Opportunities from the Oceans for the Food Industry

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Alcantara and Venice International University 5th Symposium: Climate “HOW” to Engage Society and Deploy Decarbonization

February 7 and 8, 2019
GHG emissions – meat and dairy products

• Livestock accounts for some 15% of the world’s GHG emissions – of which some 65% is attributable to cattle (ref. FAO)

• FAO expects the consumption of meat to increase by 54% towards 2050 and the consumption of milk by 73% - the growth rate is significantly higher than the population growth rate

• Are there better sources of animal proteins than from cattle, pigs and chicken in a GHG context?
Feed conversion ratio

Amount of feed to produce 1 kg of animal:

Cattle 4-10 kg (depends on feed)
Pork 3 kg
Chicken 2.2 kg
Farmed salmon 1.1 kg

Percentage of edible meat varies with animal – highest 61% for salmon

Source: Marine Harvest
GHG emission per kilo throughout food supply chain measured in kg CO2 equivalent – data for Denmark
source: tabel over fødevarers klimaaftryk, Mogensen et al, DCA, 2016

<table>
<thead>
<tr>
<th>Meat and dairy products</th>
<th>Vegetables, fruit, whole grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef: 14</td>
<td>Salat 0.5</td>
</tr>
<tr>
<td>Pork: 5</td>
<td>Potato 0.2</td>
</tr>
<tr>
<td>Chicken 3</td>
<td>Onion 0.4</td>
</tr>
<tr>
<td>Lamb 14</td>
<td>Apple 0.1</td>
</tr>
<tr>
<td>Milk 1</td>
<td>Wheat 1.2</td>
</tr>
<tr>
<td>Yellow cheese 10</td>
<td>Pasta 1.2</td>
</tr>
<tr>
<td>Butter 10</td>
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07/02/2019 Henrik O. Madsen, Venice February 2019
GHG emission per kilo throughout food supply chain measured in kg CO2 equivalent – data for Denmark

**Seafood from the ocean**
- Cod 1.2
- Herring 0.7
- Shrimp 3.0
- Mussels 0.1

**Sea food from aquaculture**
- Trout 1.8
- Salmon 2.0-2.5
Can fish farming be sustainable?

• Norway produces more than 1 million tons of salmon per year in fish farms in the ocean in sheltered water. There are limits to further growth.

• We see two mega trends to multiply production in a sustainable manner:
  • Move production to RAS facilities on land (RAS stands for recirculating aquaculture system)
  • Move production sites further offshore
Traditional near shore fish farm lay-out
Krüger RAS 2020 System – land based fish farm
Salmar Ocean Farm 1 – offshore fish farm
Nordlaks “Havfarm”- offshore fish farm
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Marine Harvest and Haga Aqua “The Egg” – offshore fish farm
Atlantis Subsea Farming “Atlantis” – offshore fish farm
“Aquatraz” – Offshore fish farm
Converted Cape Size Bulk Carrier fish farm
Feed – “you are what you eat”

- 75% of the world’s agriculture area is used for animal production including animal feed production
- Denmark with a population of 6 million people imports soya from an area in South America corresponding to the area of the largest island Zealand – this is mainly to feed 30 million pigs

- Farmed salmon has a diet with 50-75% soya imported from South America
- The percentage of fishmeal and fish oil in the feed is decreasing
- Introduction of more krill in the feed can be sustainable
- Today you need to eat twice as much farmed salmon to get the same amount of Omega 3 as 10 years ago
Sugar tongs and other seaweeds can be a solution for sustainable fish food production

• Can be produced industrially in the ocean – more “natural” to fish
• Scale is needed to reduce cost – e.g. for drying
• Absorbs phosphor and nitrogen from the ocean
• Absorbs CO2 at the same level as a rain forest
• Can be harvested once or twice a year
• Can also be used for production of biofuels
• Combined fish farming, mussel production and seaweed production has additional value creation potential
Seaweed production

10 kg m$^{-1}$ rope after 4.5 months
Marine Algae can be another fish feed solution

- We have only studied a very small portion of marine algae
- Some marine algae allows light to penetrate thereby making fast growth in large tanks possible
- Pilot projects on land utilize CO2 emissions from smelters to increase growth rate of marine algae in very large tanks
- Marine algae has many uses also beyond fish feed
Conclusion

• The Ocean Space will become increasingly important to create solutions to our sustainability challenges

• Industrial production of healthy and sustainable feed and food from the oceans must become a priority

• We must increase the amount of farmed fish in our diets – both fresh and frozen

• How can we motivate for this to happen – and fast?