

# Examining resource use for feed crops: Challenges and opportunities for aquaculture

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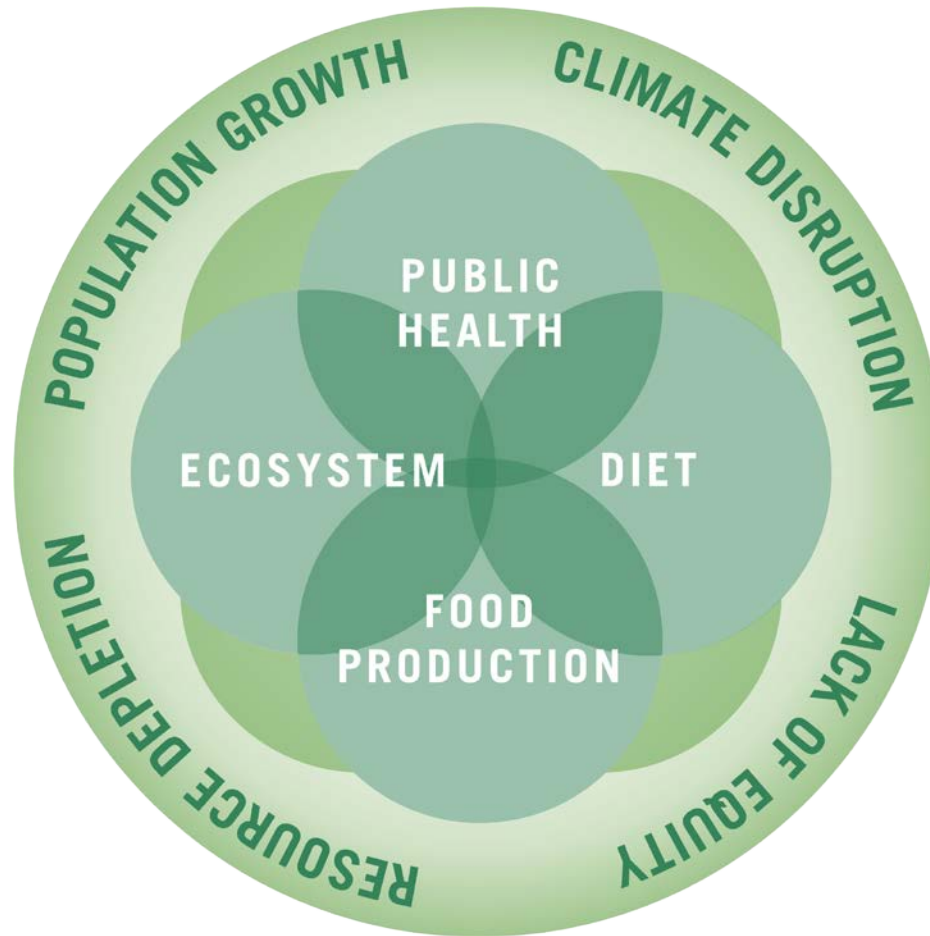
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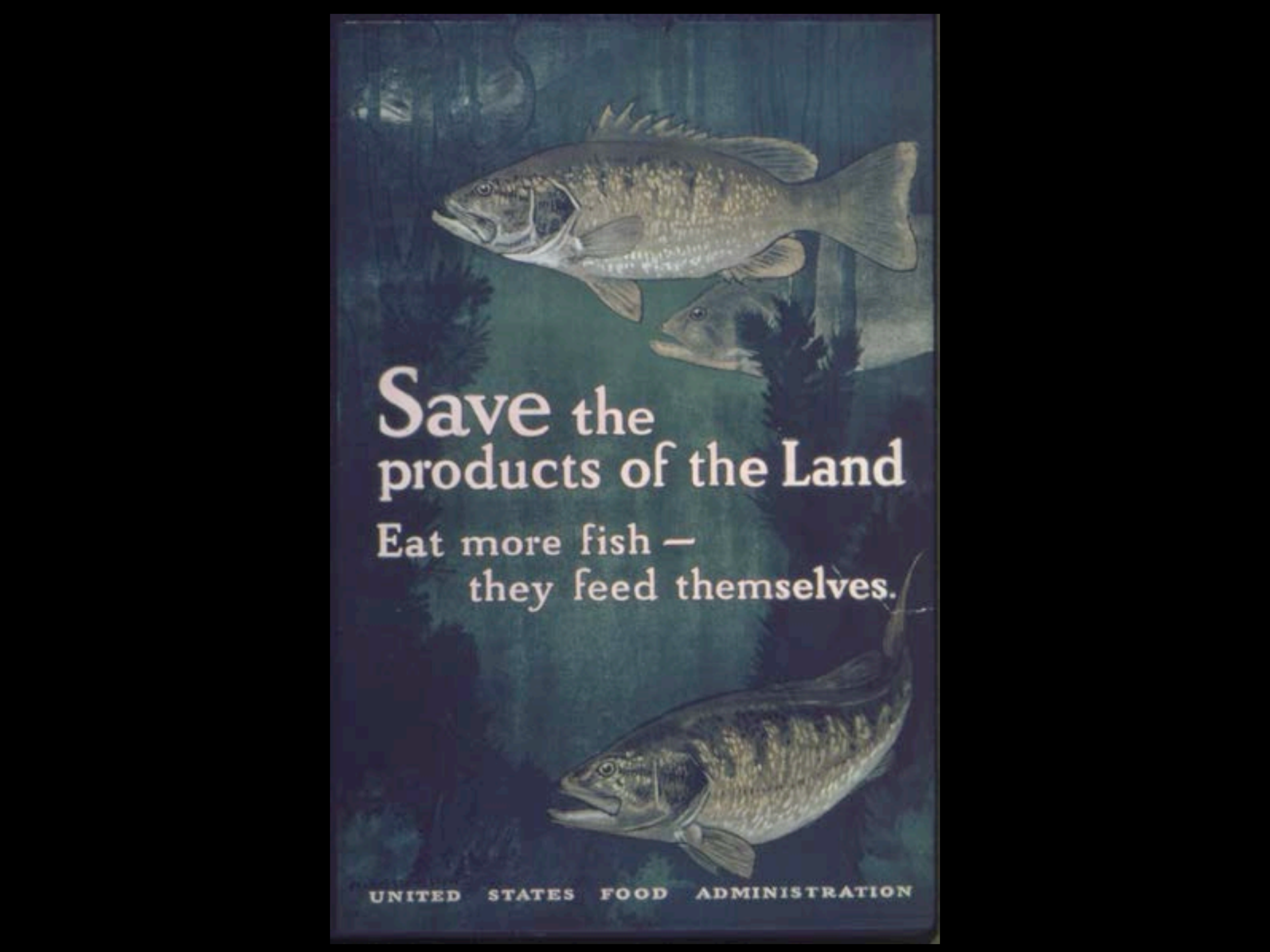
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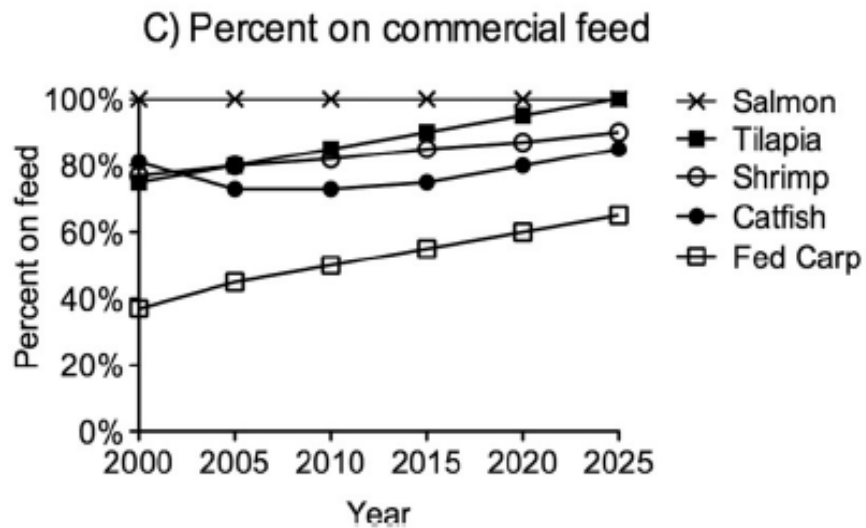
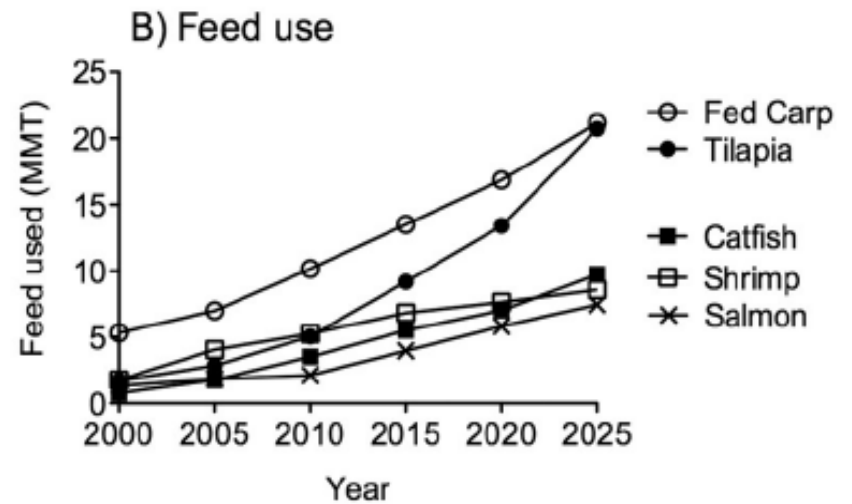
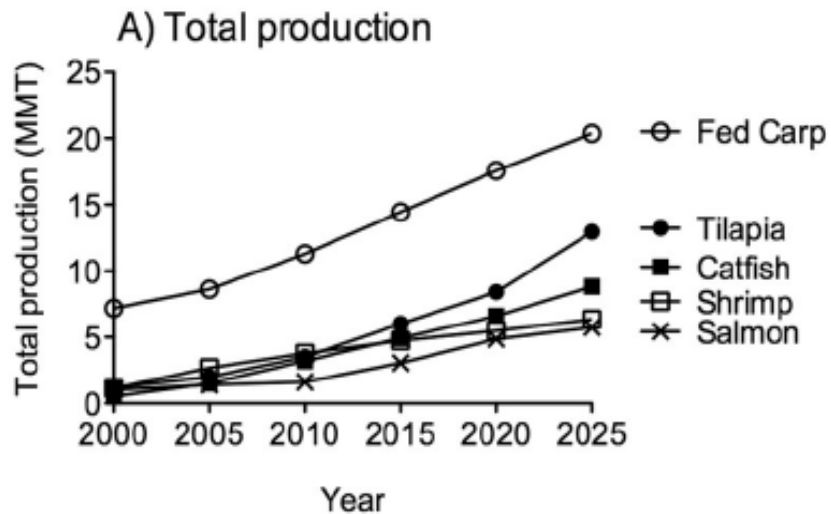


An illustration of three fish swimming in a pond. The background is a deep blue-green color with dark, feathery seaweed or coral-like structures. Three fish are depicted: one large fish at the top, one smaller fish in the middle, and another large fish at the bottom. The fish are rendered in shades of brown, tan, and white, with detailed scales and fins. The text is centered in the middle of the image.

# Save the products of the Land

Eat more fish —  
they feed themselves.

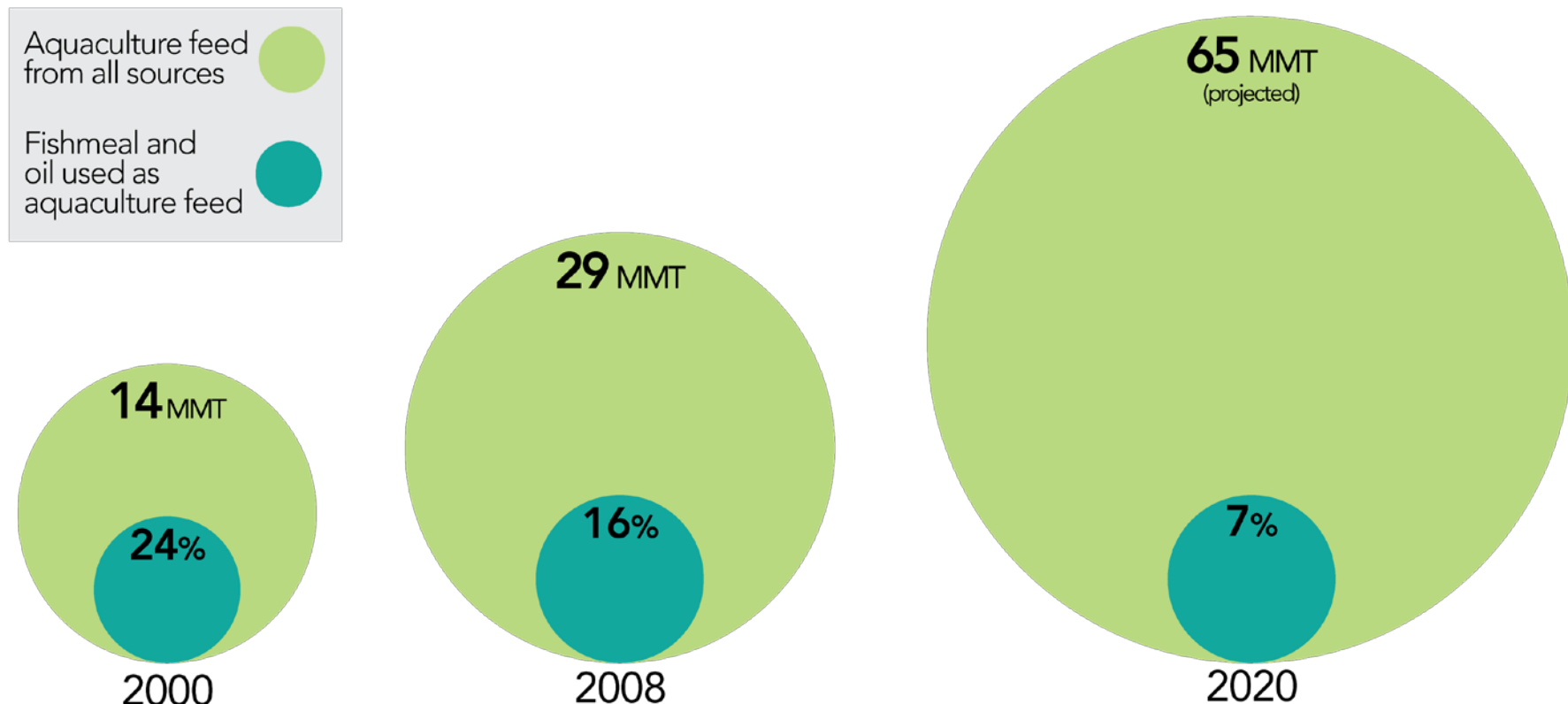
UNITED STATES FOOD ADMINISTRATION



**D) Feed Conversion Ratio**

Fed Carp	1.6 - 2.0
Shrimp	1.5 - 2.0
Tilapia	1.6 - 1.9
Catfish	1.3 - 1.8
Salmon	1.3

# Aquaculture Feed Ingredients





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## Review Article

# Environmental health impacts of feeding crops to farmed fish



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## ABSTRACT

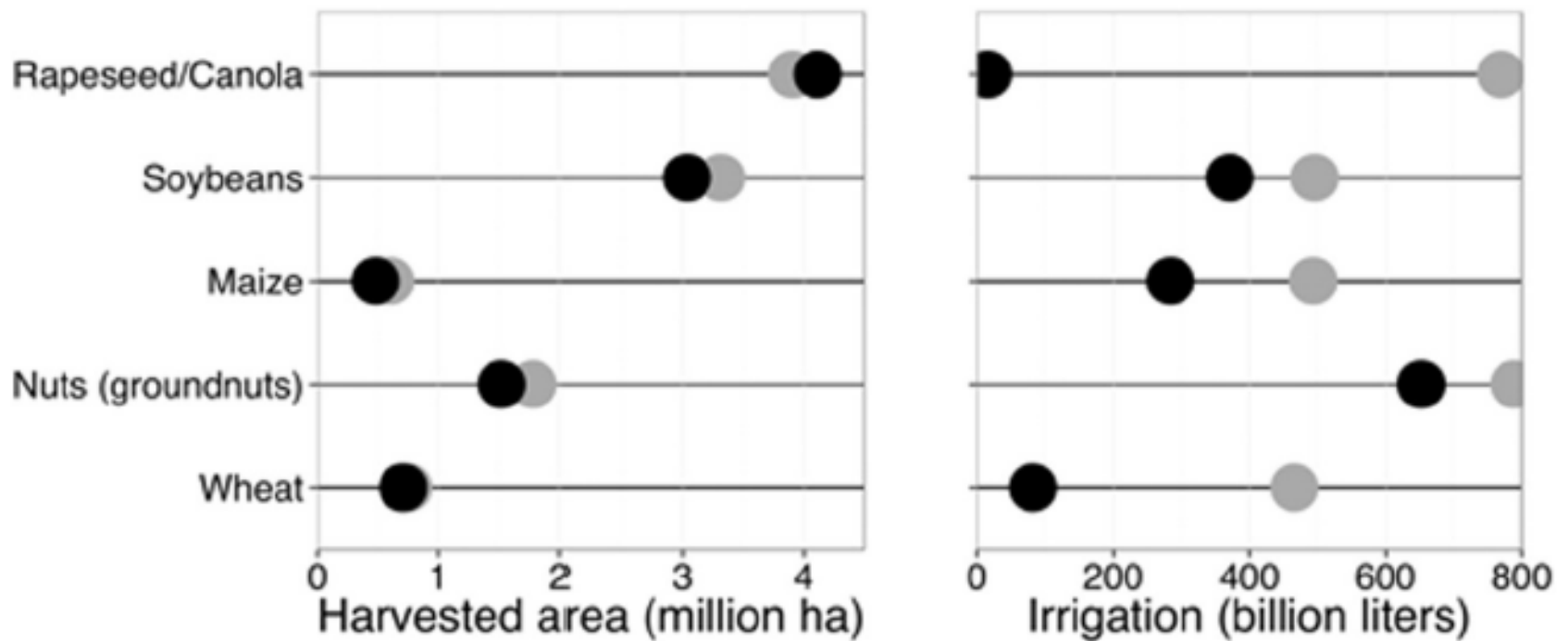
Half of the seafood consumed globally now comes from aquaculture, or farmed seafood. Aquaculture therefore plays an increasingly important role in the global food system, the environment, and human health. Traditionally, aquaculture feed has contained high levels of wild fish, which is unsustainable for ocean ecosystems as demand grows. The aquaculture industry is shifting to crop-based feed ingredients, such as soy, to replace wild fish as a feed source and allow for continued industry growth. This shift fundamentally links seafood production to terrestrial agriculture, and multidisciplinary research is needed to understand the ecological and environmental health implications. We provide basic estimates of the agricultural resource use associated with producing the top five crops used in commercial aquaculture feed. Aquaculture's environmental footprint may now include nutrient and pesticide runoff from industrial crop production, and depending on where and how feed crops are produced, could be indirectly linked to associated negative health outcomes. We summarize key environmental health research on health effects associated with exposure to air, water, and soil contaminated by industrial crop production. Our review also finds that changes in the nutritional content of farmed seafood products due to altered feed composition could impact human nutrition. Based on our literature reviews and estimates of resource use, we present a conceptual framework describing the potential links between increasing use of crop-based ingredients in aquaculture and human health. Additional data and geographic sourcing information for crop-based ingredients are needed to fully assess the environmental health implications of this trend. This is especially critical in the context of a food system that is using both aquatic and terrestrial resources at unsustainable rates.

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# 1. Environmental Footprint



## 2. Environmental Health Impacts of Industrial Crop Production

- Associated with environmental health risks for workers, their families, and communities
- Nitrates in water
- Pesticide exposure
  - Occupational
  - Fence-line communities



# 3. Implications for Human Nutrition

- Reducing or eliminating FO in feed changes ratio of omega-3/6
- High value fish prized for omega-3 content are getting FO



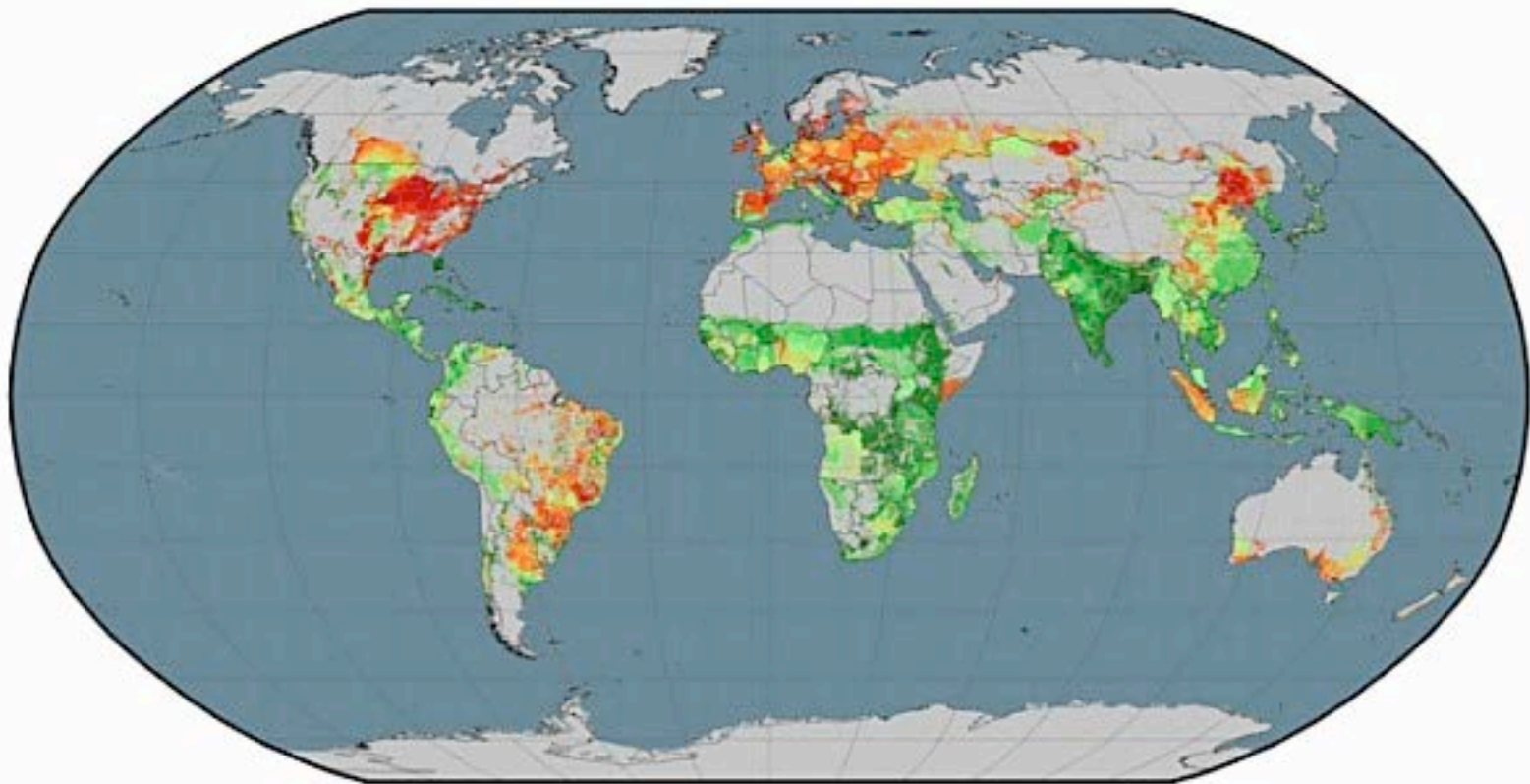
# Trends

- Finishing feeds
- Alternative ingredients:
  - Algae
  - Yeast
  - *Camelina sativa*
  - Insects
  - FeedKind



# Global Crop Use

## Calorie Delivery Fraction



calories delivered to the food system per calorie produced

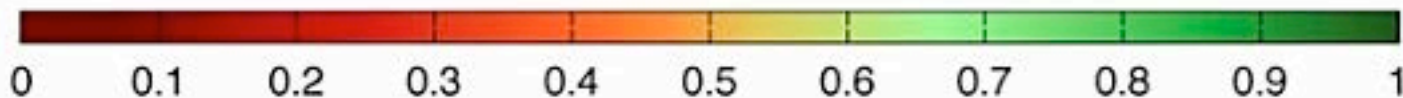
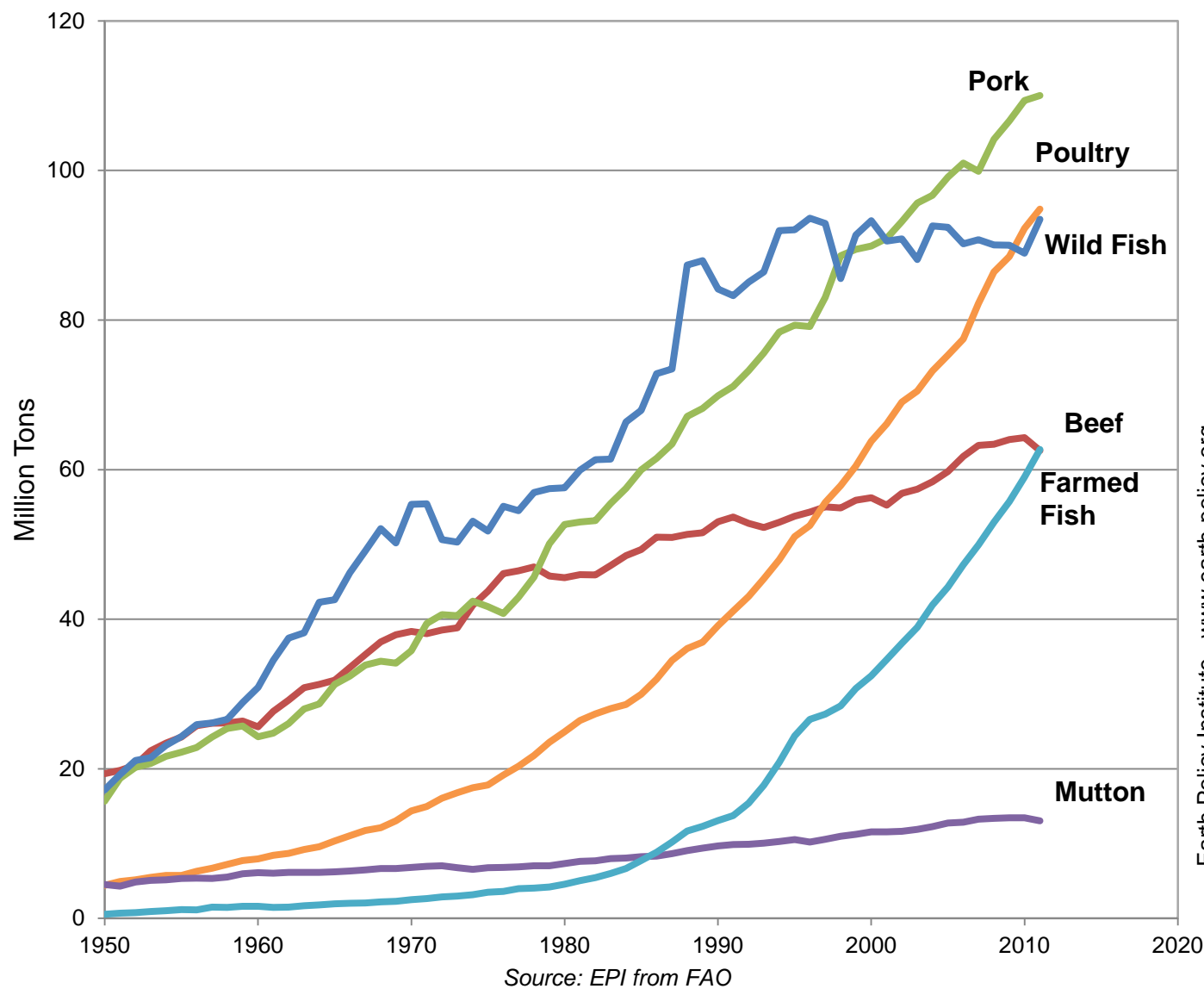


Image source: University of MN Institute on the Environment

# World Animal Protein Production, 1950-2011



# Conclusions

- All global systems are limited, aquatic and terrestrial
- Fed aquaculture will continue to compare favorably to terrestrial animal production in terms of crop-based feed use and env. footprint
- Demand for these ingredients growing globally: fish, poultry, pork
- Important considerations due to desire to scale up

# Collaborators

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# Aquaculture Feed

- Key input
- Proportion of aquaculture using commercial feed increasing
- Effort to reduce proportion of fishmeal and fish oil in feeds
- Other ingredients include crops, rendered animal products, insects, etc.

