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Fertilisers from fish processing and aquaculture waste can have similar or lower environmental impacts than mineral fertilisers but variation is high.

The need for sustainable fertilisers

- Production of mineral fertilisers causes several sustainability issues (Zhang, Akyol, and Meers 2023).
- Fertiliser production should thus shift to valorisation of waste streams (Chojnacka, Moustakas, and Witek-Krowiak 2020).
- We conducted a life cycle assessment comparing five bio-based fertilisers (BBF) from fish processing and aquaculture production against mineral fertilisers (Fig. 1).

The life cycle assessment

- **Scope:** Cradle to factory-gate (production impacts), cradle to farm-gate (overall impacts)
- **Functional units:** NPK content of 1 kg of BBF (production impacts), 1 kg of crop (overall impacts)
- **Allocation approach:** Economic allocation and burden-free assumption for waste streams
- **Life cycle impact assessment** with IMPACT World+
- Application of BBF modelled with FarmLCA tool (De Baan et al. 2024) for wheat grain, ryegrass and broccoli based on data from field and pot trials.

Results show need for optimisation

- **Production impacts**: The comparison of BBF to mineral fertilisers showed a mixed picture (Table 1). Common hotspots: (1) transport of waste to the BBF factory, (2) energy intense drying and (3) packaging.
- **Overall impacts:** BBF impacts per kg of product ranged from 69% (Terrestrial acidification, ryegrass) to 295% (Mineral resources use, broccoli) of mineral fertiliser impacts. Production mainly affected Global warming and Mineral resources use. Eutrophication was driven by field emissions during application.
- **Optimisation** of agronomic performance and production of BBF are needed to reduce impacts.

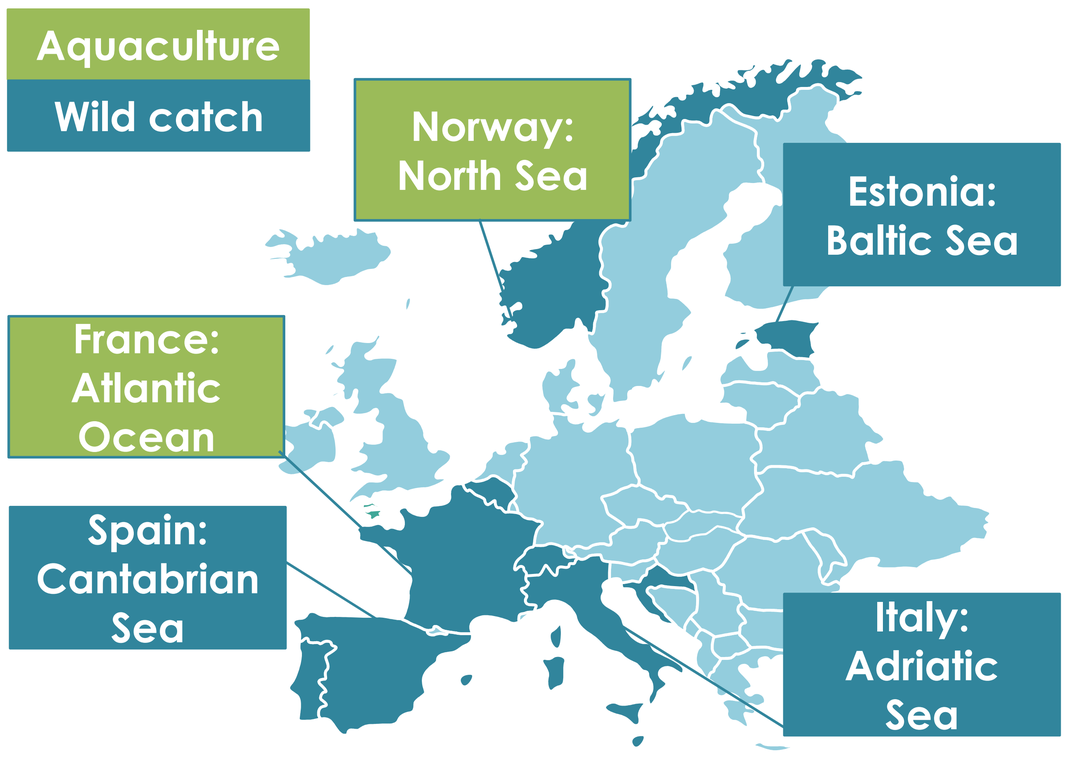

Figure 1: Origin of waste streams and location of pilot plants for BBF production in the project Sea2Land (indicated by the callout annotations).

Table 1: Environmental impacts of producing 1 kg of BBF relative to their corresponding mineral fertiliser reference with the same NPK concentration.

Pilot	BBF	Climate change, short term	Freshwater eutrophication	Marine eutrophication	Mineral resources use	Terrestrial acidification
EST	BBF granules	59%	159%	31%	249%	24%
ESP	NPK solution with amino acids	567%	47%	232%	424%	122%
ITA	Hydrolysate	619%	676%	173%	617%	386%
NOR	Pelleted fish sludge	148%	1%	26%	82%	29%
FRA	Solid BBF	84%	1%	25%	89%	24%

References:
Chojnacka K., Moustakas K., and Witek-Krowiak A. 2020. Bio-Based Fertilizers: A Practical Approach towards Circular Economy. Bioresource Technology 295
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