Comparative life cycle assessment of alternative feed in Irish rainbow trout (Oncorhynchus mykiss) production

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Introduction

Aquaculture species are currently produced using feeds which comprise large amounts of fish meal and oil from capture fisheries (standard feed). This depletion of wild fisheries to feed farmed fishes remains one of the key obstacles in the pursuit of sustainable aquaculture. The dietary demands of carnivorous finfish has long meant that fish meal was the only viable source of protein for aquaculture. Recently meal from the reduction of insects such as the Black Solider Fly (*Hermetia illucens*) has been identified as a potential alternative to wild fish derived feeds. In life cycle assessment (LCA) studies of aquaculture, standard feed production has consistently dominated the impacts associated with aquaculture. A comparative LCA was carried out to assess which of the feeds, insect-based or standard, had a lower environmental impact on the life cycle of one tonne of farmed trout at the farm gate.

Aims

1. To determine the consequences on the life cycle of 1 tonne of trout at the farm gate by substituting standard feed (fish meal) with marginal feed (insect meal).

2. To compare scenarios for domestic (Irish) and international (Danish) production of feeds.

Methods

Life Cycle Assessment (LCA) is an International Organisation for Standardisation (ISO) technique in their Environmental Management standards series (ISO: 14000). There are four distinct phases of an LCA:

1. Goal and Scope

See aims for goal and functional unit. All associated energy and material flows were accounted for in this study (Figure 1). These included; fisheries reduction, feed production, packaging, energy, transportation (Figure 2) and insect production. Beyond the scope of this study are the burden associated infrastructure and therapeutics.

2. Life Cycle Inventory (LCI)

The LCI of this study was created using a variety of sources which included proprietary data, industry reports and databases.

3. Impact Assessment

The impact assessment of this study was completed using the characterisation factors of the CML method (Figure 3). 6 impact categories were assessed which included: abiotic depletion, global warming potential, acidification and eutrophication.

4. Interpretation

See conclusions.

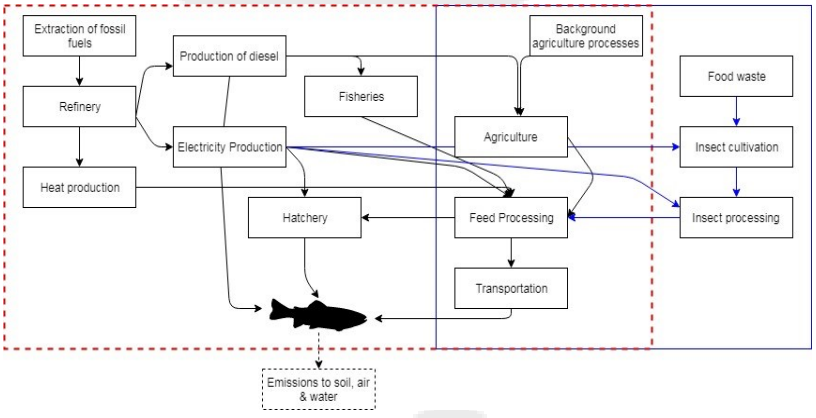

Figure 1: A simplified life cycle flow chart of rainbow trout production in Ireland. The processes inside the dashed red line account for the standard feed production processes. The unit processes inside the solid blue line account for the processes used in the production of insect derived feed.

Figure 3: The trout production scenarios considered using insect and fish derived feed produced in Ireland and Denmark and there respective impacts displayed cumulatively. The negative values in the graph are from the use of domestic food waste as the nutrition source for the black soldier fly larvae. The use of food waste results in avoided processes such as incineration and processing.

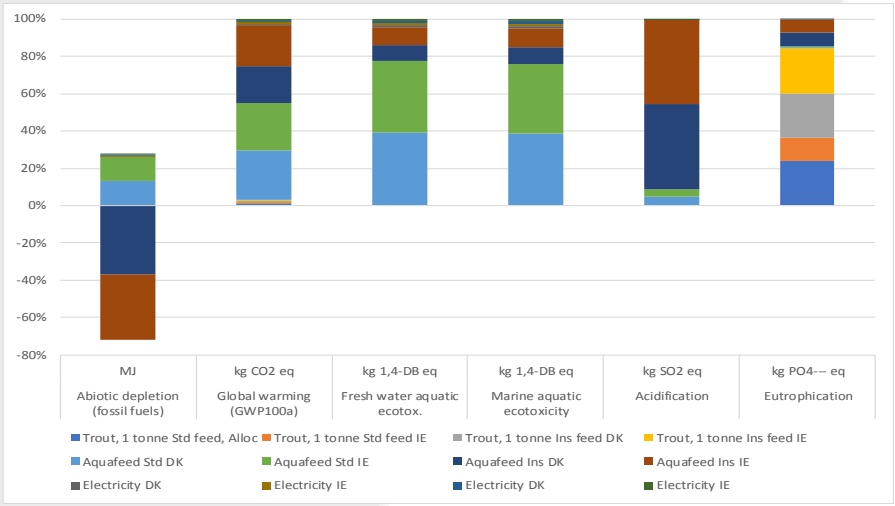

Figure 2: The transport routes considered as part of this study. Major ports in Denmark and likely Irish destination ports were identified. In total 20 transportation scenarios were considered for the Danish scenarios while 6 were considered for feed production within Ireland. In the case of Irish production feed manufacturing was modelled in Co. Donegal, while insect cultivation and processing was modelled for Co. Westmeath.

Conclusions

Sensitivity analysis, using Monte Carlo analysis, was conducted on the four final scenarios, trout production in Ireland using standard and insect aquafeed produced in Ireland and Denmark. When the standard feed production scenarios were analysed the results indicate that the environmental impact for production in Ireland was 86.3 to 100% lower than that of Danish production. Conversely the impacts associated with the production of insect derived feed were much lower in Denmark than in Ireland. Danish production had reduced impact across the impact categories of between 66.7% to 100%.

The results of this study highlight how the use of renewable energy sources can decrease the environmental burden of a product. The use of insect derived aquafeeds have significant potential to reduce the impacts associated with aquaculture. It remains to be seen as to what levels of insect meal can be included in aquafeeds and not have an impact on flavour, texture, odour or optics of the finished product and that adequate nutrition is provided for the stock.

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