Alternative Feeds in Aquaculture Research

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The source of almost every challenge we face today
Limiting resources...

Population growth since 1800
Years when world population reached increments of 1 billion

= Increase in seafood demand*
Where will it come from?

FAO Fish to 2030 (2013)
>90% of wild fisheries are fished to maximum capacity or *overfished*

↑ Seafood demand **cannot** be met by wild fisheries

More reading: FAO Fisheries Statistics 2020 & FAO Fisheries at the Limit
World Catch & Aquaculture Production

- Wild fishing will continue at max capacity
- Aquaculture will grow to meet **all** additional seafood demand
Feed conversion efficiency & protein demand

<table>
<thead>
<tr>
<th>Animal</th>
<th>FCR – feed per unit mass gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmed BC Salmon</td>
<td>1.2</td>
</tr>
<tr>
<td>Broiler Chicken</td>
<td>1.69</td>
</tr>
<tr>
<td>Eggs</td>
<td>2.36</td>
</tr>
<tr>
<td>Duck</td>
<td>2.41</td>
</tr>
<tr>
<td>Turkey</td>
<td>2.46</td>
</tr>
<tr>
<td>Pork</td>
<td>2.99</td>
</tr>
<tr>
<td>Goose</td>
<td>3.26</td>
</tr>
<tr>
<td>Sheep</td>
<td>10.4</td>
</tr>
<tr>
<td>Beef</td>
<td>10.4</td>
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</tbody>
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*Figures are for live weight

Fish are efficient, but aquaculture as a whole still requires a lot of protein

Carnivore: Salmon, Fish, Chicken

Herbivore/Omnivore: Eggs, Duck, Turkey, Pork, Goose, Sheep, Beef
Fishmeal & fish oil

- FM made from forage fish
- Ecologically & economically unsustainable
- Controversial!
- Feed = #1 production cost

- Now only comprises ~5-30% of feed, but...
- Aquaculture uses 75% FM d.t. *large volume*
- Alternative protein sources = an industry top priority

anchoveta, herring, menhaden, capelin, anchovy, pilchard, sardines, mackerel...
Protein alternatives

- Plant derivatives (legumes, grains)
- Animal processing byproducts
- Insect larvae

“de novo” vs...

Invasive species

Convert food waste

60%!

Industrial waste streams
Housefly larvae
Good source of protein and lipid
High in MET (EAA)
Manure, organic waste remediation

Black Soldier Fly
Good source of protein and lipid
Organic waste remediation
Currently used in aquafeeds (EU ‘17, U.S. ‘18)
FAO: high potential for aquafeeds
InnovaFeed: 60K MT plant IL

Quality dependent on 1) feed substrate, 2) harvest timing, 3) processing

NY producers: River Road Research, Clean Label Solutions
Invasive carp
Good source of protein and lipid
Incentivize commercial fishery
Mitigate ecological damage

Carp meal

Carpmeal
CP: 63%
Lip: 12%

NY industry: E&E Marketing
Fish silage-based aquafeed

A) Raw materials from processor
B) Grind to pulp, preserve at low pH
C) Liquefaction by digestive enzymes from GI tract
D) Solidification: add binder, extrude into pellets

- Replace controversial fishmeal
- Reduce organic landfill
- Eliminate disposal costs
- Complete use of resource

- Dock to farm
- Reduce carbon footprint (transport/processing)
- Minimal technology
- Utility in developing countries
Aquaponics: fish wastewater = plant fertilizer

- Remove nutrients from fish effluent
- Avoid discharge into watershed
- Use to grow plant cash crops
Circular (network?) economy paradigm

Feed inputs → Production → Outputs

- Animal/seafood byproducts
- Industrial side streams
- Insects

Wastewater

It’s not waste if you use it; it becomes a resource!
Opportunities in the Won Lab
Fish nutrition, physiology research
Fish husbandry
Aquaponics
Tech R&D

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Students participate in construction, maintenance and research in the aquaculture and aquaponics labs.