Life Cycle Assessment of Valorizing Olive Cake Waste in Animal Feed Production

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Olive Cake Waste & its Valorization into Animal Feed

- The olive-oil extraction industry produces olive cake (OC).
- It contains a diversity of phytochemicals such as phenolic compounds and other bioactive molecules, including sterols, pentacyclic triterpenes, tocochromanols, carotenoids and mono- and polyunsaturated fatty acids.
- It poses environmental challenges due to its high organic content and potential for soil and water contamination.
- Its valorization into valuable secondary feedstuff for poultry via solid-state fermentation has been suggested[1].

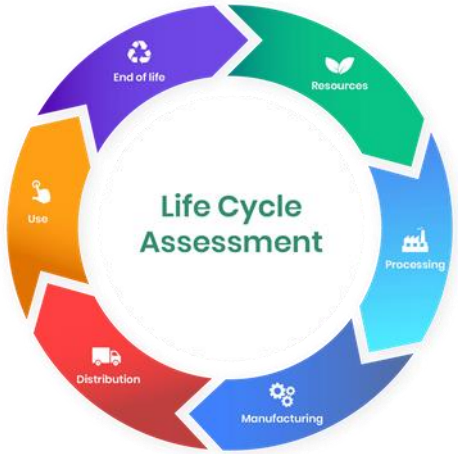
The life-cycle environmental impacts of this new feed ingredient/feed compared to the current state?

[1] **NEWFEED Project, Turn Food Industry By-products into Secondary Feedstuffs via Circular-Economy Schemes. EU's Horizon 2020 research and innovation programme, Grant Agreement number: 2013. 2021-2025.**

Objective

To assess the environmental impacts of this valorization strategy.

LCA



Scope

Processing of Olive Cake by Solid-State Fermentation

Feed Ingredient

Formulation of Animal Feed -w/and w/o supplement

Animal Feed

Environmental Impacts?

Data from Pilot Plant

Contribution to Environmental Impacts?

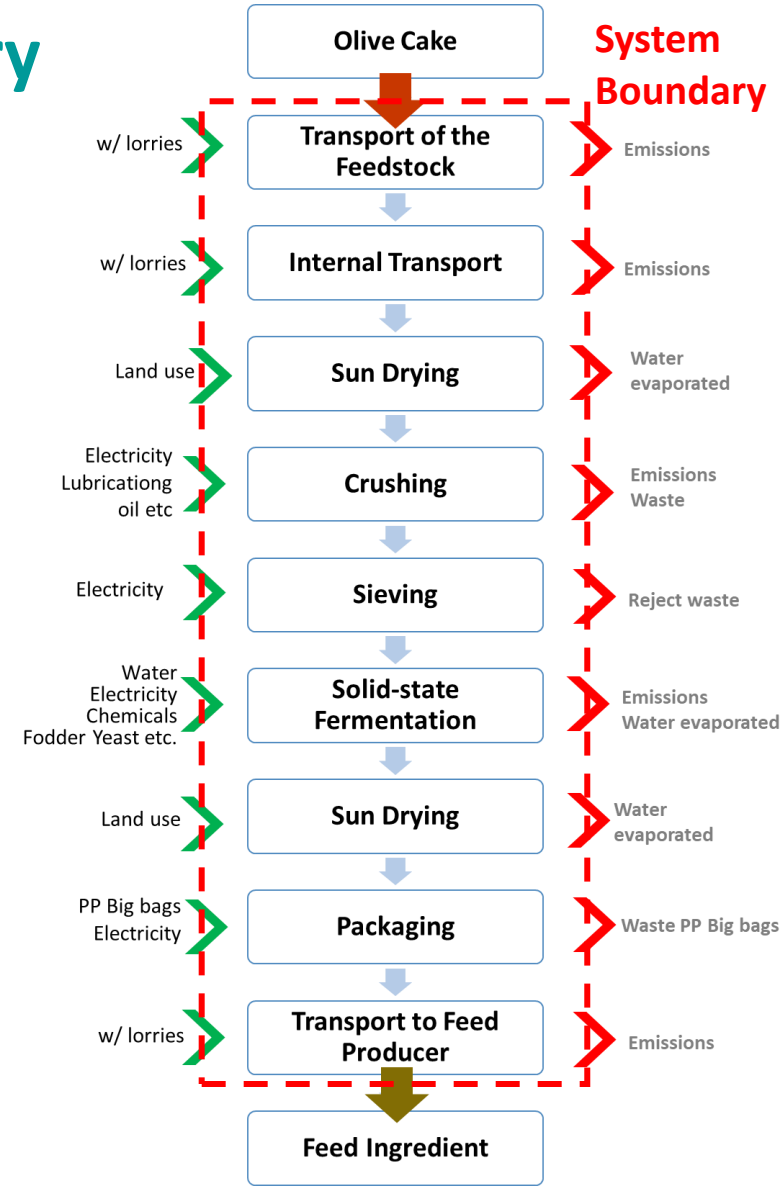
Data from Pilot Plant

- Landfilling
- Incineration
- Composting

Data from Databases

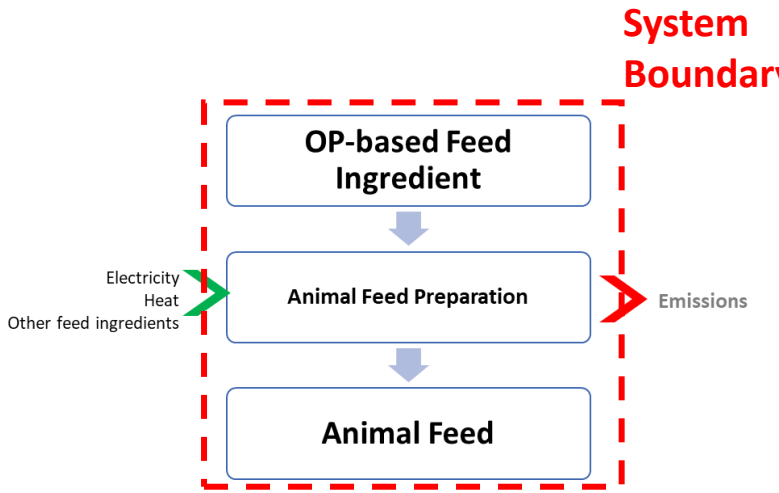
Environmental Impacts?

System Boundary



Feed Ingredient Production

- Energy use?
- Chemicals/fodder yeast?



Feed Production

- Energy use?
- Other ingredients?
- Contribution of OC-based ingredient?

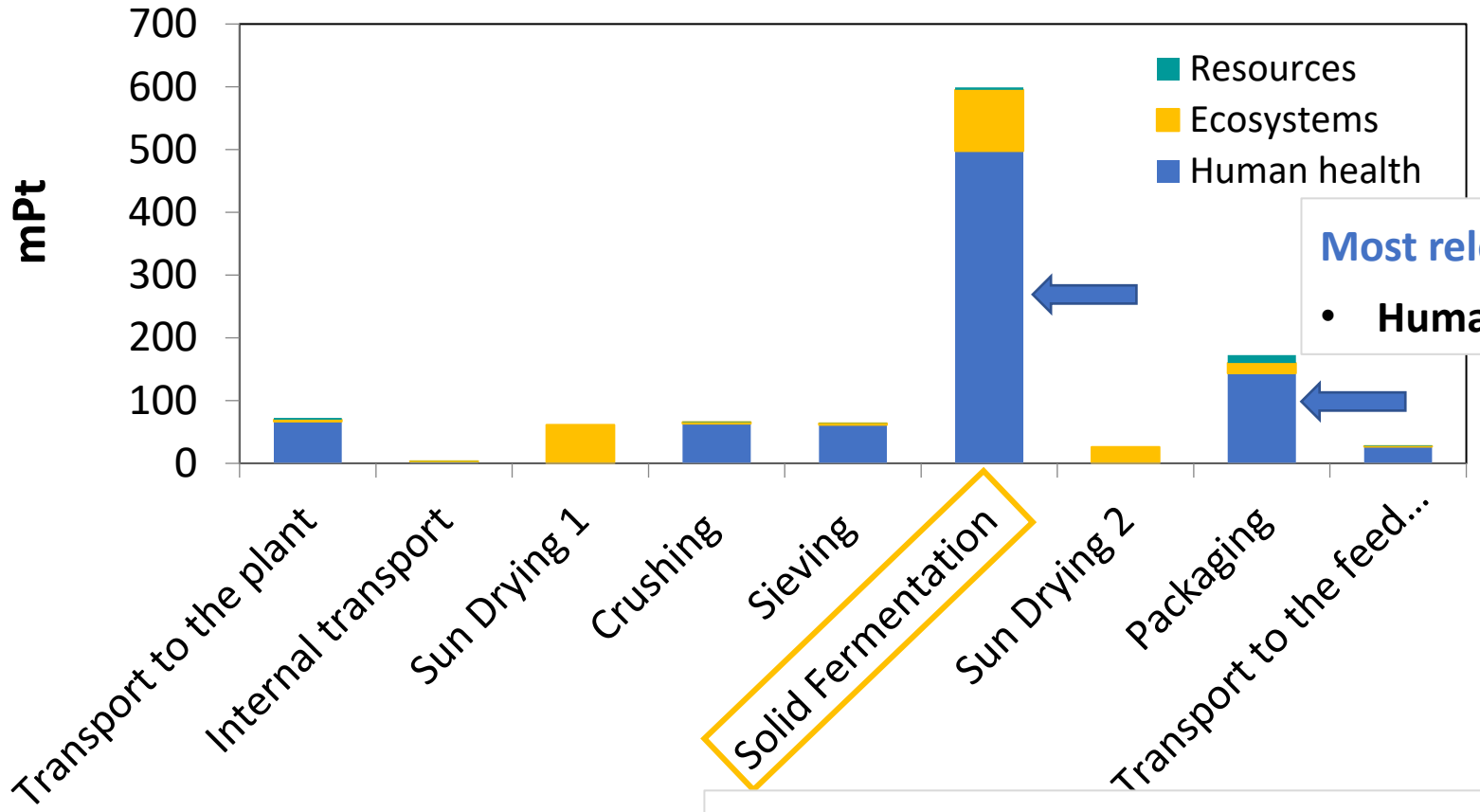
Life Cycle Assessment

- Functional Unit: 1 ton of animal feed produced (10% OC-based ingredient)
- System Boundary: Cradle to Grave
- Software Tool: SimaPro 9.3.0.3
- Database: Ecoinvent 3.7 (primarily)
- Impact Analysis Method: Recipe 2016 (hierarchical)

Impact categories

Midpoint (18)	Endpoint (3)
Global warming	Human Health
Stratospheric ozone depletion	Ecosystems
Ionizing radiation	Resources
Ozone formation, Human health	
Fine particulate matter formation	
Ozone formation, Terrestrial ecosystems	
Terrestrial acidification	
Freshwater eutrophication	
Marine eutrophication	
Terrestrial ecotoxicity	
Freshwater ecotoxicity	
Marine ecotoxicity	
Human carcinogenic toxicity	
Human non-carcinogenic toxicity	
Land use	
Mineral resource scarcity	
Fossil resource scarcity	
Water consumption	

Single Score LCA Results for Feed Ingredient Production



Most relevant impact category

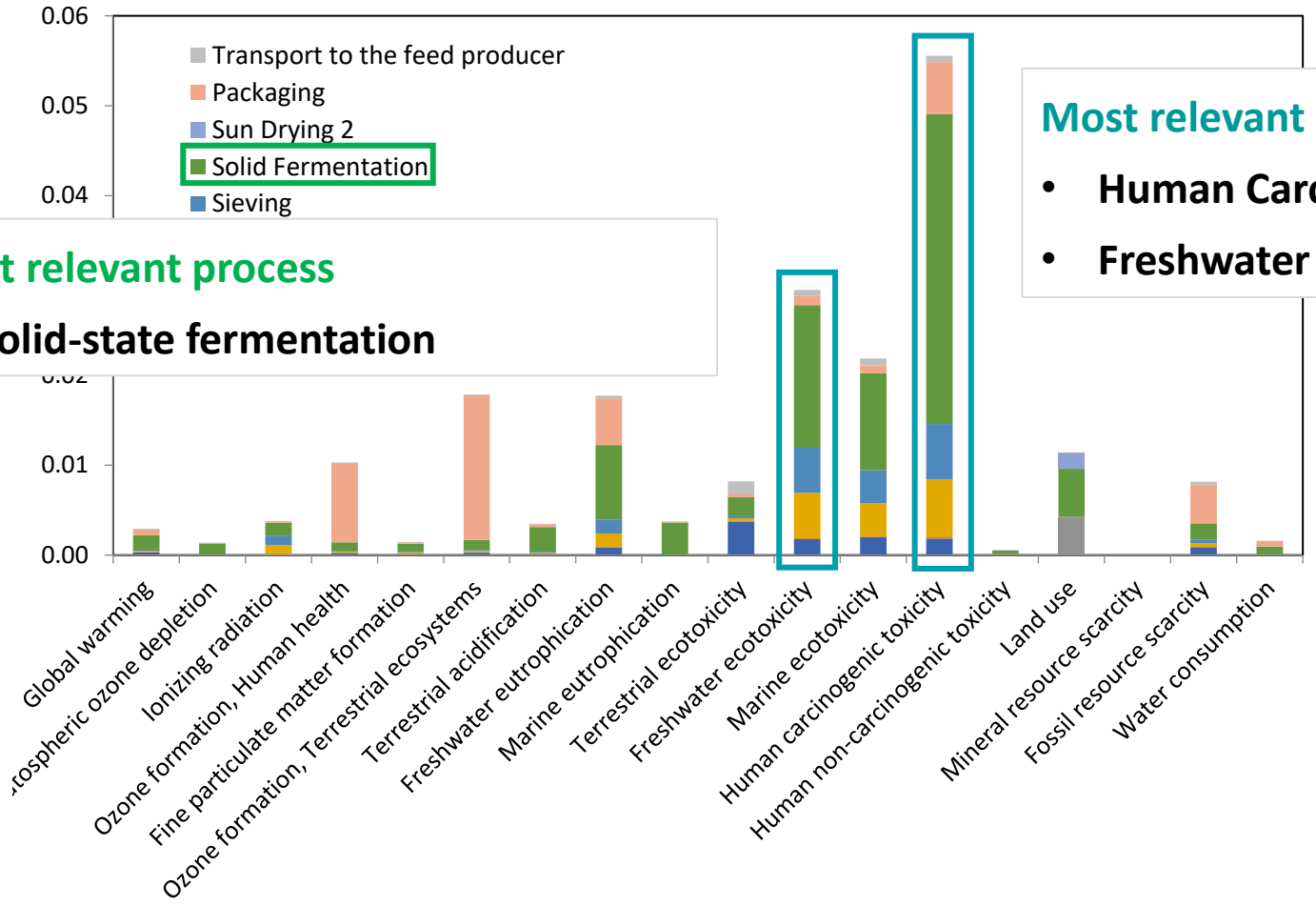
- **Human Health**

Most relevant process

- **Solid-state fermentation**

Normalized Impacts for Feed Ingredient Production

(using global normalization factors for environmental footprint per person)



Most relevant process

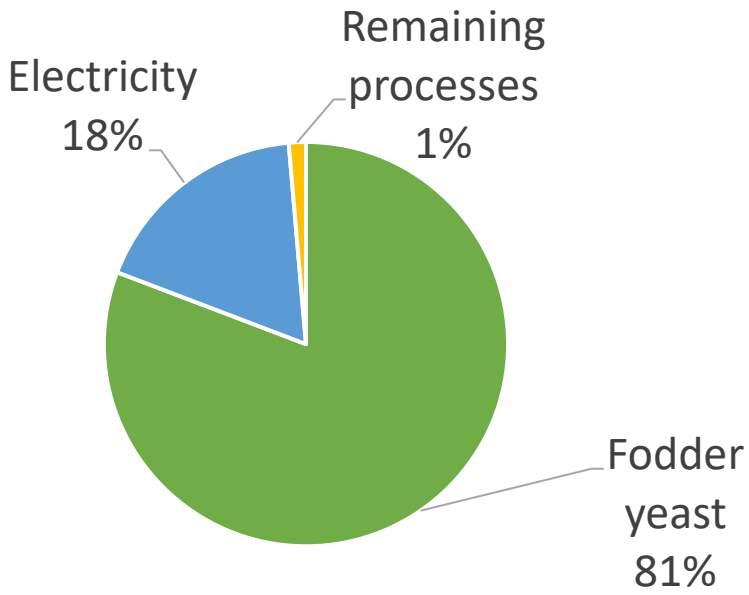
- **Solid-state fermentation**

Most relevant impact categories:

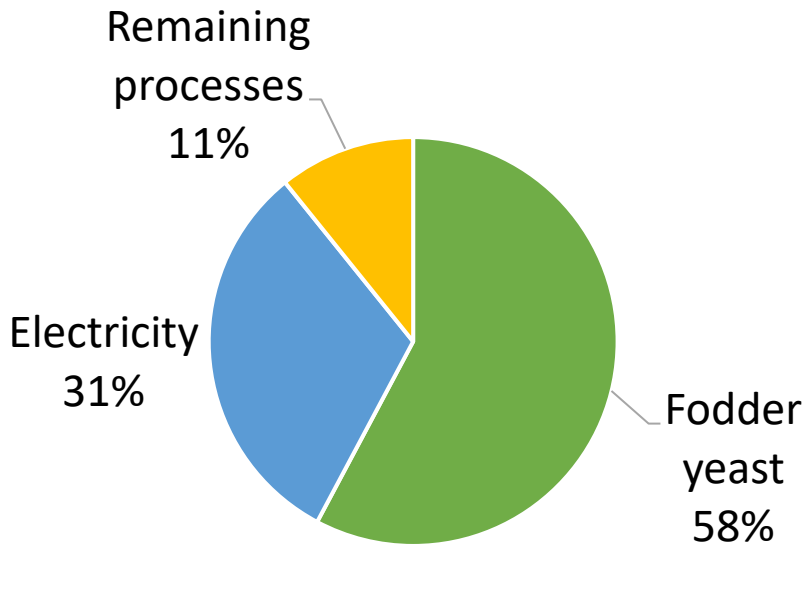
- **Human Carcinogenic Toxicity**
- **Freshwater Ecotoxicity**

Most Relevant Elementary Flows

Human Carcinogenic Toxicity



Freshwater Ecotoxicity



Its production includes preparation of nutrient medium, thermal treatment, filtration, fermentation, extraction of fodder yeast, drying, packing, labelling and storage.

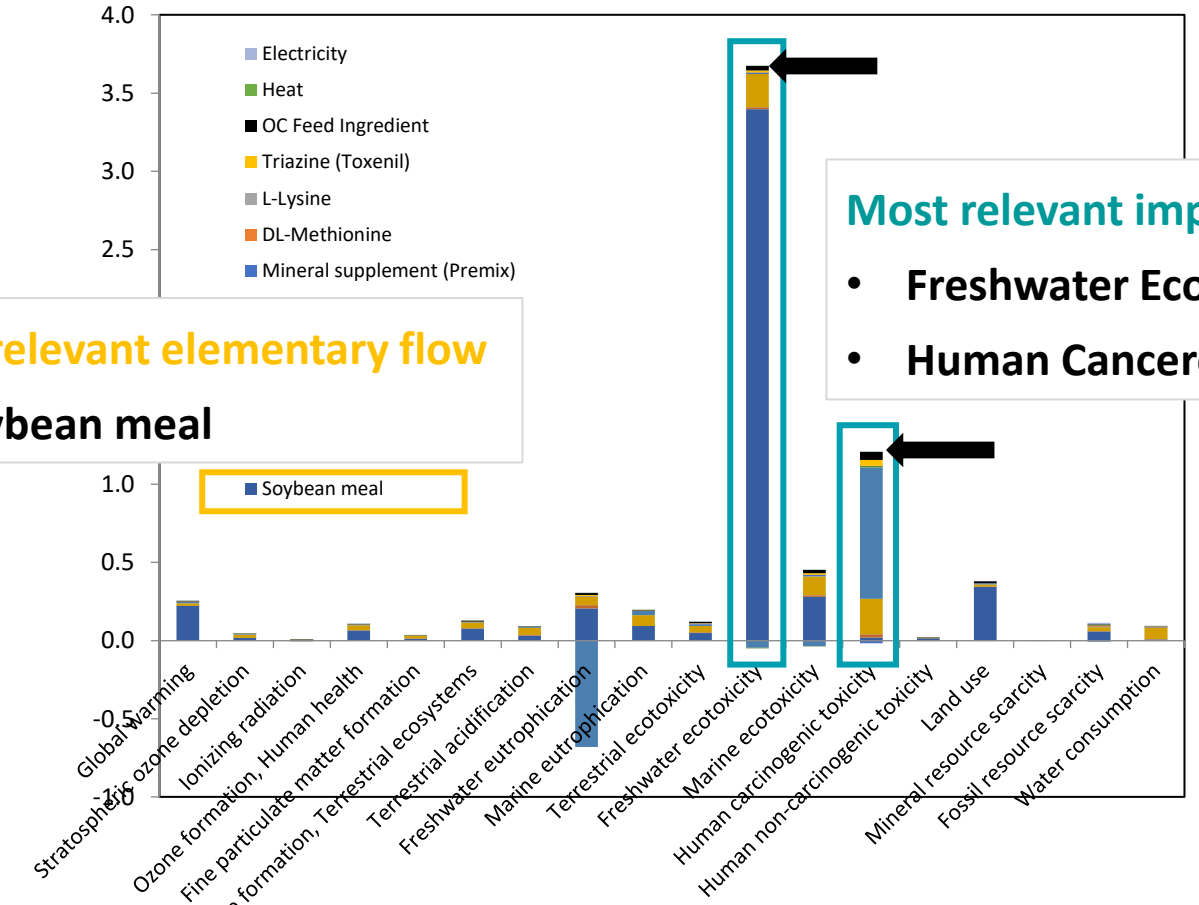
How much is the contribution of the feed ingredient’s impacts to those of animal feed?

Animal Feed Diet for Poultry

Two different formulations

Ingredient	Conventional (kg/ton)	OC based w/suppl. (kg/ton)	OC-based w/out suppl. (kg/ton)
Yellow Corn	503.5	417	417
Soybean Meal	420	410	410
Soybean Oil	36.5	34.5	34.5
Calcium Carbonate	13	13	13
Calcium Dibasic Phosphate	16	15	15
Salt	3	3	3
Premix	3	3	3
DL-Methionine	2.5	2	2
Lysine	1.5	1.5	1.5
Toxenil	1	1	1
OC-based feed ingredient	**0**	**100**	**100**
Supplements (Yeast &Herbs)	0	**50**	0

Normalized Impacts for Animal Feed Production (w/o supplement)



Most relevant elementary flow

- **Soybean meal**

Most relevant impact categories:

- **Freshwater Ecotoxicity**
- **Human Cancerogenic Toxicity**

The contribution of the OC-based feed ingredient to the impacts is almost negligible.

Soybean meal is produced by cracking, heating and flaking dehulled soybeans and reducing the oil content of the conditioned flakes by the use of solvents.

Normalized Impacts for Animal Feed Production (w/ supplement)

Most relevant elementary flow

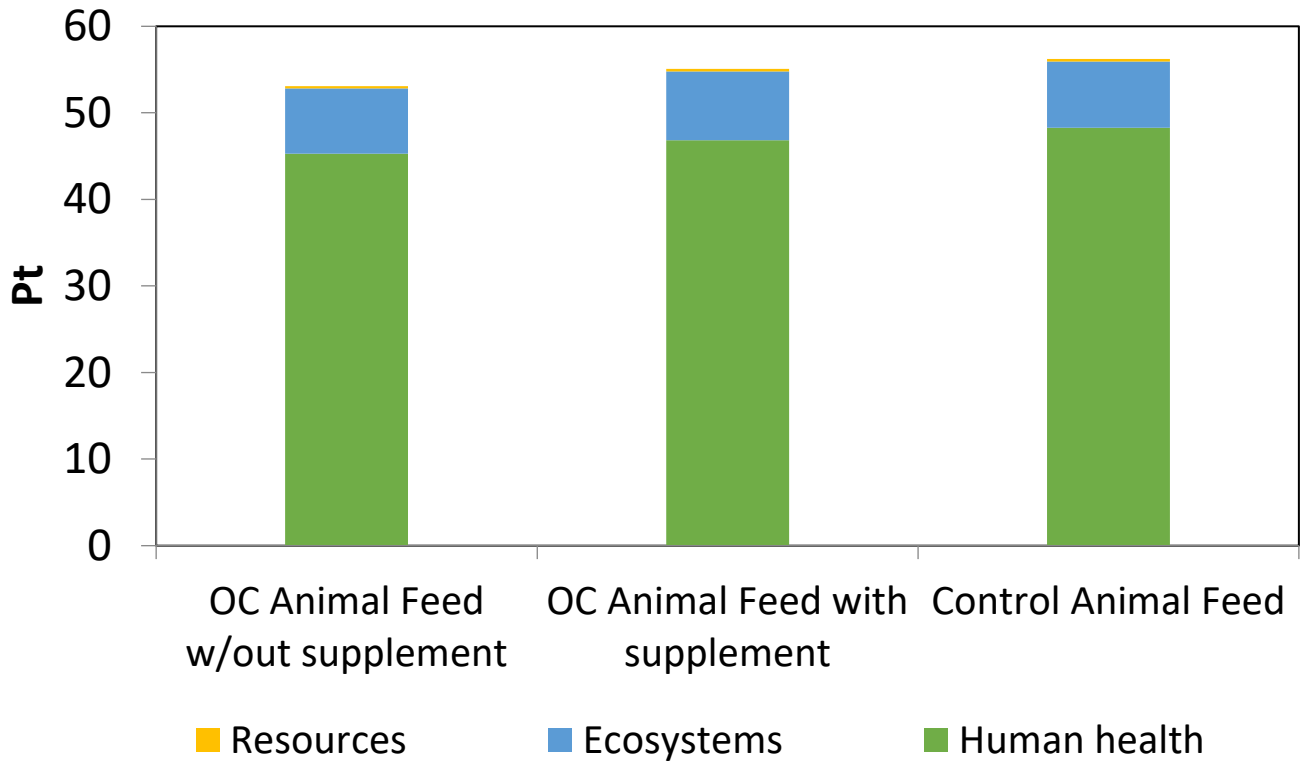
- **Soybean meal**

Most relevant impact categories:

- **Freshwater Ecotoxicity**
- **Human Cancerogenic Toxicity**

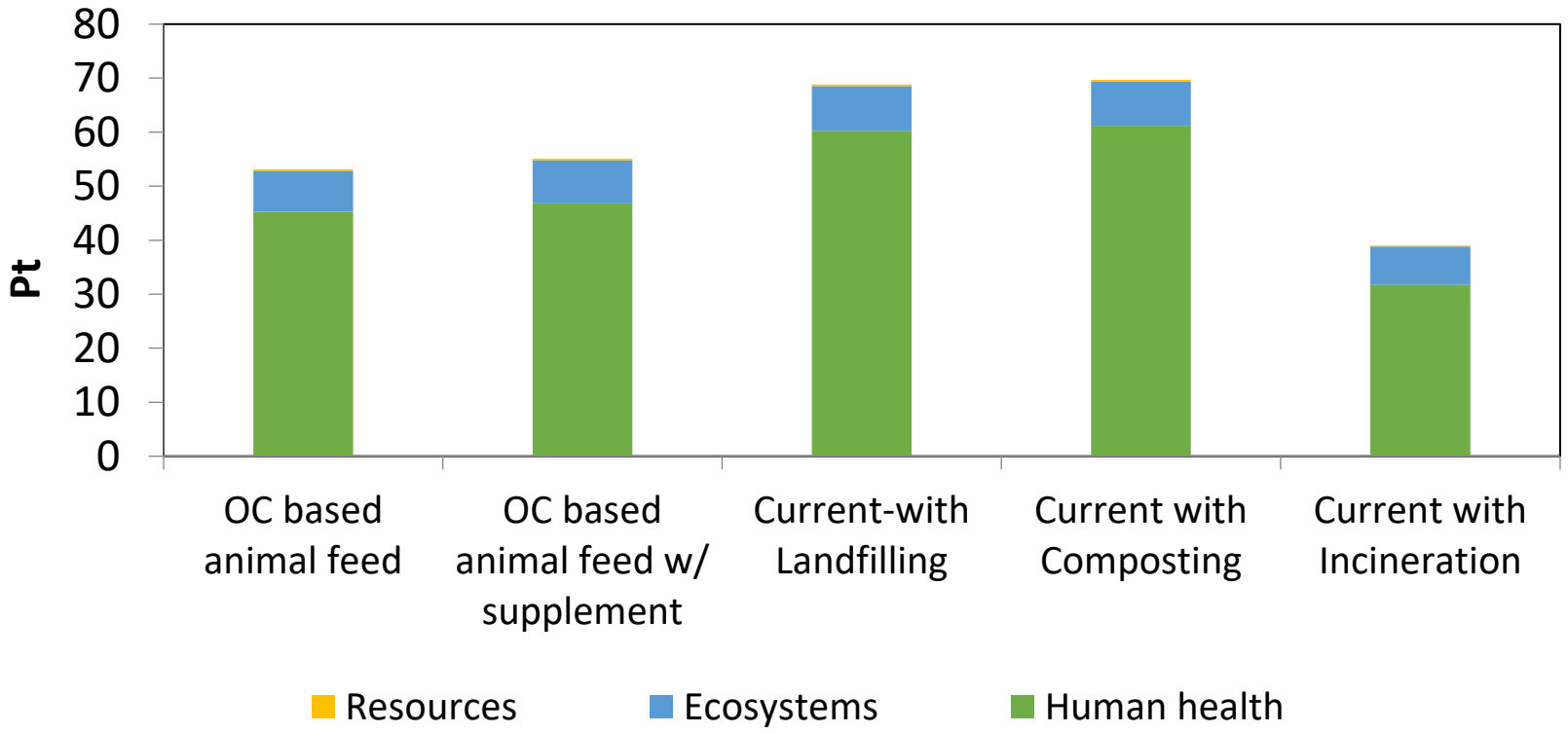
The contribution of the OC-based feed ingredient to the impacts is almost negligible.

Single Score Impacts of Animal Feed Preparation



No remarkable difference between OC-based animal feed and the conventional feed!

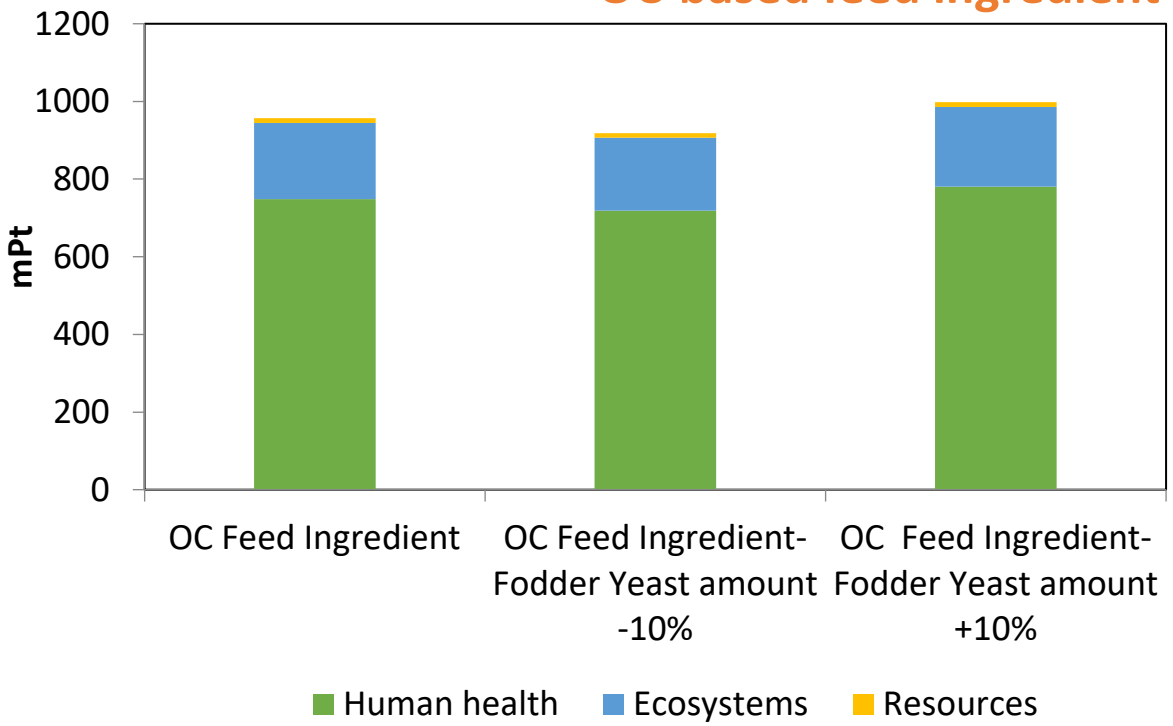
Comparison with Current Situation



Less burdensome than the current situation involving composting and landfilling, but more burdensome than incineration with heat recovery!

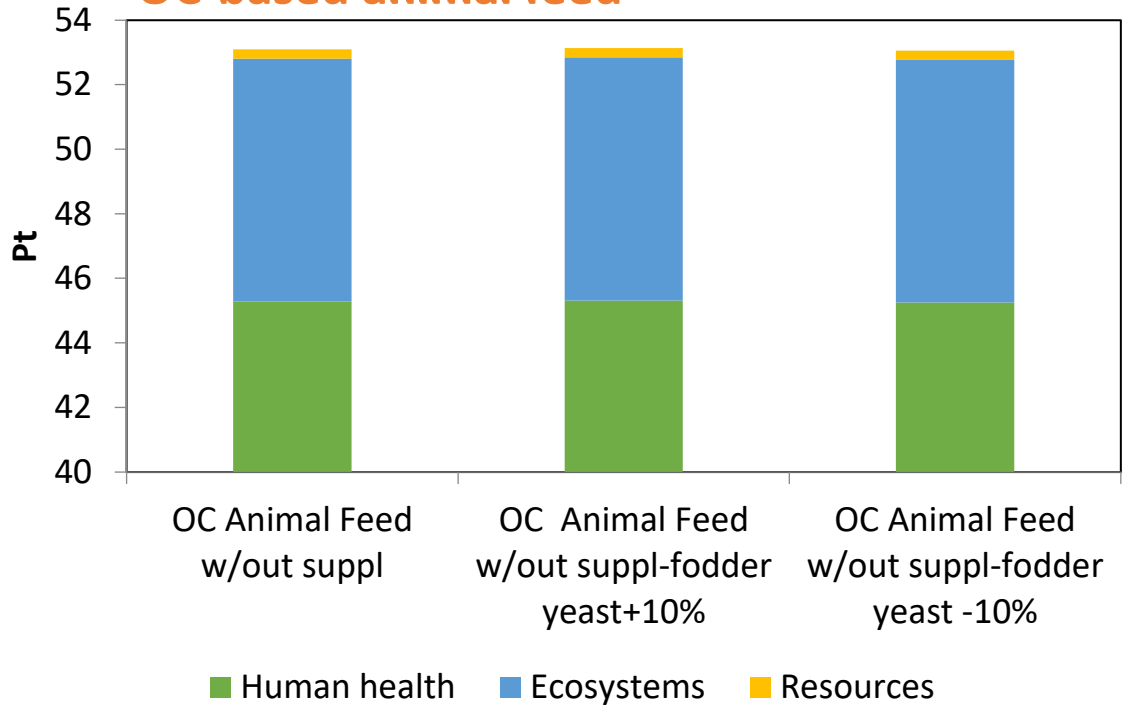
Sensitivity to most influencing parameter (Fodder Yeast)

OC-based feed ingredient



10% decrease in fodder yeast use during the process resulted in a **4 % decrease in total impact**.

OC-based animal feed



Not sensitive to the Fodder Yeast use!

Conclusions

- The stage with the highest impact is the solid-state fermentation process.
- The use of fodder yeast during fermentation plays a critical role in the proposed valorization process.However, this sensitivity diminishes when integrated into animal feed.
- The proposed valorization chain is superior to the disposal scenarios of composting and landfilling, though not to incineration.
- The proposed valorization process presents an environmentally sustainable option for the livestock sector.

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Thank you for listening...