Transition towards sustainable waste valorization from agricultural production systems: Insights from salmon aquaculture and aquaponics

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Sustainable Value Creation Based on Organic Rest-products

Transition towards sustainable waste valorization from agricultural production systems: Insights from salmon aquaculture and aquaponics

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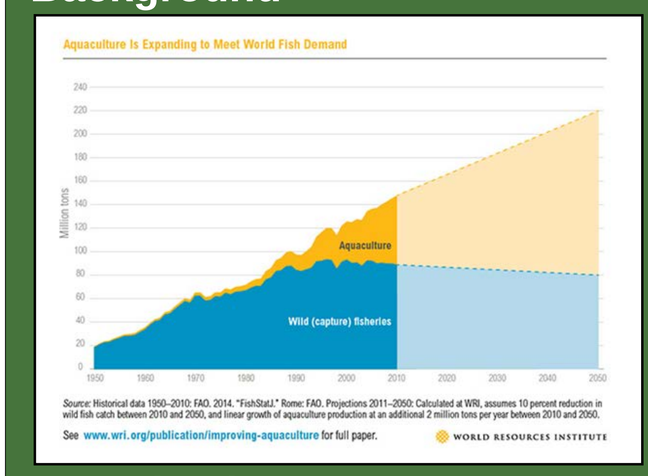
Abstract

This study focuses on optimizing waste streams from land-based Atlantic Salmon fish farms in Nordic countries. Fisheries are in a transition period as global demand continues to increase and global wild catch has plateaued. In 2016, the world passed a milestone where now over half of the world's fish supply is from fish farms. Nearly three quarters of Atlantic salmon are produced in farms. As the economic costs associated with sea lice and infection increase, and recirculating aquaculture systems technology improves, firms are now moving smolt production and even the entire production process (Langsand Laks) on land. It is currently more expensive to produce fish in these systems, but firms can receive a price premium for sustainably produced fish, particularly when marketed to high-end restaurants. We are witnessing the beginning of a transition in fish production to land-based systems motivated by sustainability: maximizing fish in/fish out ratios, and thereby minimizing waste (i.e., organic residue). Options for valorization of the waste production include integrated algae systems, hydroponic systems, and centralized processing operations that return the residue into the larger bio-economy. These technologies will therefore become more important in the near future.

We conducted semi-structured interviews at two entrepreneurial firms: Langsand Laks in Hvide Sande, Denmark, and Aquaponics in Evje, Norway. We used a global value chain approach to structure the interview questions. In this study, we identify some potential technical, economic, and regulatory barriers and opportunities to the expansion of land based aquaculture and waste utilization. We find that regulation and entrenched food distribution regimes can hamper the development of novel systems like aquaculture. Furthermore aquaponic systems make more economic sense at larger scales.

Background



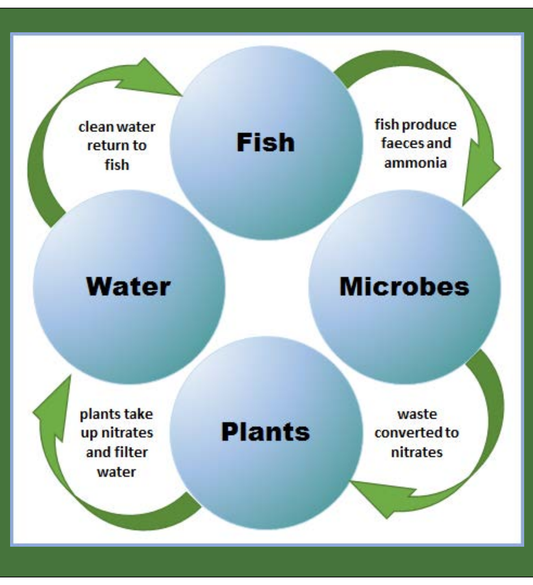
The supply of wild fish has plateaued, yet the demand or fish continues to increase. This additional demand is being met by land based systems; currently, farming meets 50% of demand. This trend will likely continue in the future where farming will meet an increasingly larger share of total fish production.

However, there is high economic cost associated with sea lice and infection, and these costs are increasing. This is putting pressure to move more of the production to land-based systems.

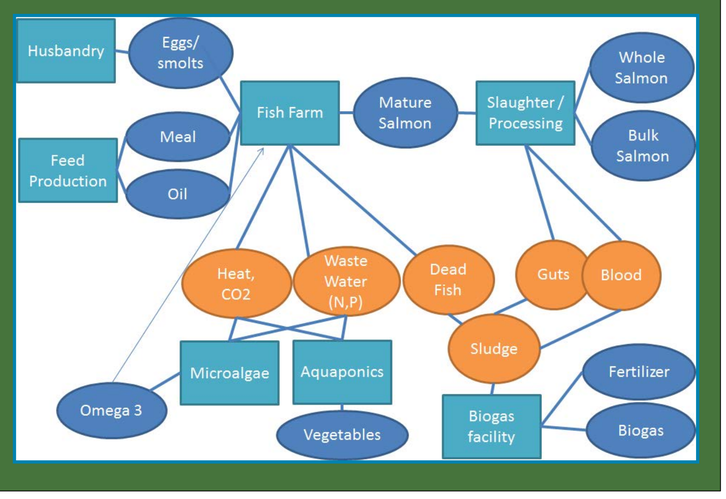
Hypothesis

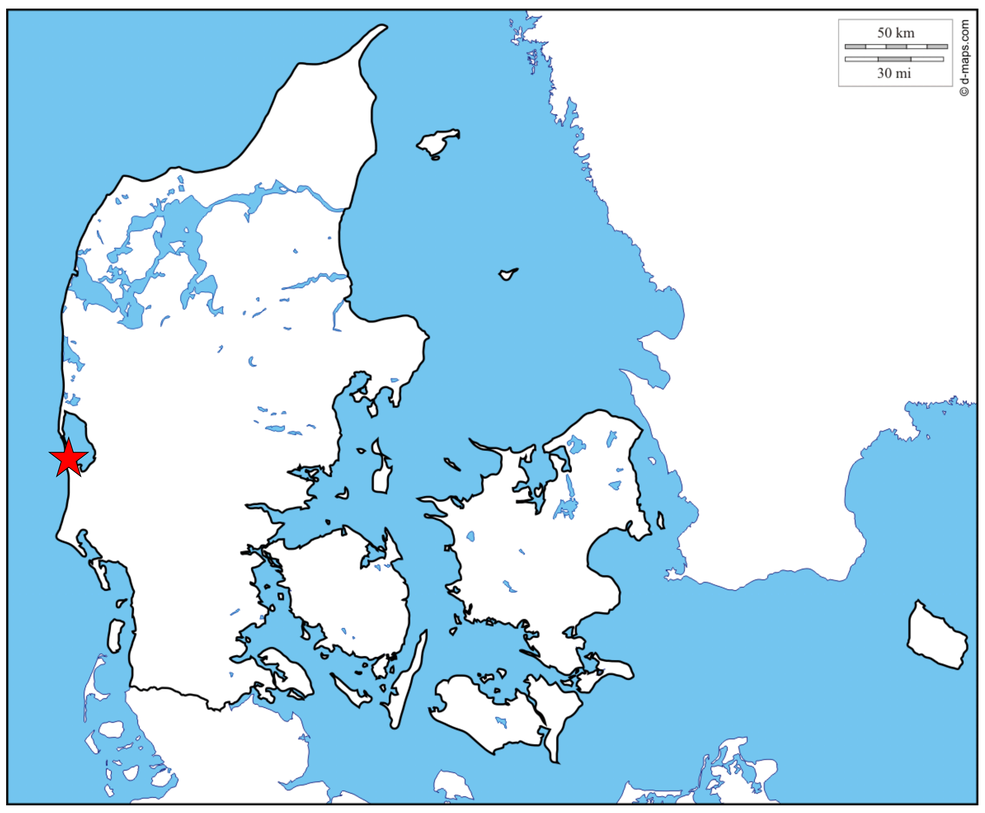
Land based technologies will become more important in the near future; value chain and support structures are needed to link the resources and technologies to optimize residue reduction and valorization.

Framework



Aquaponic systems are production systems where waste products of one process serve as a resource to another: fish waste is converted to nitrate fertilizer by microbes, which benefit vegetable production. The plants then filter the water and return clean water to the fish (*left*). Though this process is designed to close the system, some waste is nevertheless produced (*right*). These waste resources potentially have beneficial uses. From a value chain perspective, there are push and pull factors for waste valorization and utilization. The need to deal with waste and the technological improvements brought on by entrepreneurship find valuable end uses for the waste produced. This is supported (or hampered) by policy, public perception, and emerging markets (*above*).





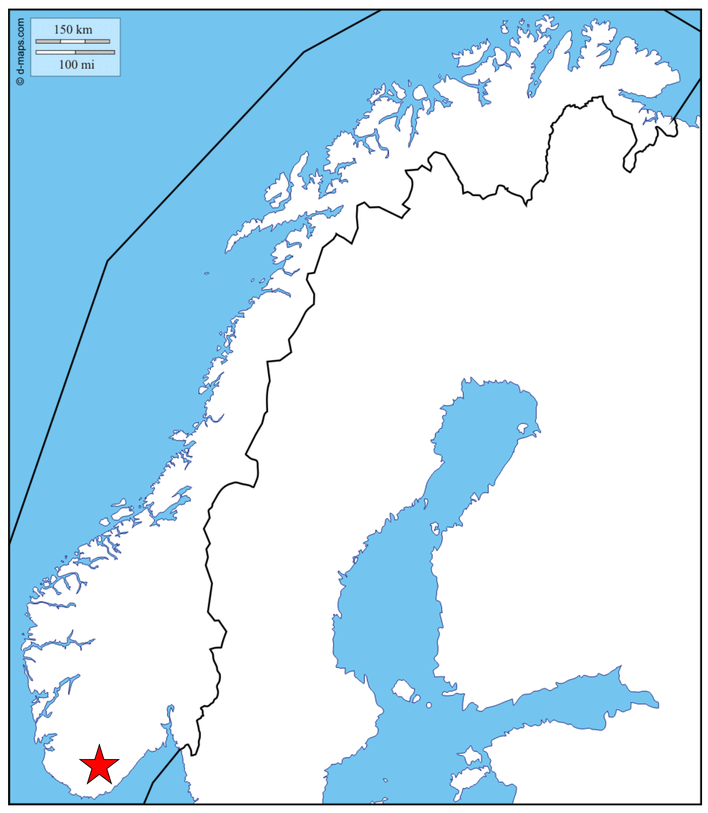
Case Studies

Langsand Laks, Hvide Sande, Denmark
is a full land-based salmon farm (demonstration scale) with technology from Billund Aquaculture. There is no aquaponic system yet, but this is an option for future plants. Waste is converted to biogas.

The market is currently limited in Denmark for high end fish and for waste. However, in Denmark, environmental permitting is relatively easy. There is also an existent value chain for handling animal waste from pork production that can be augmented.

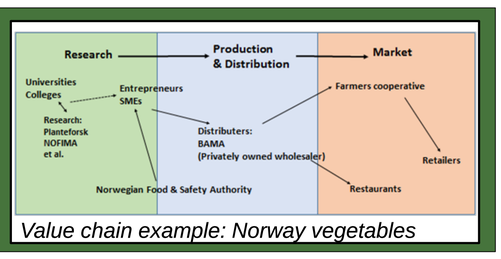
Aquaponics, Evje, Norway
is a pilot scale hydroponic vegetable production system experimenting with expanding to an aquaponic system. Technical, financial, and regulatory hurdles are currently preventing further development.

Food distribution structures in Norway are highly regulated and controlled, and some hurdles may need to be overcome in order to bring novel production systems to the market. Most fish farming in Norway uses sea-based systems and waste is centrally processed.



Method

Semi-structured interviews were conducted at two entrepreneurial firms: global value chain approach, qualitative analysis to identify technological, regulatory, and social barriers and opportunities to waste utilization in developing aquaponic systems.



Value chain example: Norway vegetables

Conclusions and Further Research

New products and technology must be approved by the food safety authorities
New products have to be accepted by the food distributer, the farmers cooperative, and customers
Producers need support from experts (R&D) and government (financing and incentives) during early phases
Important to establish relations with niche markets (e.g., restaurants and independent ecological retailers)
Development of Aquaculture systems as a means to utilize residue needs economy of scale

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SusValueWaste

The SusValueWaste research project focuses on the potential of organic waste and other rest-products from the bioindustry.

Exploiting the full potential of these resources requires increased innovation, systemic change as well as better regulation and governance. SusValueWaste analyses industrial cases and collaborates with highly relevant actors in the Nordic region. Find more info at www.SusValueWaste.no