Alternative feed ingredients in a world of volatile fishmeal supply

Opportunities and Risks

RaboResearch Food and Agribusiness
March 2018
Dr. Beyhan de Jong
All seafood supply growth will continue to come from aquaculture
Aquaculture seafood is the fastest growing protein industry

While global capture fisheries have been stagnant, aquaculture has shown rapid growth

Source: Rabobank, FAO 2018
It is the intensive part of aquaculture which is growing fastest

Global aquaculture production (excluding aquatic plants) per key species group

Source: Rabobank, FAO 2018
New premium aquaculture species are mainly carnivores – and the high FM price is holding back their development

New farmed species, key drivers of demand for fish meal and fish oil in the future
Aquaculture is the biggest consumer of the finite ingredients fishmeal and fish oil

Source: IFFO, Rabobank 2017
Fishmeal supply is at best stagnant or declining - but very volatile
Peru is the biggest, but also the most volatile fishmeal supplier

Peruvian TAC and catch rate, 2010-2018

Source: Exalmar, Rabobank 2018
Long term fishmeal supply decline halted in 2017

Global FM production reached a new low in 2016, but recovered in 2017

Source: Kontali, Rabobank 2018
Since December 2017, FM prices has started to increase again.

FM prices likely to move sideways after correction in late 2016.

Source: Oil World, Rabobank 2018
To deal with FM scarcity, alternative ingredients in aquafeed formula are being explored.
It is increasingly more difficult to lower the FM inclusion in aquafeed further

**Salmon feed formula evolution**

<table>
<thead>
<tr>
<th>Era</th>
<th>Marine Ingredients (fish meal and fish oil)</th>
<th>Plant Ingredients</th>
<th>Novel Ingredients</th>
<th>Other (binders and micro ingredients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990's</td>
<td>69%</td>
<td>12%</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>31%</td>
<td>53%</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>Future?</td>
<td>10%</td>
<td>69%</td>
<td>10%</td>
<td>11%</td>
</tr>
</tbody>
</table>

Source: EWOS 2015, Marine Harvest Handbook 2017, Rabobank 2018
... so alternative ingredients started to attract innovators, formulators and even investors

- Key alternative source so far
- Logistics issues
- No growth in supply long term?

- Lower protein content
- Anti-nutritional factors
- Will not work for all species

- Krill and mesopelagics
- Marine worms
- Yeast-based ingredients
- Insect-based feeds
- Algae
- Bacterial proteins
- Guar protein
- GM canola
- Duckweed

- Vegetable and nut meals
- PAP & Animal by-products
- Vegetable meal concentrates
- Future alternatives

- Expensive?
- Lack minerals, amino acid profile
- Also limited in supply

Source: Rabobank 2018
Insects are potentially one of the most sustainable sources of alternative feeds

- **Black soldier fly**
- **Larvae**: 14-day feeding cycle
- **Protein-rich meal**

- **Sustainable**: Can use food waste as a feed stock
- **Very quick lifecycle**
- **Lower environmental impact**
- **Requires limited land**

- **Good for the fish**: Has high protein content
- **Already in the natural diet of fish**
- **Hypoallergenic features**

Source: Rabobank 2017, 2018
Leading insect farming start-ups are showing path to scale – with backed up investments

**Insect-based aquaculture meal supplier nabs €15 million in fresh financing**

Group hopes to expand capacity dramatically with new facility.

Insect-based aquafeed ingredients start-up InnovFeed was given a big boost Tuesday with a multi-million euro capital injection from a French equity fund.

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**Insect-based feed firm nets $50 million Rabobank, Aqua-Spark funding**

Protix plans to invest the fresh funding in aquaculture feed, R&D.

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**Canadian insect farm sees continued investment, expansion**

25-Jan-2018 By Aerin Einstein-Curtis

Additional investment in Midgard Insect Farm seeks to support product research and an expansion into animal feed.

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**Wilbur-Ellis venture arm invests in mealworm production**

02-Feb-2018 By Jane Byrne

Beta Hatch, a Seattle, Washington-based insect meal production company set up in 2015, has received backing from Cavello Ventures, the venture capital arm of US agribusiness company, Wilbur-Ellis.

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Source: Intrafish, Feed Navigator, AgriProtein, Rabobank 2018
The first ever insect fed salmon is recently launched by Protix

Press Release

PROTIX

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Mediafolder CLICK HERE

The Blue Shift
Protix presents the Friendly Salmon, the first insect-fed salmon in the world.

February 6, 2018 – DONGEN, THE NETHERLANDS – Protix announced today the first ever full-grown salmon raised on insect-based proteins. This major step towards aquaculture sustainability will accelerate the diversion from fish meal which places a heavy burden on marine ecosystems.

Source: Protix, Rabobank 2018
Major aquaculture industry participants focus on algae, primarily for the algae oil

Key agro industry and aquaculture value chain companies are involved in development of algae ingredients

- Better ratio of omega-3/omega-6 oils in fish flesh vs. vegetable sources
- More health benefits than in fish fed with soy and corn-based foods

- Essential amino acids and high levels of protein
- Better digestibility and better growth rates
Salmon farmed with microalgae ingredients is scoring high on sustainability

Lerøy’s salmon is farmed with feed partly deriving from the microalgae ingredient

Verlasso salmon is produced with a diet rich in concentrated algae

Source: Feed Navigator, Bunge, Verlasso, Rabobank 2018
Bacterial proteins are one of the other novel alternatives which are expected to grow.

Different feedstocks are used in the production process:

- Ethanol
- Methanol
- Methane gas
- CO2
- Other abundant low cost feedstocks
- Other sources of waste carbon

Source: Rabobank 2017, 2018
Calysta is leading the way on scaling up, but others are constructing commercial scale facilities, too

Calysta’s pilot facility in UK

Unibio’s production facility in Denmark

“...We’re about five years behind Calysta in terms of technology. “But in the aquafeed, high quality amino acid space there’s going to be multiple players.”

-- David Tze

Source: Undercurrent, Undercurrent Feed Innovation report, Feed Navigator, Rabobank 2018
Great long-term prospects, but short-term challenges for alternative feed producers
Conclusions: The next few years could be difficult for suppliers of alternatives to fish meal

I. Aquaculture volume growth and intensification of aquaculture production drive demand for fishmeal in the long term

II. Supply of fishmeal from wild-caught has been declining for years, but recovered partially in 2017, and declined again in the last months. Depending on El Nino, next year could be good again

III. Prices of fish meal have declined in early 2017 and recently increased again. Perhaps the next 1-2 years as aqua feed formulators have more flexibility and more options then before

IV. Alternatives to fish meal and oil have gathered momentum and some will achieve scale in the next 3-5 years
Strategies for the alternative protein producers

Reach scale first

- Those who will reach scale and lower cost and commercial acceptance will have a strong advantage

Niche strategy

- Do not compete with FM on price but have a additional functionality

Long term view

- Ensure good capital availability and have investors with a long term view