Quantifying and mitigating greenhouse gas emissions from Scottish aquaculture - Research Brief

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Quantifying and mitigating greenhouse gas emissions from Scottish aquaculture[1]

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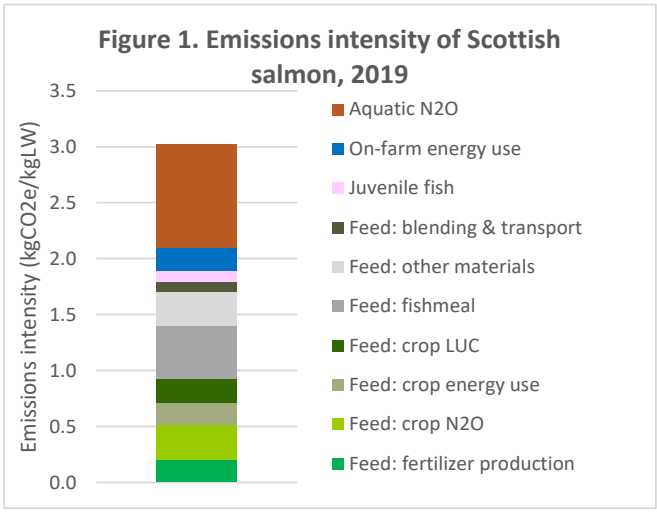
Key message: The total greenhouse gas (GHG) emissions from farmed salmon in Scotland are small compared to cattle and sheep. However, it is a rapidly growing sector and there is potential for improvement of productivity and reduction in the emissions.

Main Findings

- It is estimated that Scottish salmon farming was responsible for 616ktCO_2e of GHG emissions in 2019 (on a life cycle basis, cradle to farm gate). Only part of these emissions (from on-farm energy use and feeds produced in the UK) currently appear in the UK inventory.
- Salmon has a carbon footprint of 3kgCO_2e per kg of liveweight at the farm gate (Figure 1), which is similar to chicken meat (produced in a conventional UK broiler unit), and lower than pork, beef or lamb.



- Ways of reducing emissions include: Improving <u>efficiency</u> (e.g. reducing feed conversion ratios via breeding or health interventions), <u>substitution</u> of high carbon inputs (such as fishmeal or soy products associated with land use change) with lower carbon alternatives.
  There may also be scope for switching systems in the future, though some of these would require a plentiful supply of cheap, low carbon electricity.
- The growth of Salmon farming represents an economic development opportunity for rural Scotland. In order to contribute to Scotland's climate change targets, efforts should be made to identify cost-effective ways to reduce the emission intensity of farmed salmon.

Introduction

Global aquaculture makes an important contribution to food security and is also a driver of economic development. While farmed fish is a premium product, its production entails the emission of greenhouse gases, primarily through pre-farm feed production and on-farm aquatic N_2O and energy use.

[1] This research was undertaken within the Scottish Government Rural Affairs and the Environment Portfolio Strategic Research Programme 2016-2021, For more information please see: https://www.sefari.scot/research
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A recent study[3] found that globally the fish farming sector generated 263 million tonnes of carbon dioxide equivalent ($MtCO_2e$) in 2017, equivalent to 0.49 per cent of anthropogenic GHG emissions.

In Scotland, salmon farming is an important and rapidly expanding sector:

"The total production of Atlantic salmon during 2019 was 203,881 tonnes, an increase of 47,856 tonnes (30.7%) on the 2018 total and the highest ever level of production recorded in Scotland."[4]

In order to enable sustainable expansion of the sector, we need to understand its contribution to greenhouse gas emissions and how it can be mitigated. While there is a lot more to sustainability than GHG emissions, they are an important part of the picture. This study estimates the emissions from Scottish salmon farming on a life-cycle basis, including the emissions arising pre-farm in feed production.

Methods

The study quantifies the emissions arising cradle to farm gate, specifically it quantifies the emissions arising from the production of key inputs (feed, energy and juvenile fish) and the N_2O arising directly from the fish farm. It uses an adapted version of FISH-e, FAO's aquaculture GHG tool[5]

Research Implications

Future research could include investigation of the feasibility and cost-effectiveness of GHG mitigation measures such improved genetics, health and feeding (e.g. the substitution of high carbon feed materials (such as fishmeal) with alternatives such as GM camelina and waste-derived proteins[6]). The approach could also be used to evaluate alternative production systems. The analytical approach could be refined to include better estimates of aquatic N_2O emissions, and the scope widened to include some of the non-GHG impacts of aquaculture supply chains.

Implications for the Scottish Salmon Farming Industry

As a relatively young sector there is a great deal of potential for improvement of productivity and reduction of the GHG emissions of the sector. Basic biophysical modelling approaches can help the sector to identify the most cost-effectiveness improvement options, thereby enabling more sustainable growth of the sector.

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[3] MacLeod et al. (2020) Quantifying greenhouse gas emissions from global aquaculture. Sci. Rep. https://rdcu.be/b5Dg3
[4] Scottish Government (2020) Scottish Fish Farm Production Survey 2019
[5] http://www.fao.org/fishery/affris/affris-home/fish-e-faos-tool-for-quantifying-the-greenhouse-gas-emissions-arising-from-aquaculture/en/
[6] https://www.sruc.ac.uk/downloads/file/2768/the_feasibility_of_using_insects_in_salmon_feed_in_scotland