



# Alternative Feeds in Aquaculture Research

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NY Sea Grant Seafood Summit  
March 7, 2023



Cornell University

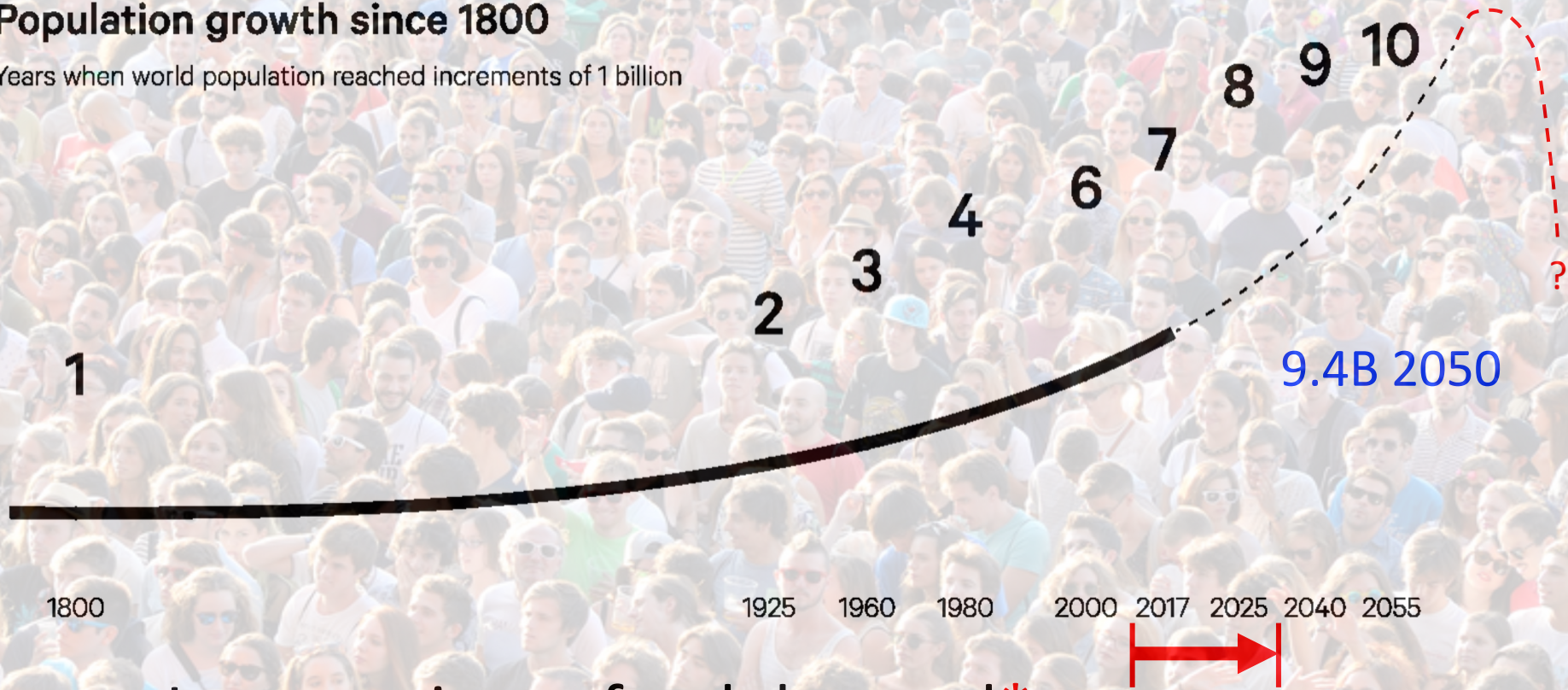


# The source of almost every challenge we face today

Limiting resources...

## Population growth since 1800

Years when world population reached increments of 1 billion

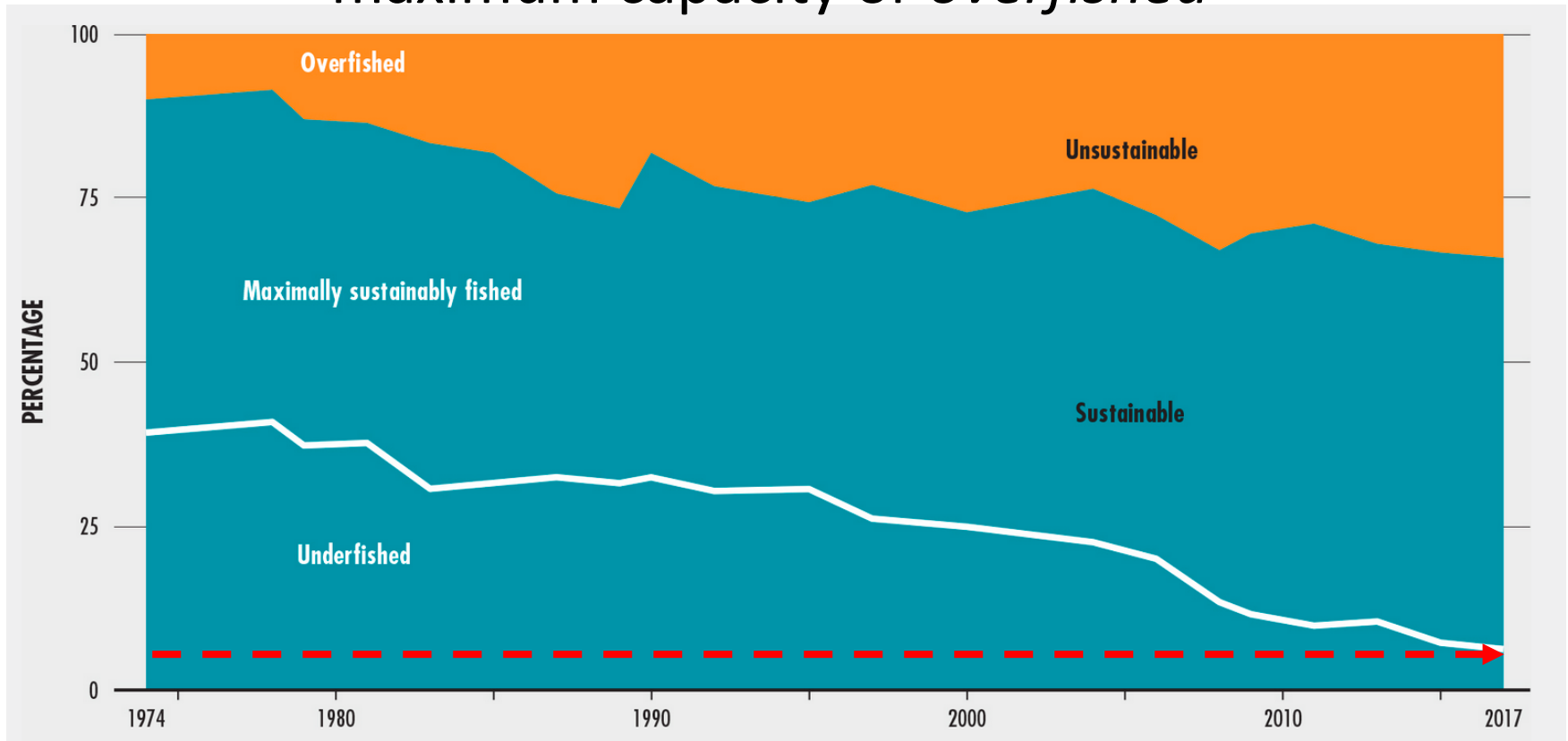


= Increase in seafood demand\*

*Where will it come from?*

**>90%** of wild fisheries are fished to maximum capacity or *overfished*

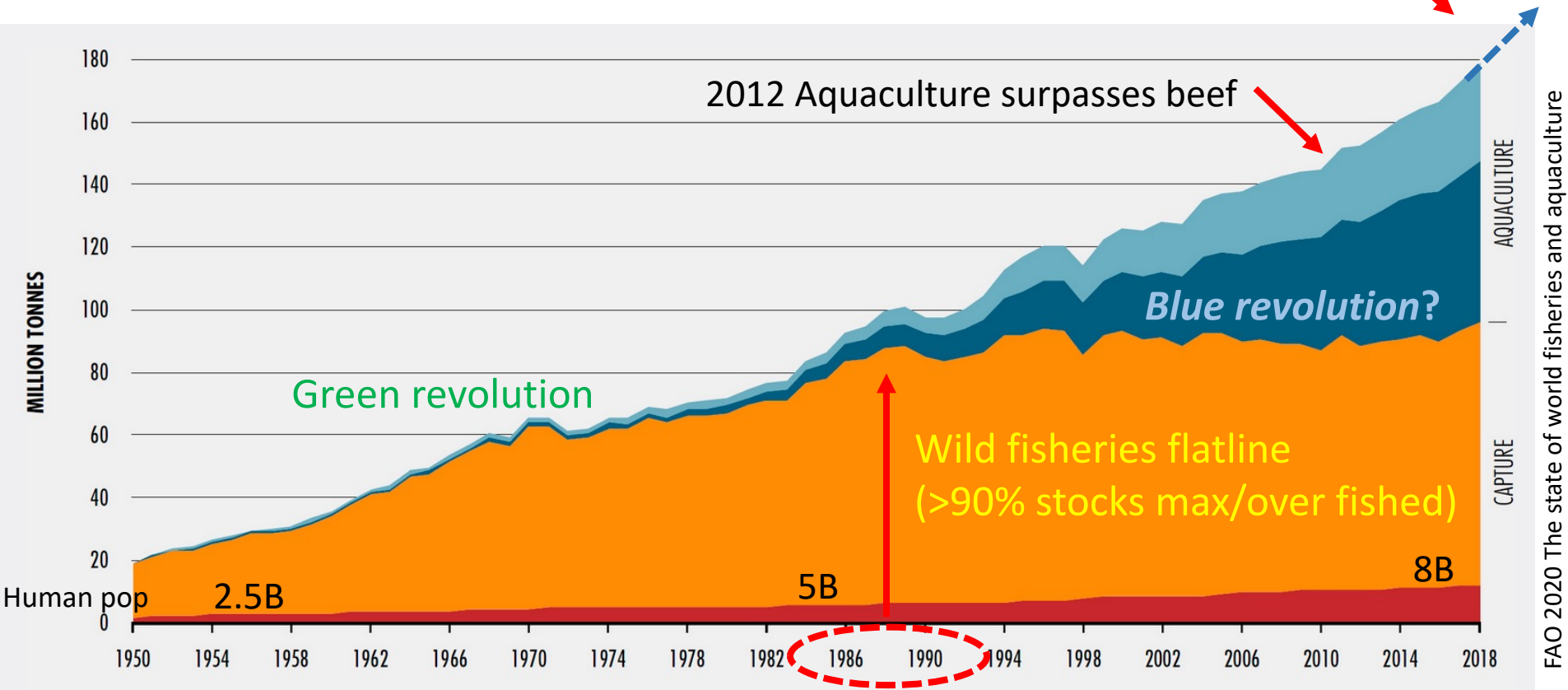
% Targeted wild fisheries



↑ Seafood demand cannot be met by wild fisheries

# World Catch & Aquaculture Production

Aquaculture currently supplies **half** the world's seafood (62% by 2030)



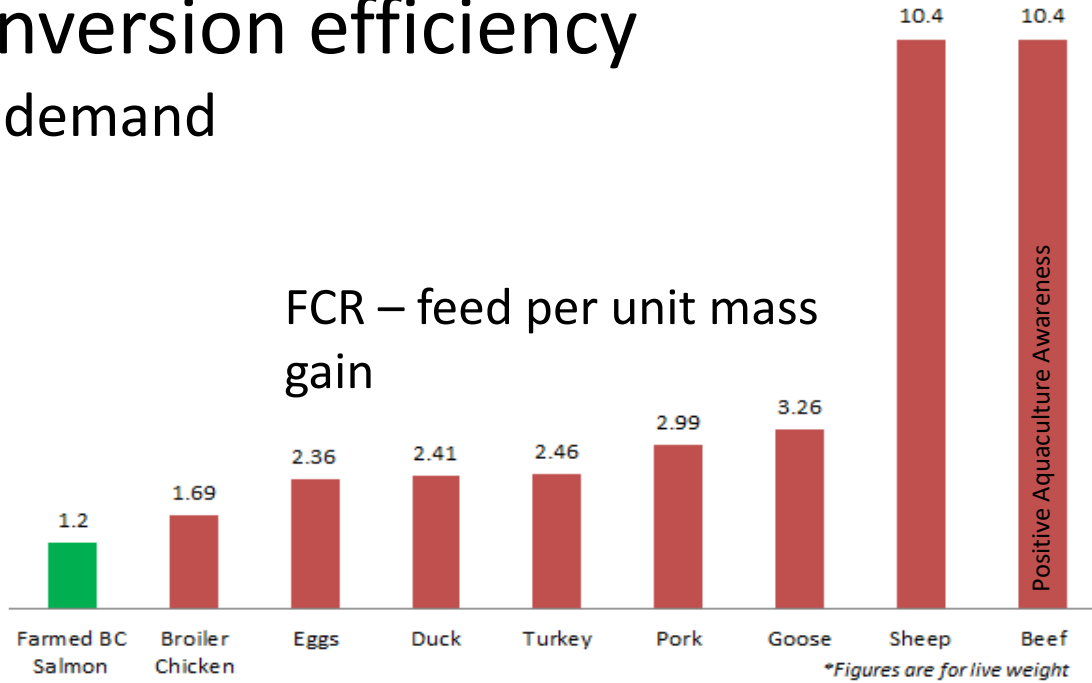
FAO 2020 The state of world fisheries and aquaculture

- Wild fishing will continue at max capacity
- Aquaculture will grow to meet **all** additional seafood demand



# Feed conversion efficiency & protein demand

FCR – feed per unit mass gain



Carnivore



Herbivore/Omnivore

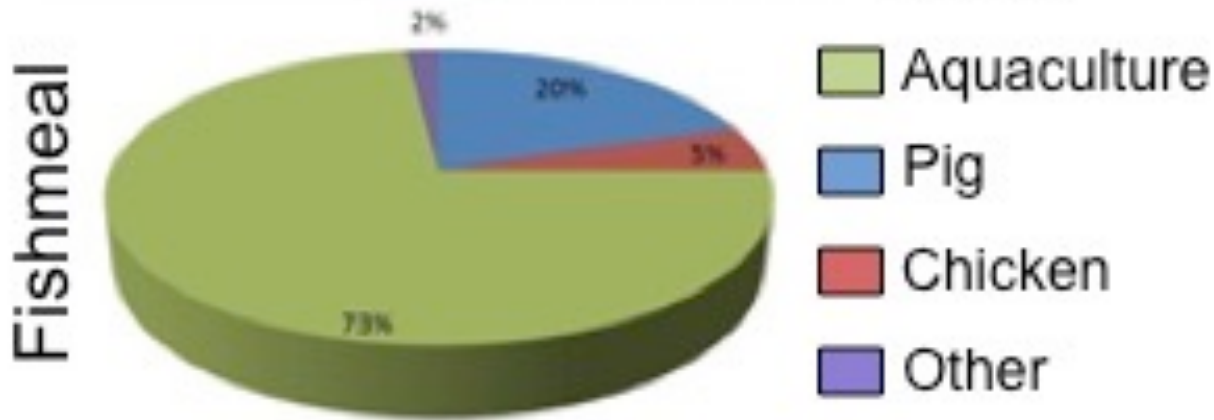
Fish are efficient, but aquaculture as a whole still requires *a lot* of protein

# Fishmeal & fish oil



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

- 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**

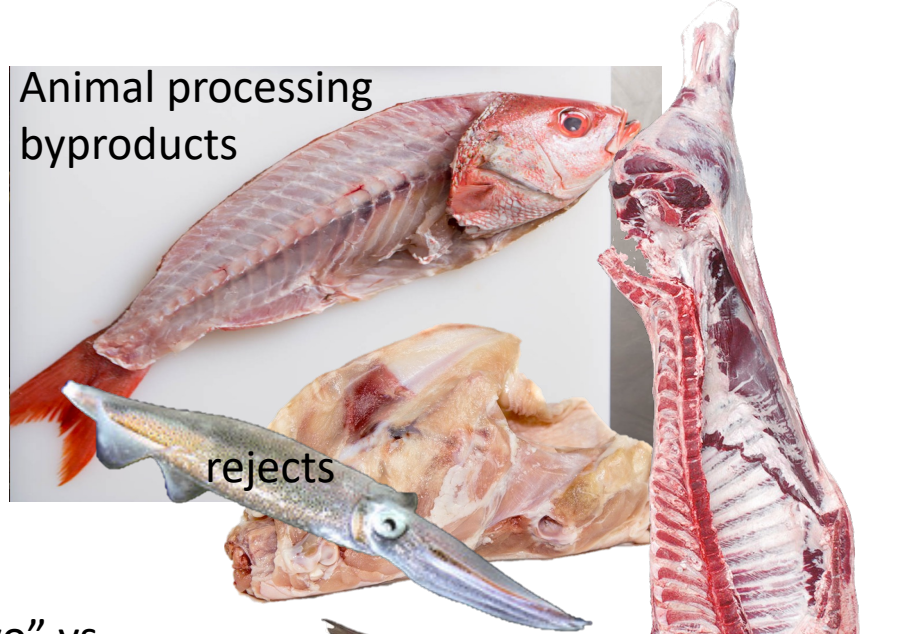


# Protein alternatives

Plant derivatives (legumes, grains)



Animal processing byproducts



rejects

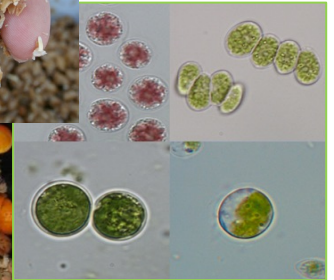
"de novo" vs...



Invasive species



Insect larvae



Convert food waste



60%!

Industrial waste streams

Dr. V. Selveraj (Cornell An Sci)

## Housefly larvae

Good source of protein and lipid

High in MET (EAA)

Manure, organic waste remediation



CP: 60%

Lip: 20%

Sustainable production of housefly (*Musca domestica*) larvae as a protein-rich feed ingredient by utilizing cattle manure  
PLOS ONE. 2/7/2017, Vol. 12 Issue 2, p1-19. 19p.



CP: 52%

Lip: 14%

## 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

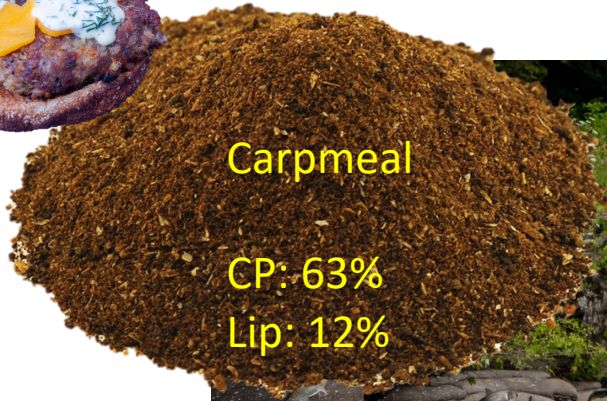
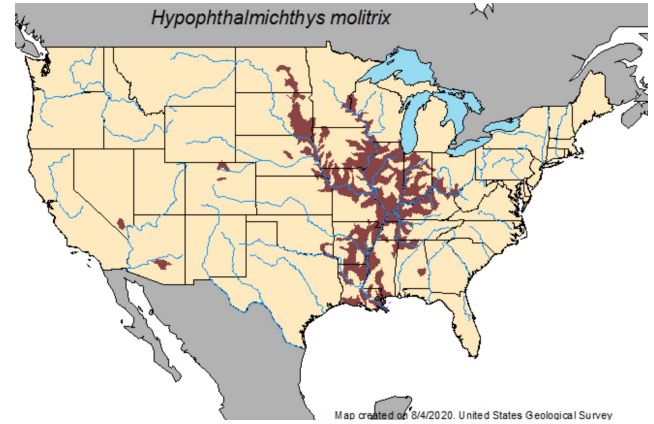


# Invasive carp

Good source of protein and lipid

Incentivize commercial fishery

Mitigate ecological damage



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



Integrated systems:

Aquaponics: fish wastewater =  
plant fertilizer

- Remove nutrients from fish effluent
- Avoid discharge into watershed
- Use to grow plant cash crops

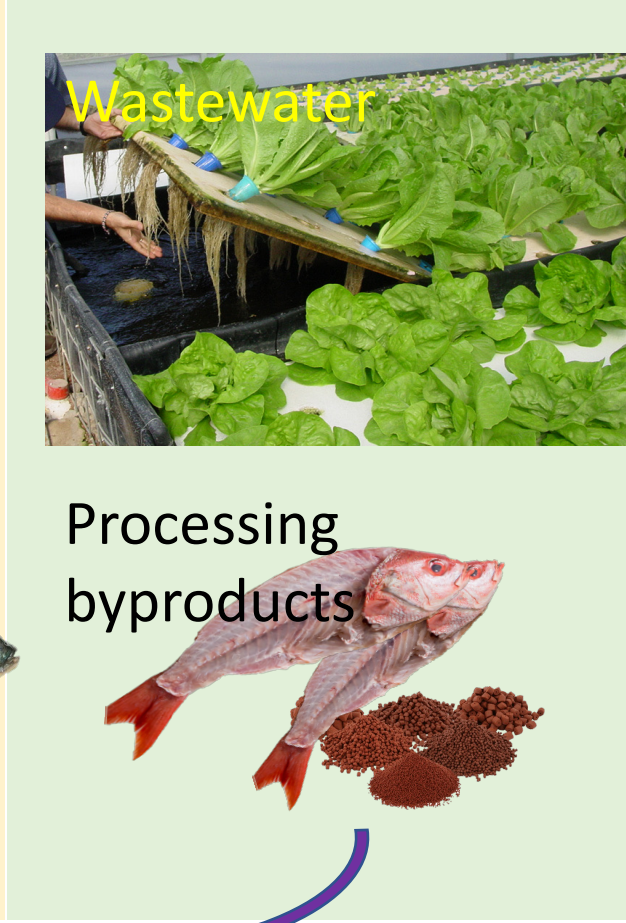




# Circular (network?) economy paradigm



- Animal/seafood byproducts
  - Industrial side streams
  - Insects
- 



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.