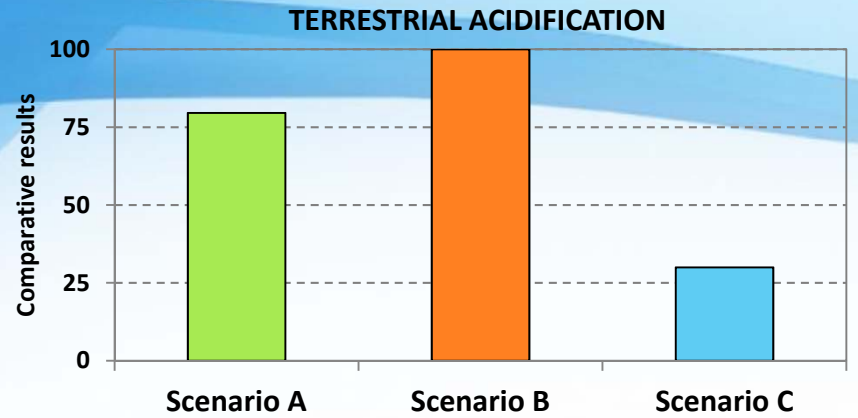


Figure 6. Comparative environmental results of the different scenarios assessed (FU = 1 ton organic mixture).

Comparative assessment – Characterization results (II)





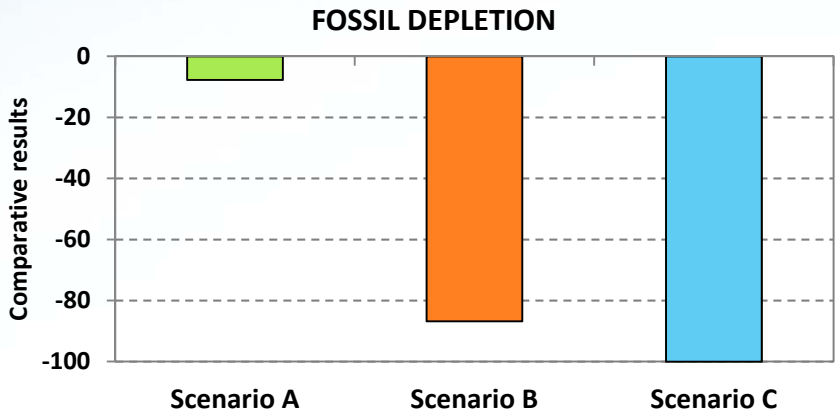


Figure 6 (cont.). Comparative environmental results of the different scenarios assessed (FU = 1 ton organic mixture).

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Main conclusions

- According to the comparative assessment, **Scenario C** would show **the best environmental profile** in the selected impact categories, with lower environmental burdens compared with Scenario A and Scenario B.

- These favorable results for Scenario C are **due to the environmental credits** related to the **energy production** as well as lower emissions derived from the **recovered nutrients**, and avoided mineral fertilization which partially offset related environmental impacts.

- However, Scenario C requires **higher energy consumption** due to additional stages of S/L separation and nutrients recovery (struvite precipitation and nitrogen removal), partially offsetting the environmental credits of Scenario C.

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