Assessment of the environmental impact of protein source used in fish feed production using Life Cycle Assessment

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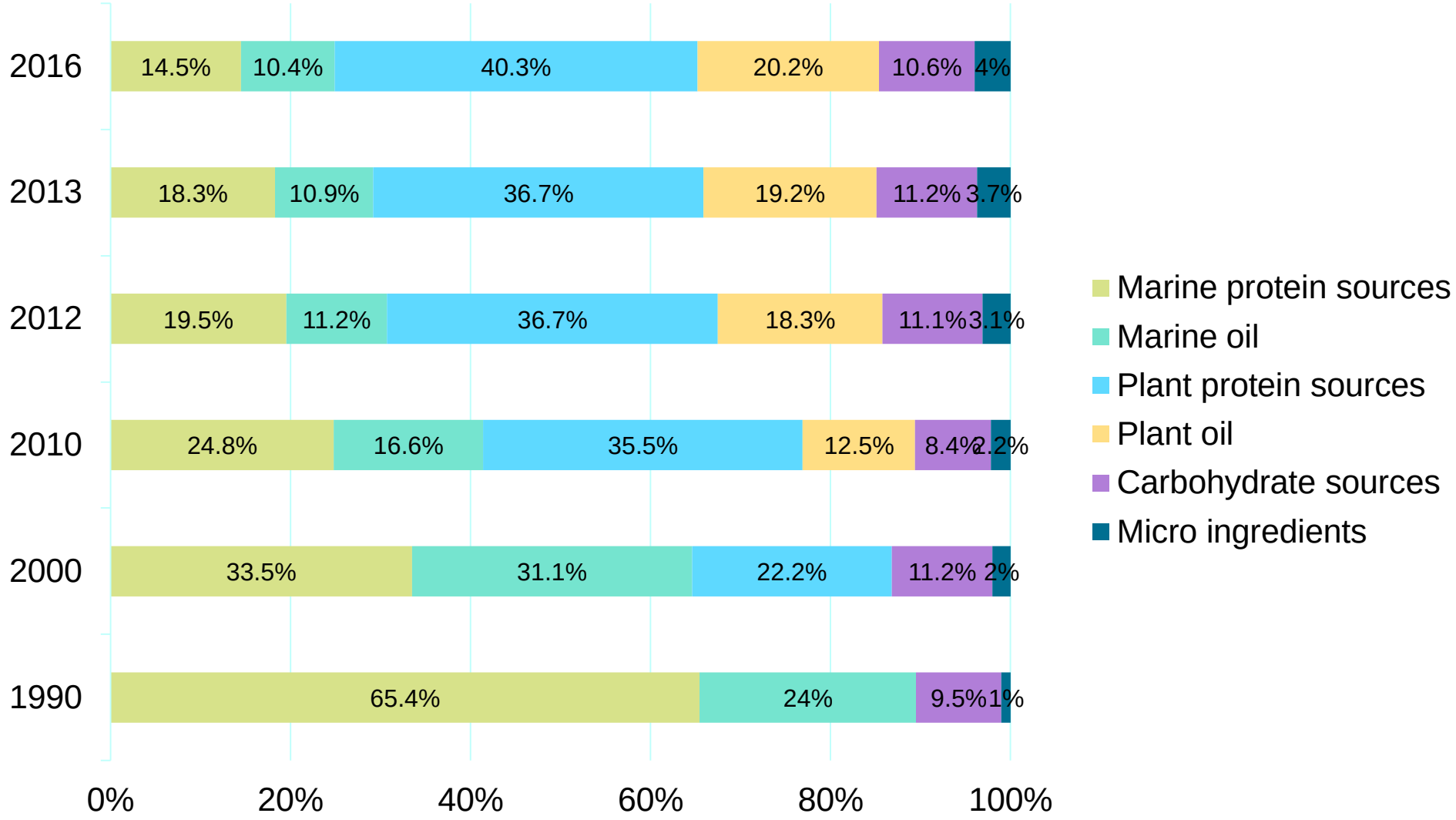
Non-Food Organic Resources-based feeds optimised for salmon until postsmolt stage (NON-Fôr)

AIM OF PROJECT

To investigate:

1. The quality of protein in the ingredients;
2. The physical quality of pellets produced by incorporating the third generation ingredients and to provide suggestions for quality improvement that can be adopted in the commercial production of these feeds;
3. The potential of algae oil as replacer of fish oil at start feeding and during smoltification and the potential of insect meals as replacers of fish meal in post smolt feeds;
4. The environmental impact of the new feeds.

COMPOSITION OF FISH FEED 1990-2016



METHODS. LCA STEPS

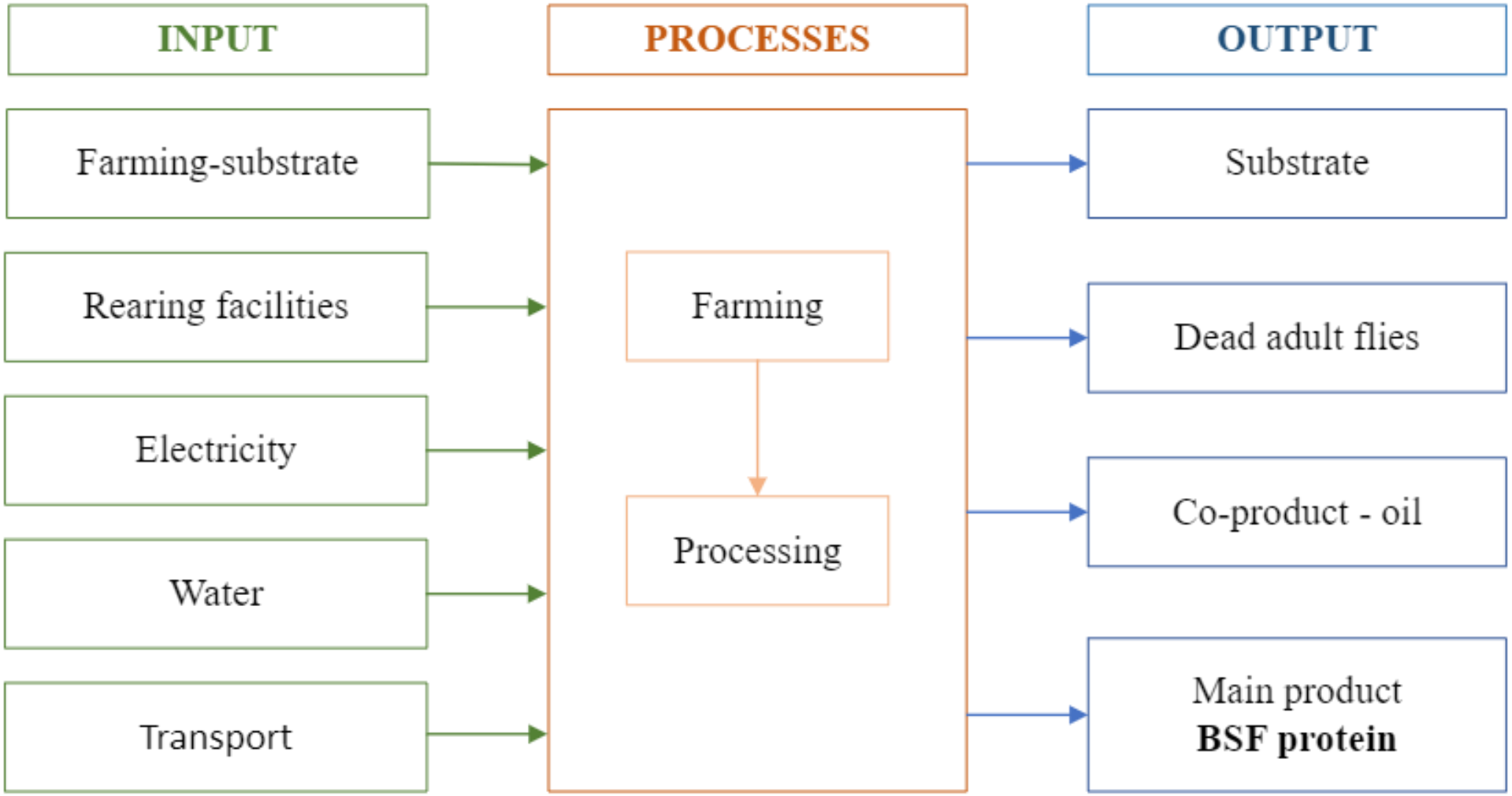
Definition of the goal and scope

Life cycle inventory

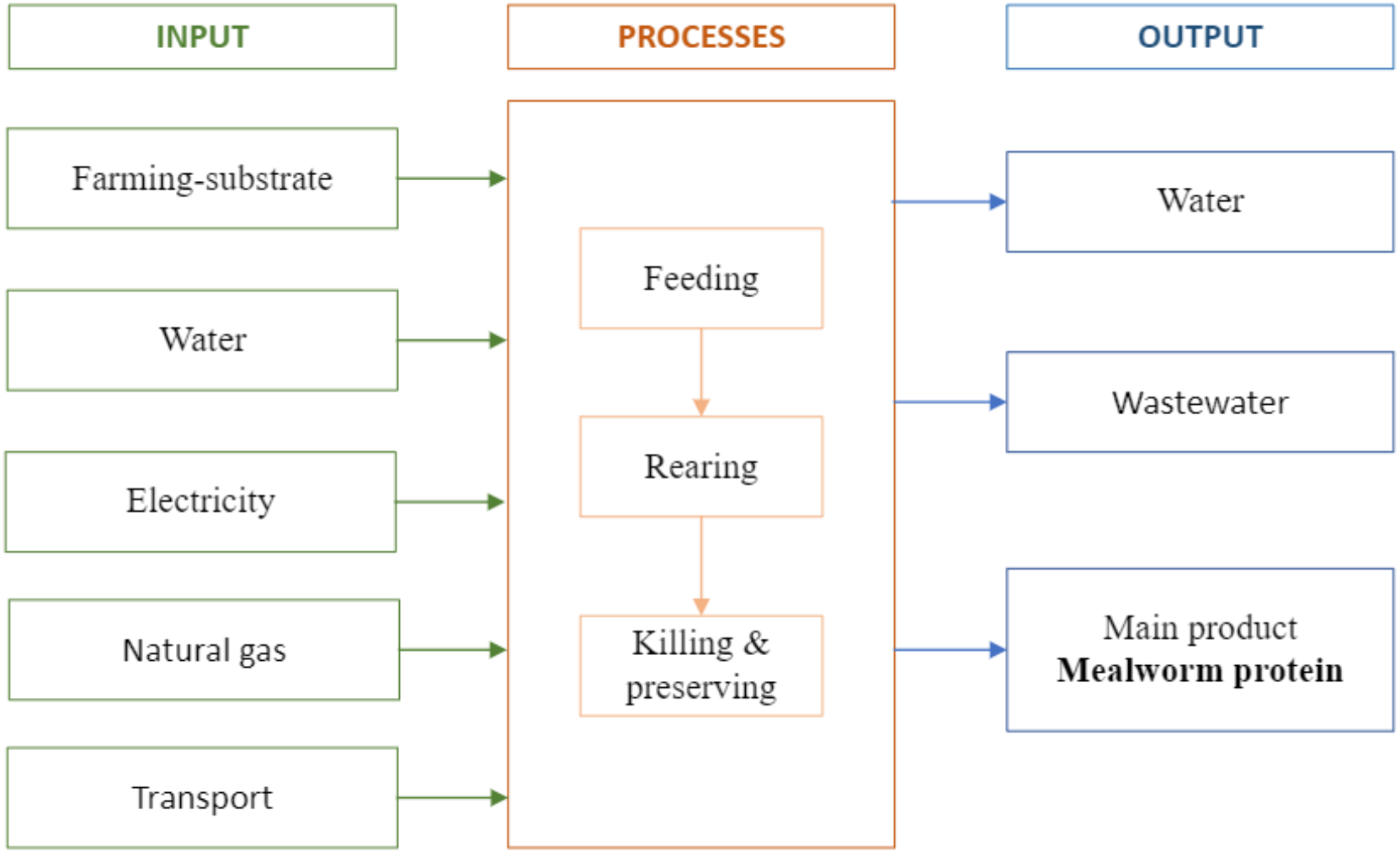
Life cycle impact assessment

Results interpretation

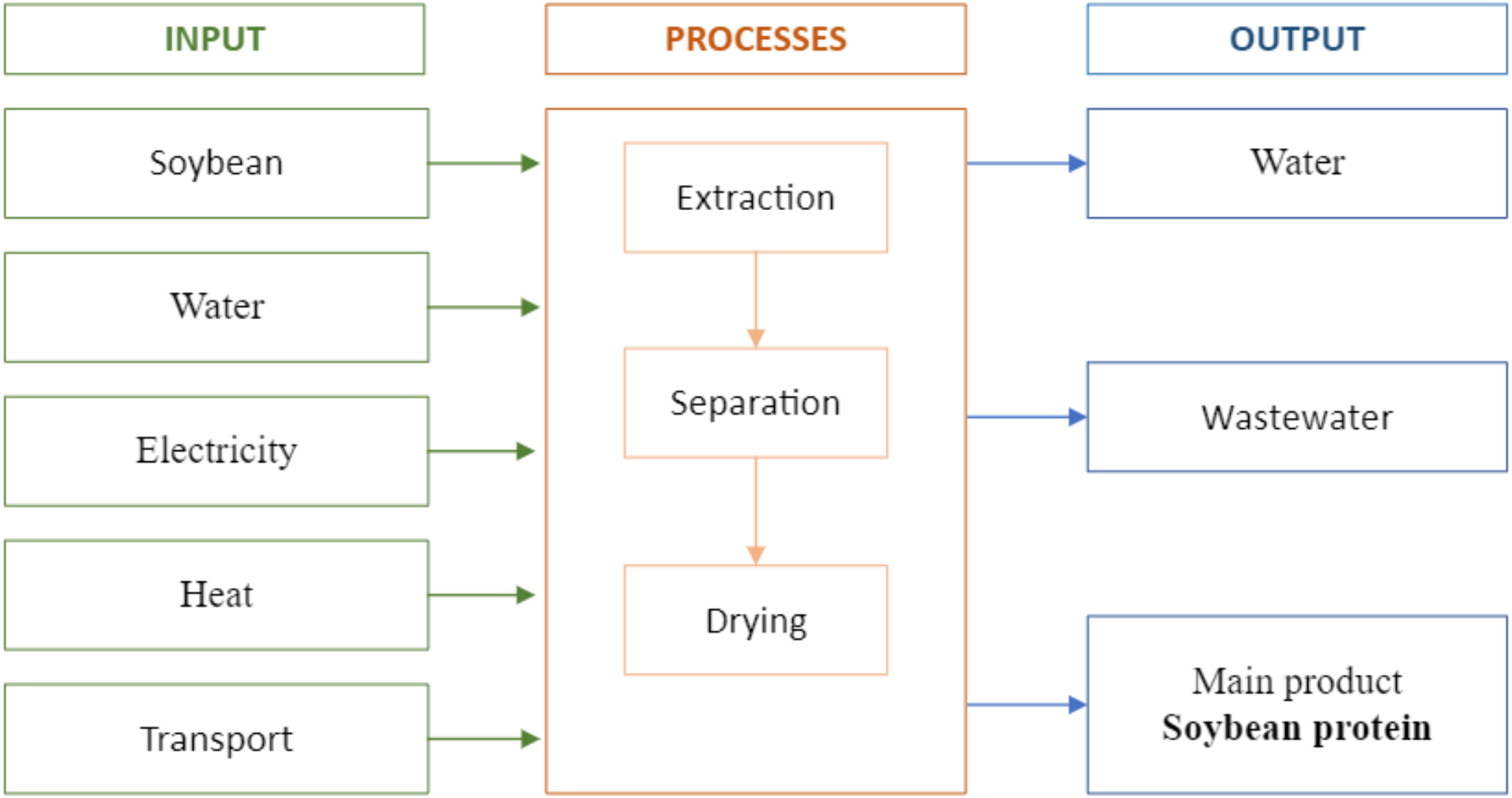
SYSTEM BOUNDARIES FOR BLACK SOLDER FLY PROTEIN PRODUCTION



SYSTEM BOUNDARIES FOR MEALWORM PROTEIN PRODUCTION



SYSTEM BOUNDARIES FOR SOYBEAN PROTEIN PRODUCTION

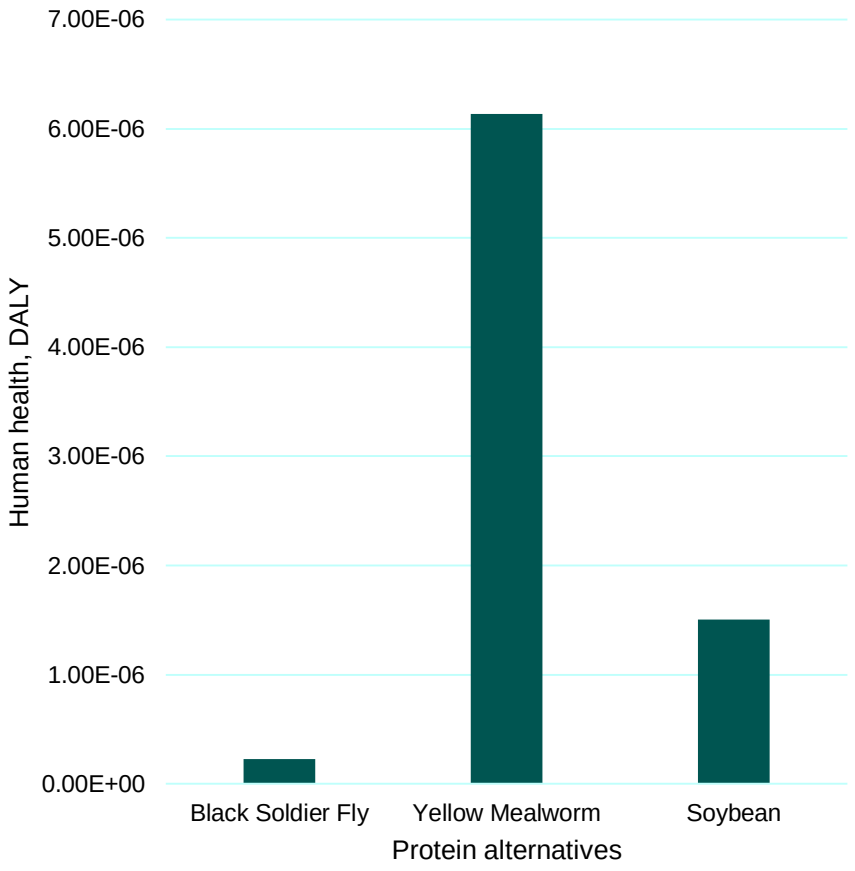


MIDPOINT RESULTS OF PROTEIN ALTERNATIVES

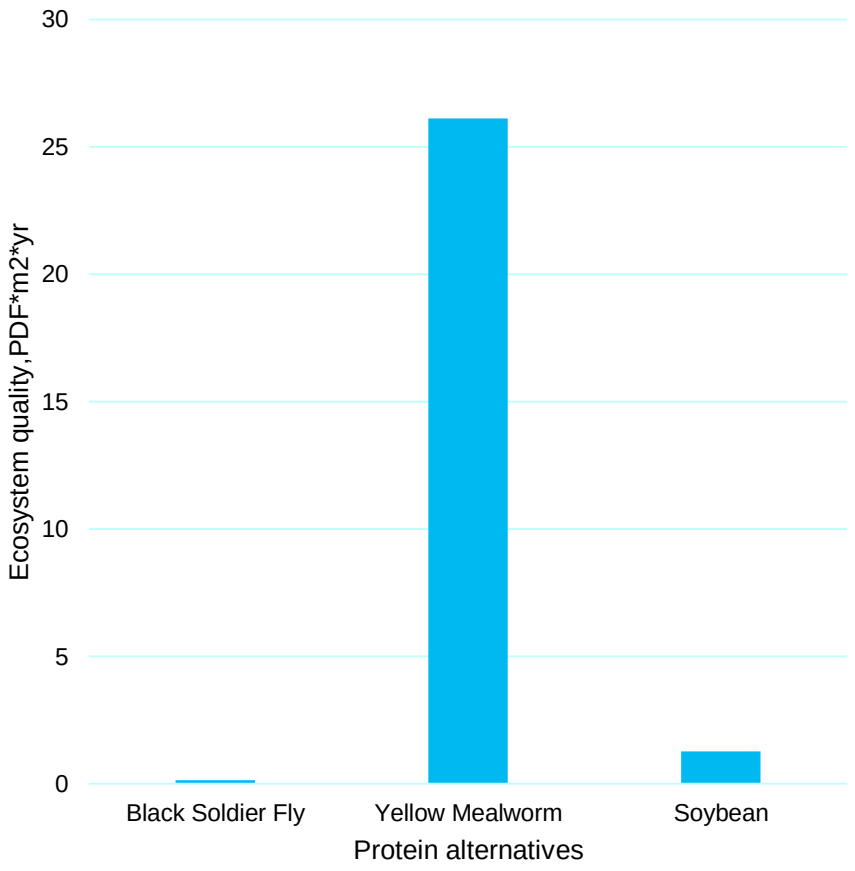
Impact category	Unit	Black Solder fly	Yellow Mealworm	Soybean
Carcinogens	kg C2H3Cl eq	0.002521337	0.056708213	0.020349784
Non-carcinogens	kg C2H3Cl eq	0.007333453	0.35118683	-0.03163716
Respiratory inorganics	kg PM2.5 eq	0.000231516	0.007113622	0.002189735
Ionizing radiation	Bq C-14 eq	182.65138	38.368328	1.8149194
Ozone layer depletion	kg CFC-11 eq	2.45E-08	2.99E-07	3.48E-08
Respiratory organics	kg C2H4 eq	0.000145381	0.001610435	0.00104251
Aquatic ecotoxicity	kg TEG water	84.235187	1742.7388	-177.71469
Terrestrial ecotoxicity	kg TEG soil	12.780546	1045.496	-198.1798
Terrestrial acid/nutri	kg SO2 eq	0.006490714	0.3585514	0.018733797
Land occupation	m2org.arable	0.041322144	15.954776	2.6001162
Aquatic acidification	kg SO2 eq	0.001426552	0.053753488	0.003173341
Aquatic eutrophication	kg PO4 P-lim	2.66E-05	0.004413199	0.001322418
Global warming	kg CO2 eq	0.32771842	5.1158004	3.6674332
Non-renewable energy	MJ primary	39.166813	49.640683	3.5043092
Mineral extraction	MJ surplus	0.008783358	0.102957	0.012998229

RESULTS OF LCA

Results in damage category human health

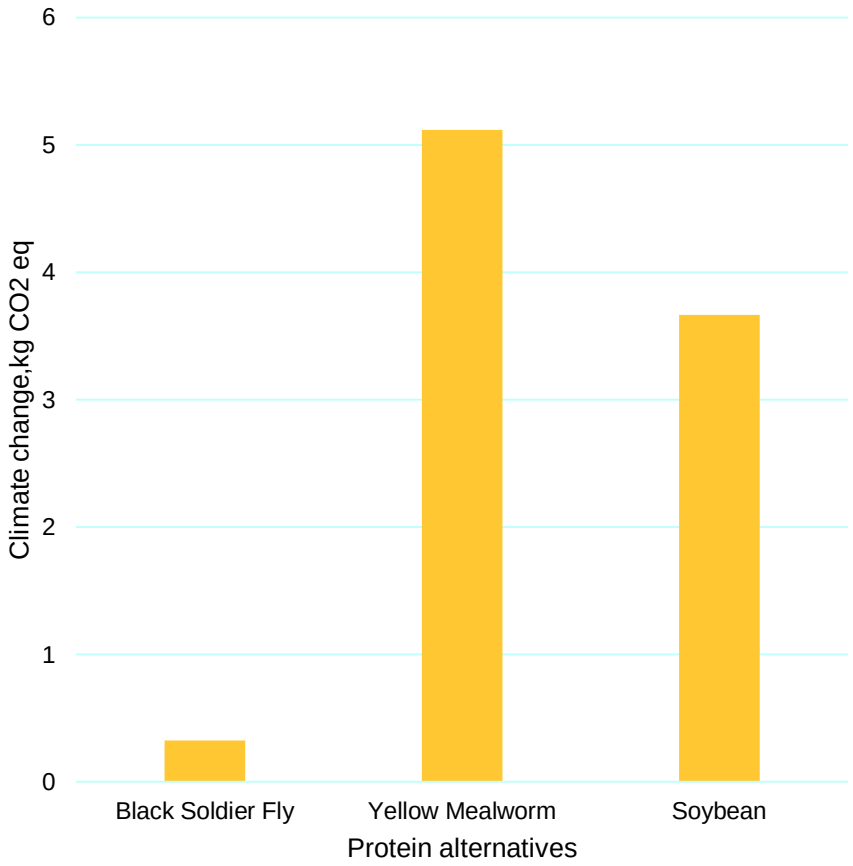


Results in damage category ecosystem quality

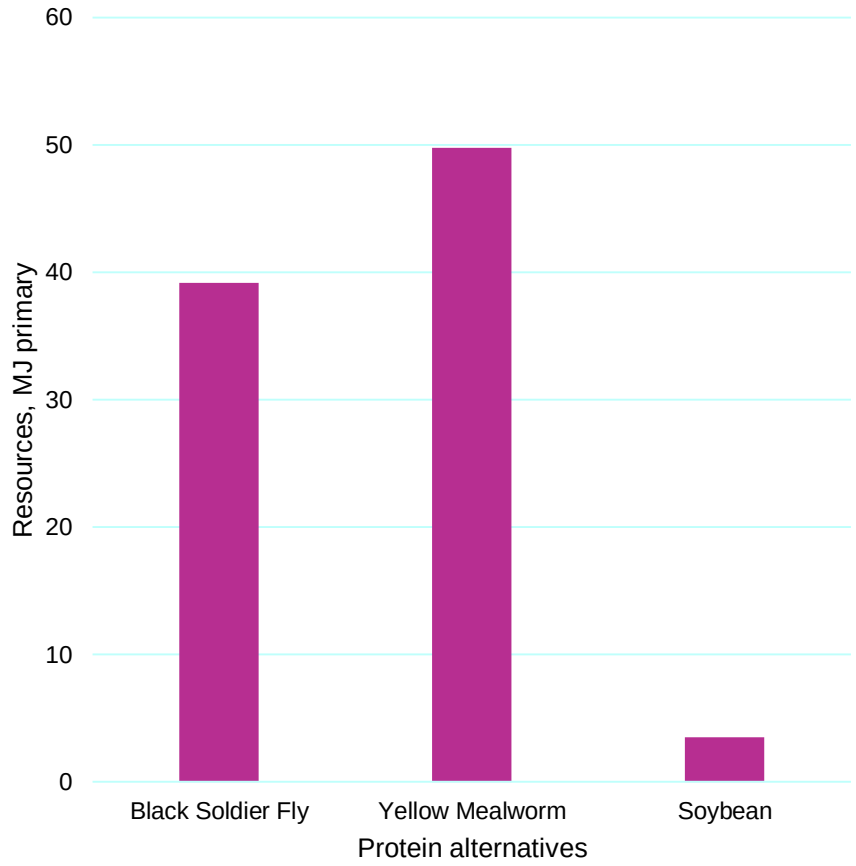


RESULTS OF LCA

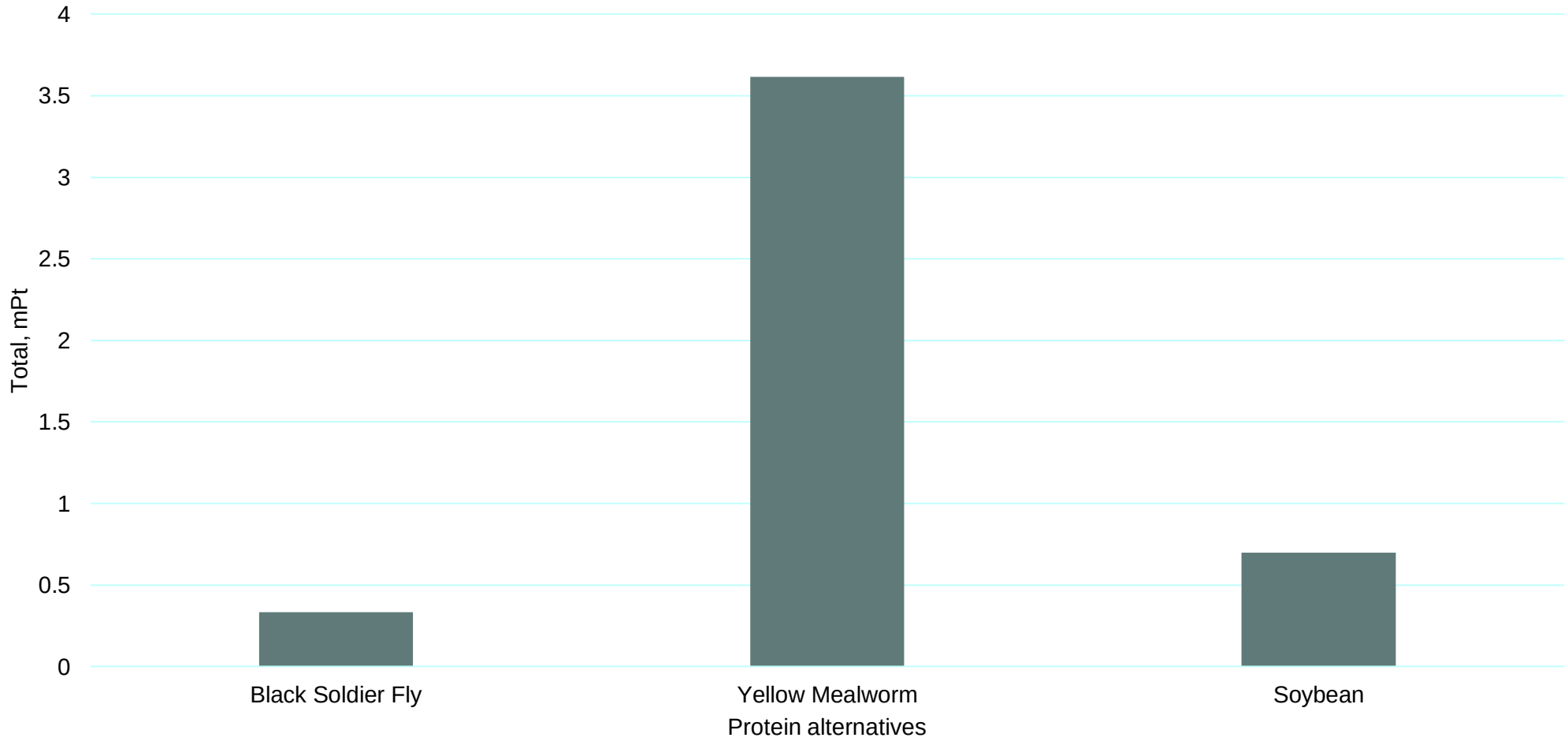
Results in damage category climate change



Results in damage category resources



TOTAL RESULT OF PROTEIN ALTERNATIVE (mPt)



CONCLUSION

- Results from LCA shows that the largest impact is Yellow Mealworm protein, then soybean protein and Black Soldier Fly protein.
- In Yellow Mealworm protein production, the largest impact (83%) came from larval rearing and the rest from electricity. Soybean protein also has a greater impact from soybean cultivation processes.
- the biggest impact of the Black Soldier Fly protein comes from the electricity consumption, probably from the fact that all the necessary processes take place in different electrical installations.
- The results show the general picture of the impact of protein alternatives that can be used in fish feed production.
- The study can be further developed by comparing other fish feed ingredients and their environmental impacts.
- the overall impact of fish feed can also be assessed when protein alternatives are used. Existing alternatives can certainly be improved to reduce the environmental impacts and using RES in production processes and choosing more sustainable alternatives to raw materials and efficient waste management.

CONCLUSION

- Results from LCA shows that the largest impact is Yellow Mealworm protein, then Soybean protein and Black Soldier Fly protein.
- In the Yellow Mealworm's protein production, the largest impact is caused by the food for the larvae, which consists of wheat grain, maize grain, yeast, lucerne and carrots, with the greatest effect coming from wheat grain and carrots.
- Soybean protein has a largest impact from soybean cultivation processes.
- Biggest impact of the Black Soldier fly protein comes from the electricity consumption, because it is used for heating and ventilation, power supplies, lighting and equipment to extract protein.
- The obtained results show the impact of protein alternatives on the environment, but the quality of the feed is important in the production of fish feed, both in terms of physical properties and composition. These characteristics also affect the growth of the fish and how valuable the fish is in the human diet.
- The research can be continued in several ways - by comparing other ingredients of fish feed and their impact on the environment, assessing the overall impact of fish feed, as well as looking at how to improve alternatives so that they have less impact on the environment, as well as evaluating the impact of alternatives on the environment and and the impact on feed nutritional value.

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