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Philippe de Lap rouse is director of HighQuest Partners' global food and agribusiness practice.

He has more than 20 years experience in senior leadership positions with global companies in the agroindustrial and value-added food chain, as well as in private-equity investing.

Previously, de Lap rouse was a principal at Vanikoro Advisory LLC and director of business development for Bunge North America Inc.

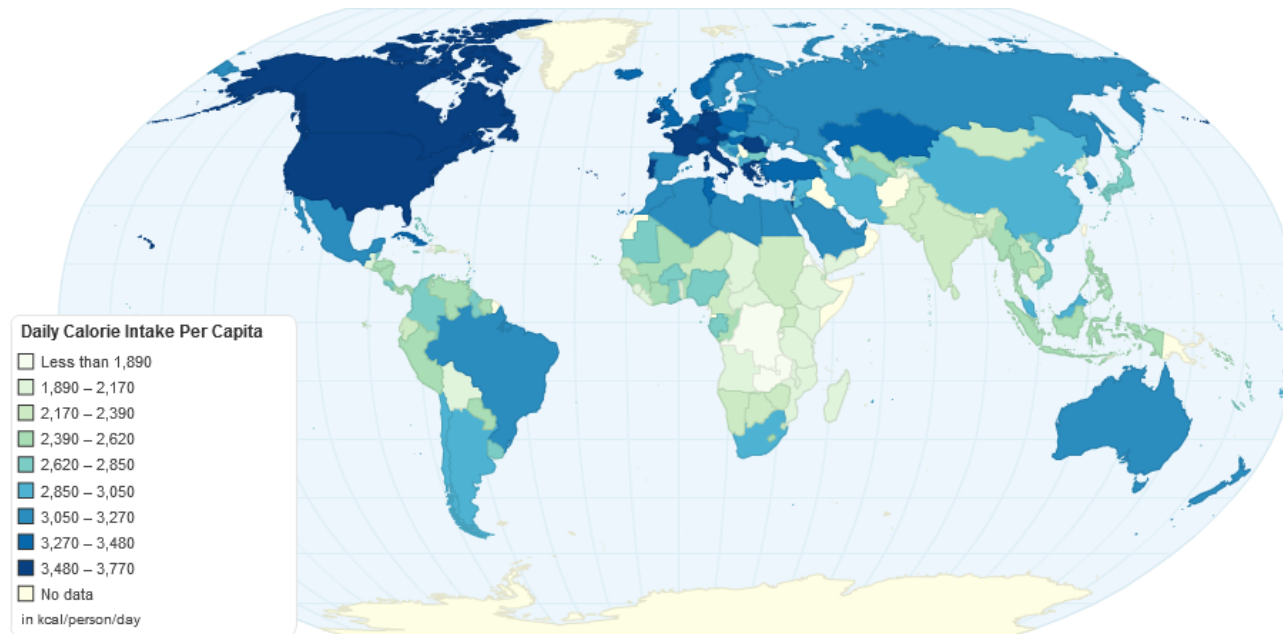


Trends in Global Feed Demand for Aquaculture

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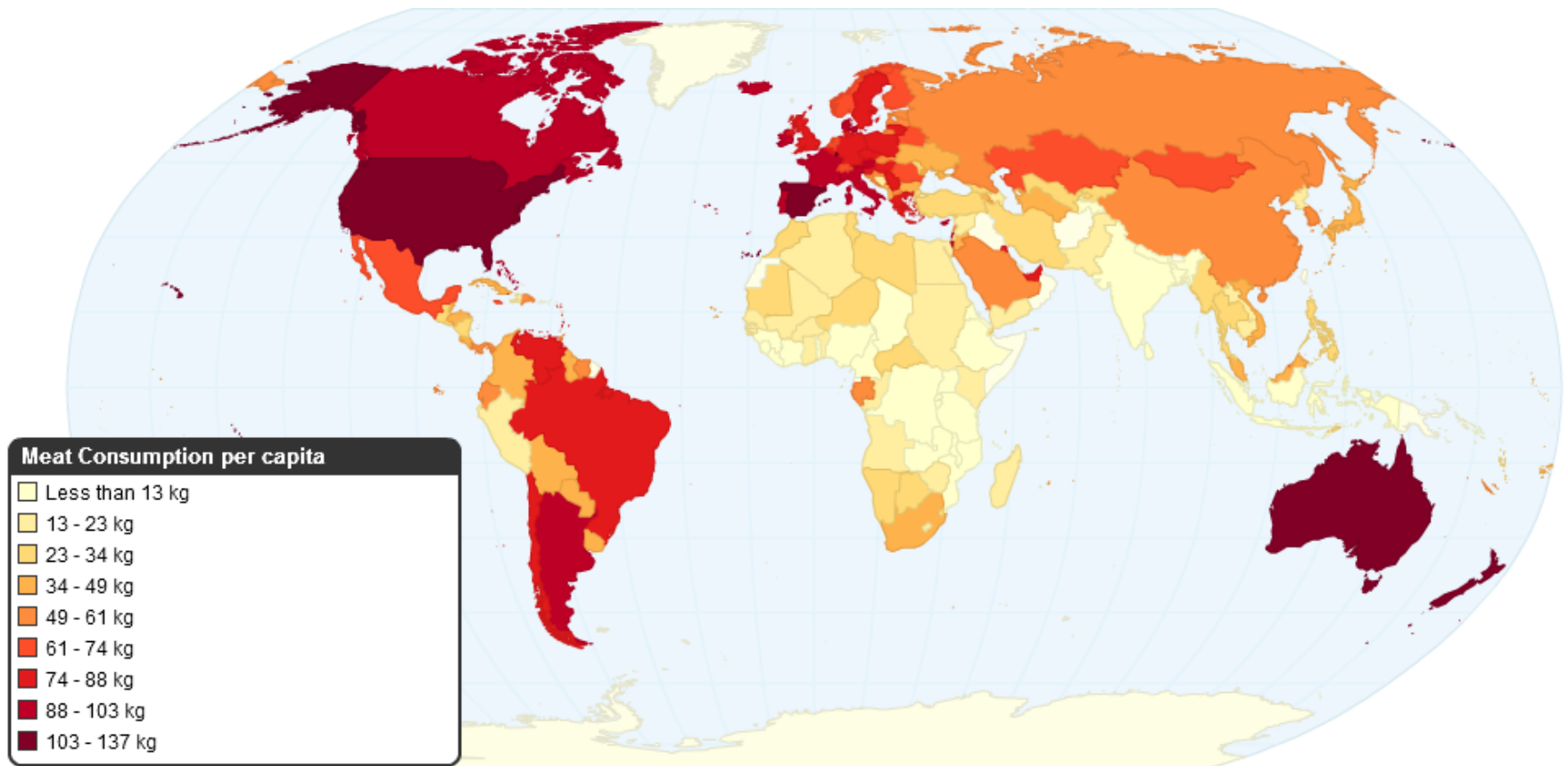
Global daily calorie intake per capita



- World: **2780 kcal/person/day**
- Developed countries: **3420 kcal/person/day**
- Developing World: **2630 kcal/person/day**
- Sub-Saharan Africa: **2240 kcal/person/day**
- Central Africa: **1820 kcal/person/day**
- **Kilocalorie:** A unit of measurement of dietary energy. One kcal equals 1,000 calories and one kJ equals 1,000 joules. In the International System of Units (ISU), the universal unit of dietary energy is the joule (J). One kcal = 4.184 kJ.

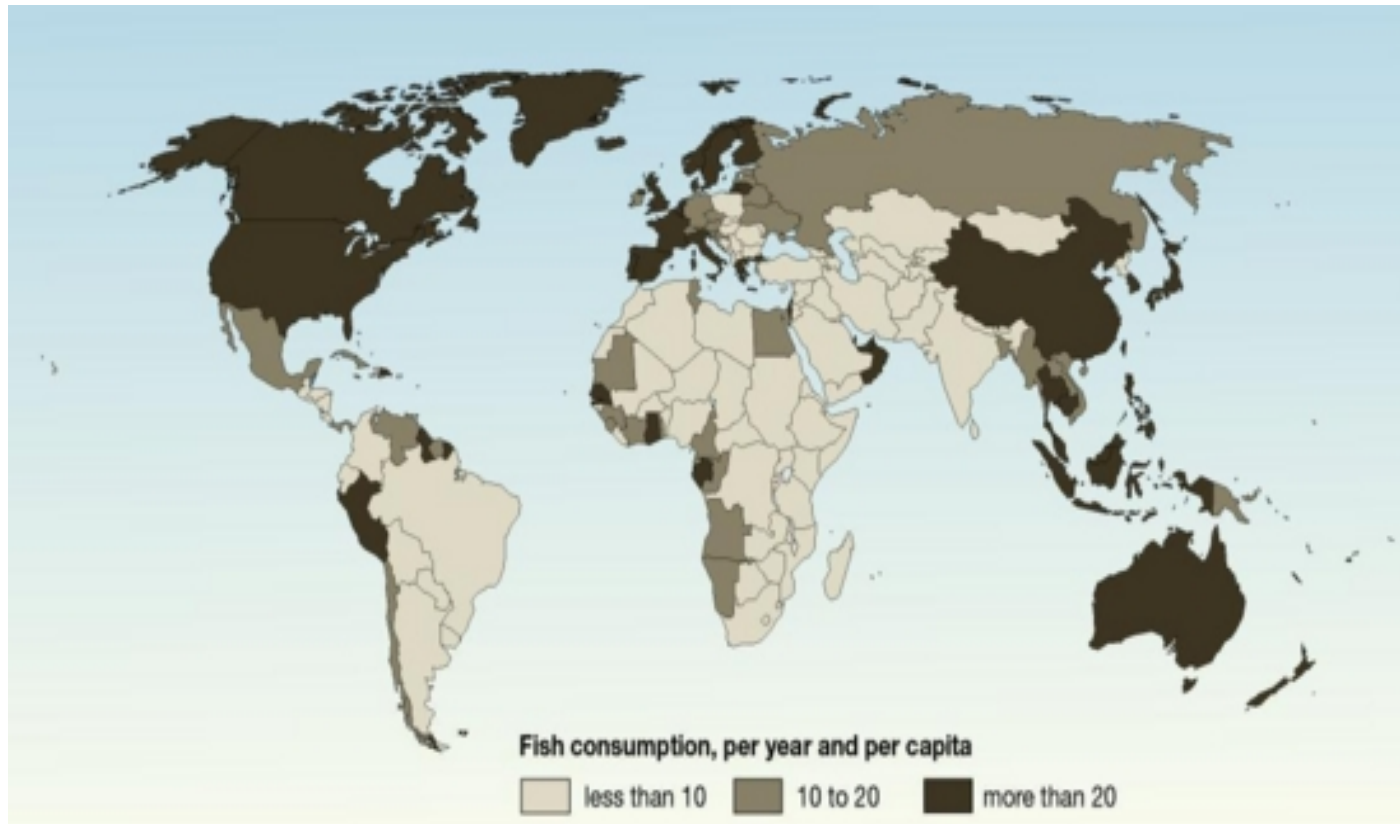
Source: UNEP-GRID-Arendal based on FAO Statistics Division Food Balance Sheets (2010)

Global meat consumption per capita



Source: UNEP-GRID-Arendal based on FAO STATS(2010)

Global fish consumption (2006)



Note: 'Fish' includes wild caught fish as well as commercial aquaculture products.

Source: FAO SOFIA

Global aquaculture production(1000 MT)

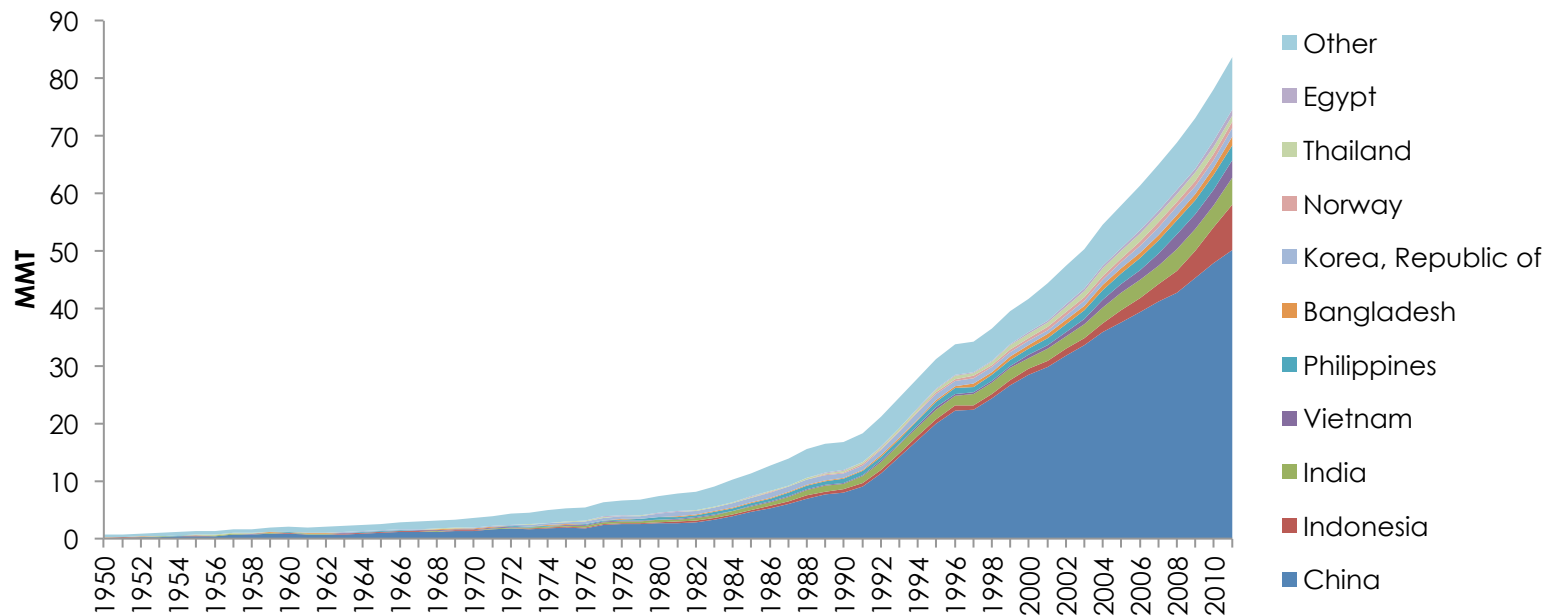


Source: UNEP-GRID-Arendal based on FAOSTAT (2011)

China is by far leading global producer of aquaculture

Aquaculture Production by Country 1950-2011

Source: FAO

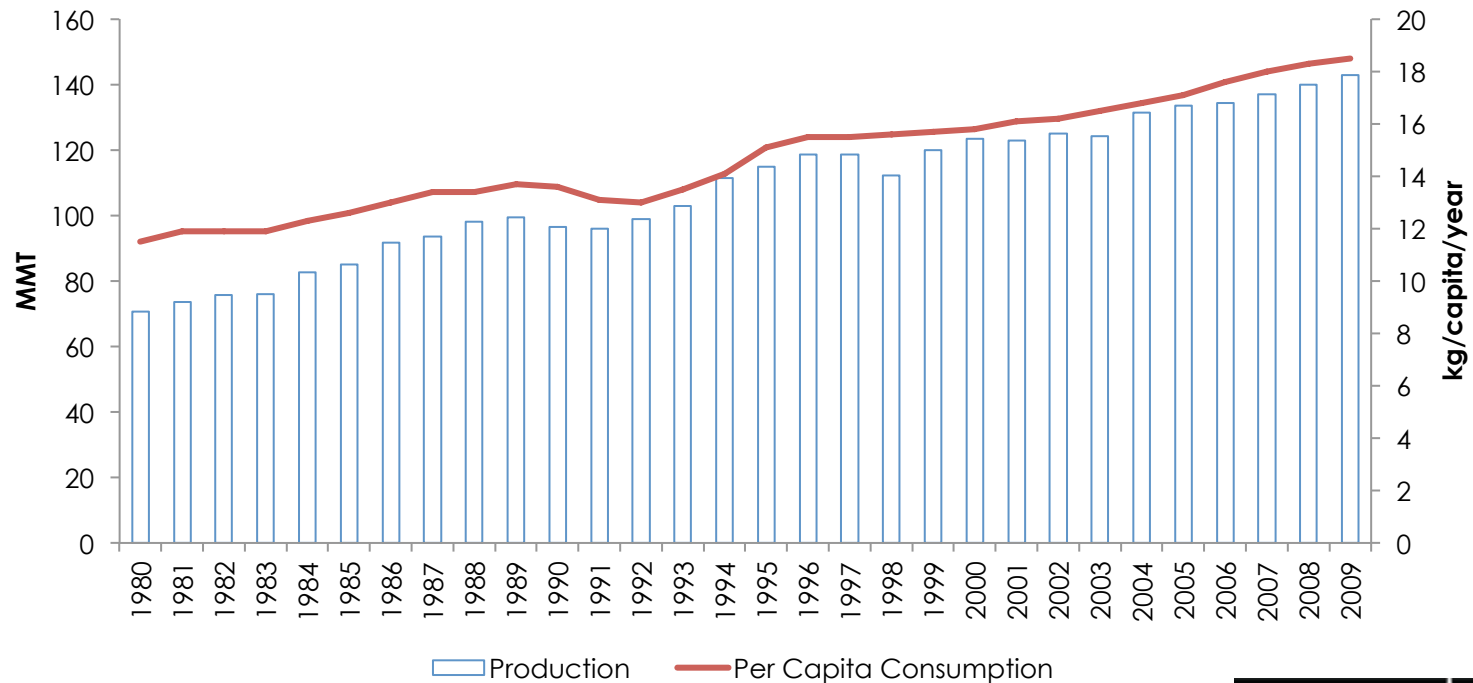


Source: FAO Fishstat Database.

Total seafood production and consumption per capita

Historical Seafood Production and Per Capita Consumption
(1980-2009)

Source: FAO

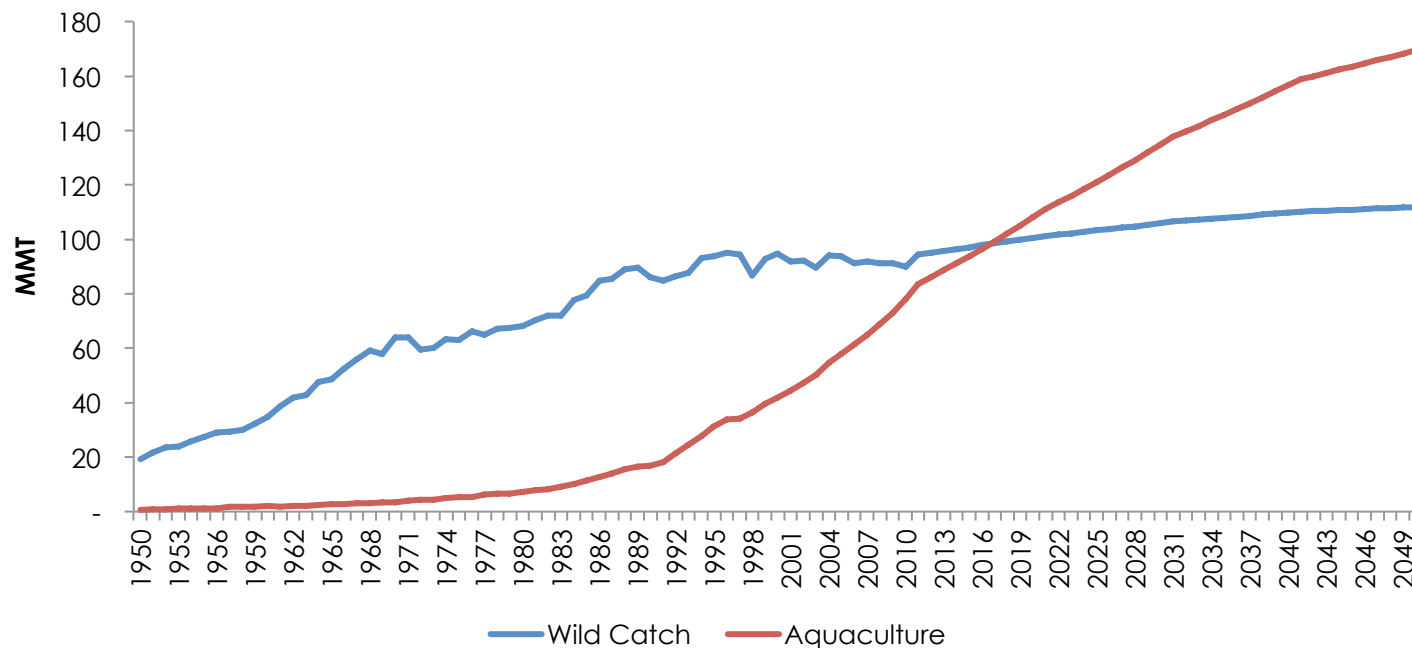


Source: FAO FishStat Database

Projected seafood consumption by source through 2050

Projected Global Seafood Production through 2050

Source: FAO, HighQuest Analysis



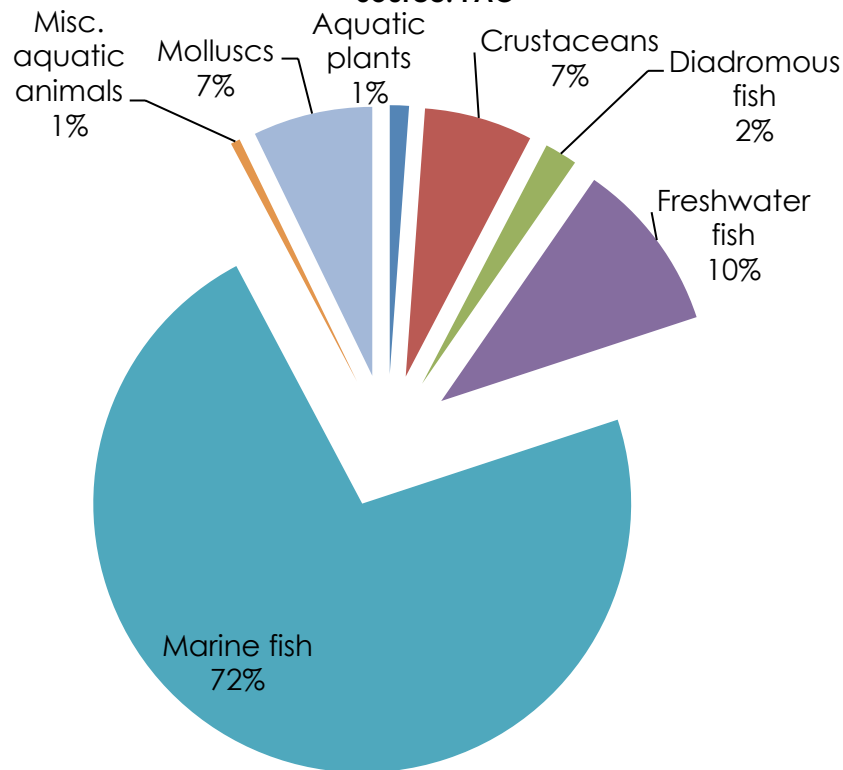
HQP estimate based on linear growth rate (1980-2011) of production for wild catch(1.0%) and aquaculture(8.1%):

- 2013 - 2021 at historical growth rate
- 2022 - 2031 at 75% of historical growth rate
- 2032 - 2041 at 50% of historical growth rate
- 2042 - 2050 at 25% of historical growth rate

Breakdown of total wild catch and aquaculture production

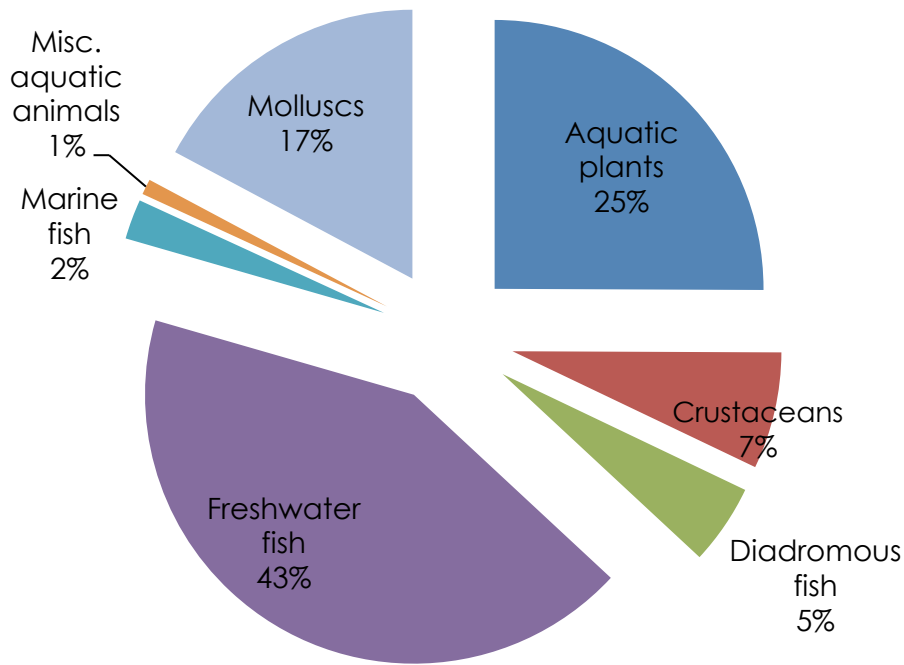
2011 Wild Capture Production

Source: FAO



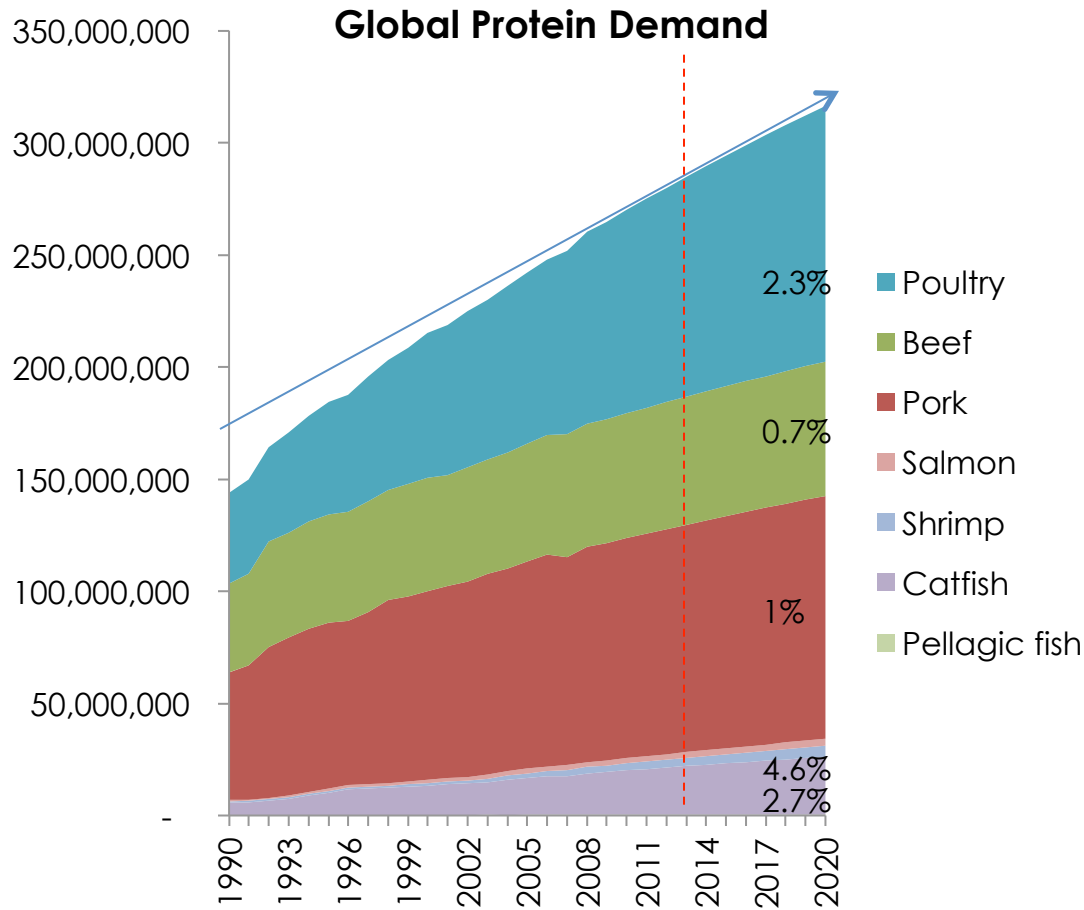
2011 Aquaculture Production

Source: FAO



Global protein consumption demand

Seafood and poultry will see the largest increases in demand in the coming decade



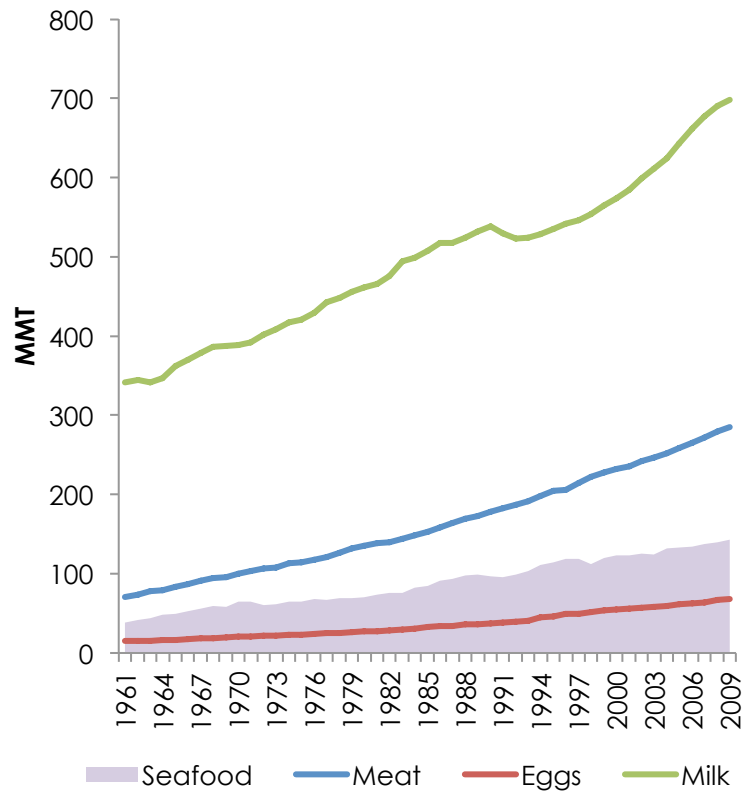
Source: FAO; HighQuest Partners

- Shrimp has the fastest growth rate out of all animal proteins at 4.6% annually.
- Catfish and poultry follow with a 10 year forecasted CAGR of 2.7% and 2.3% respectively.
- As seafood demand grows and aquaculture production replaces wild-caught harvests, demand for feed within the aquaculture industry, specifically soybean meal, will increase rapidly.

Aquaculture growth exceeds other animal proteins

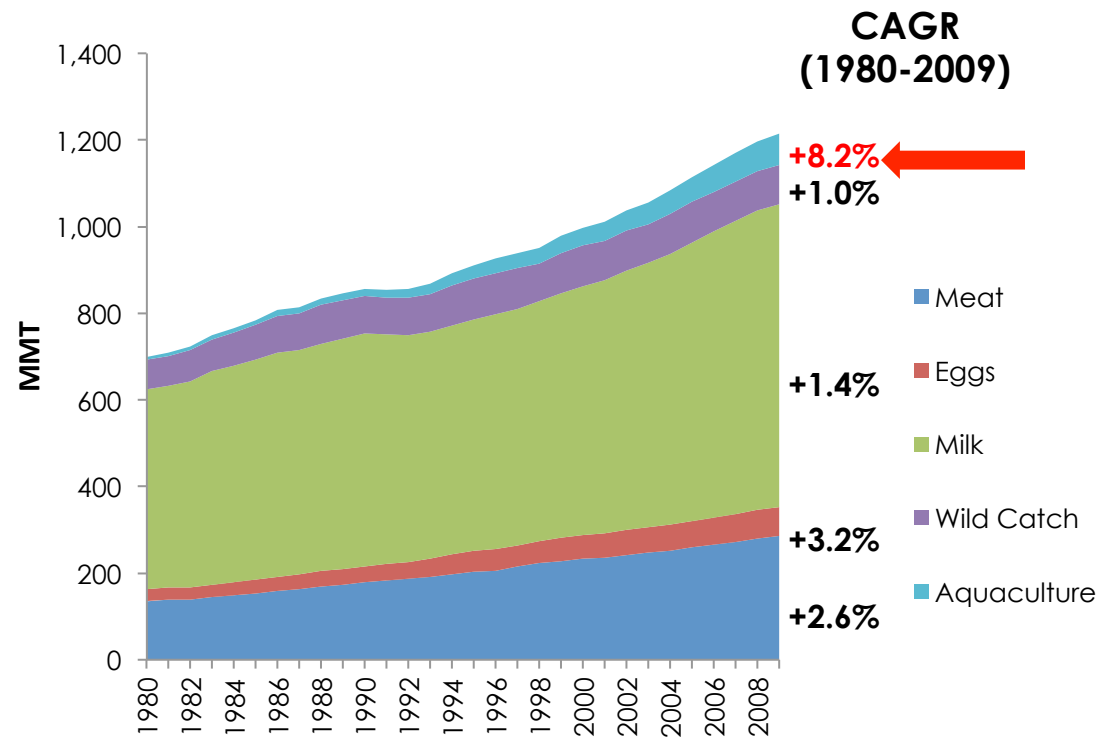
Global Animal Protein Production for Food Consumption (1960-2009)

Source: FAO



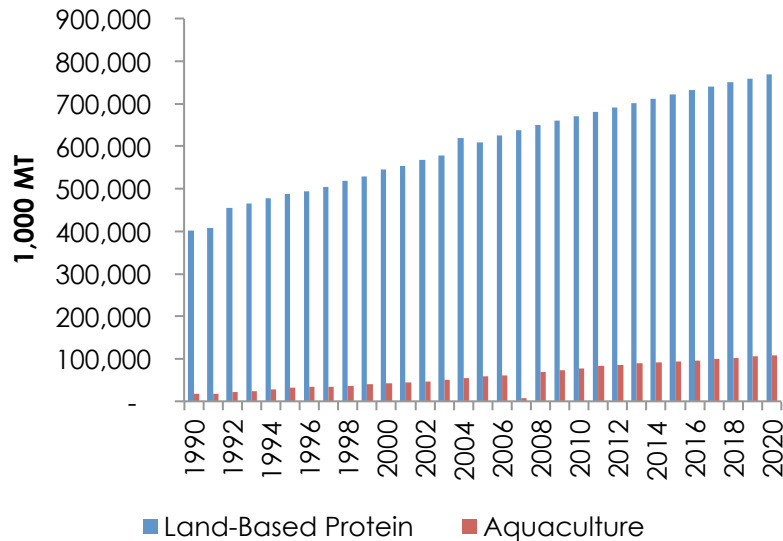
Global Growth in Protein Production (1980-2009)

Source: FAO

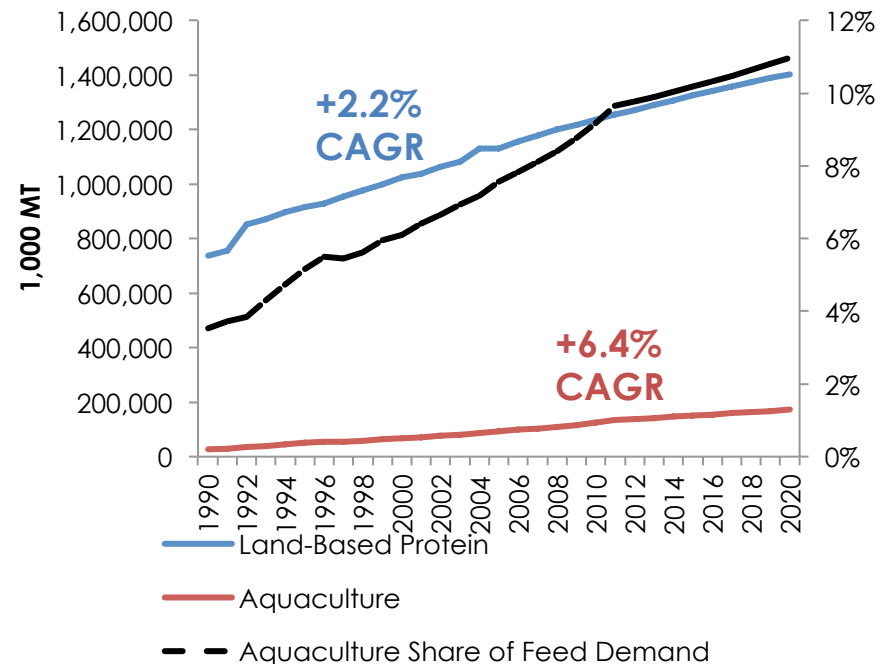


Feed requirements for aquaculture

World Protein Production
Source: USDA FAS, FAO, HighQuest Analysis



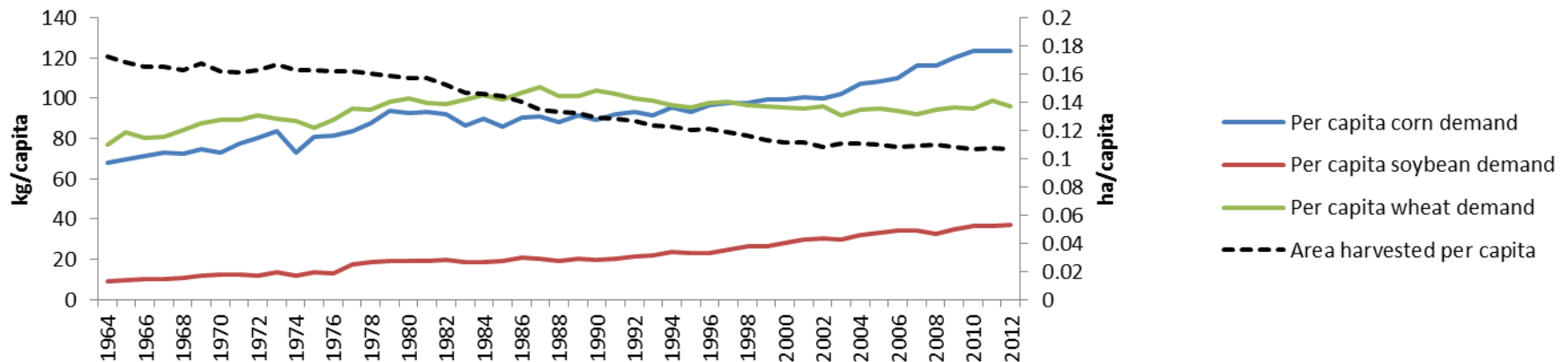
Projected Feed Requirements
Source: USDA FAS, FAO, HighQuest Analysis



Note: Land-based protein includes pork, beef, broilers, dairy, and eggs.

Rising demand as per capita acreage declines

Historical Demand for Corn, Soybeans, and Wheat and Area Harvested per Capita
1964-2012

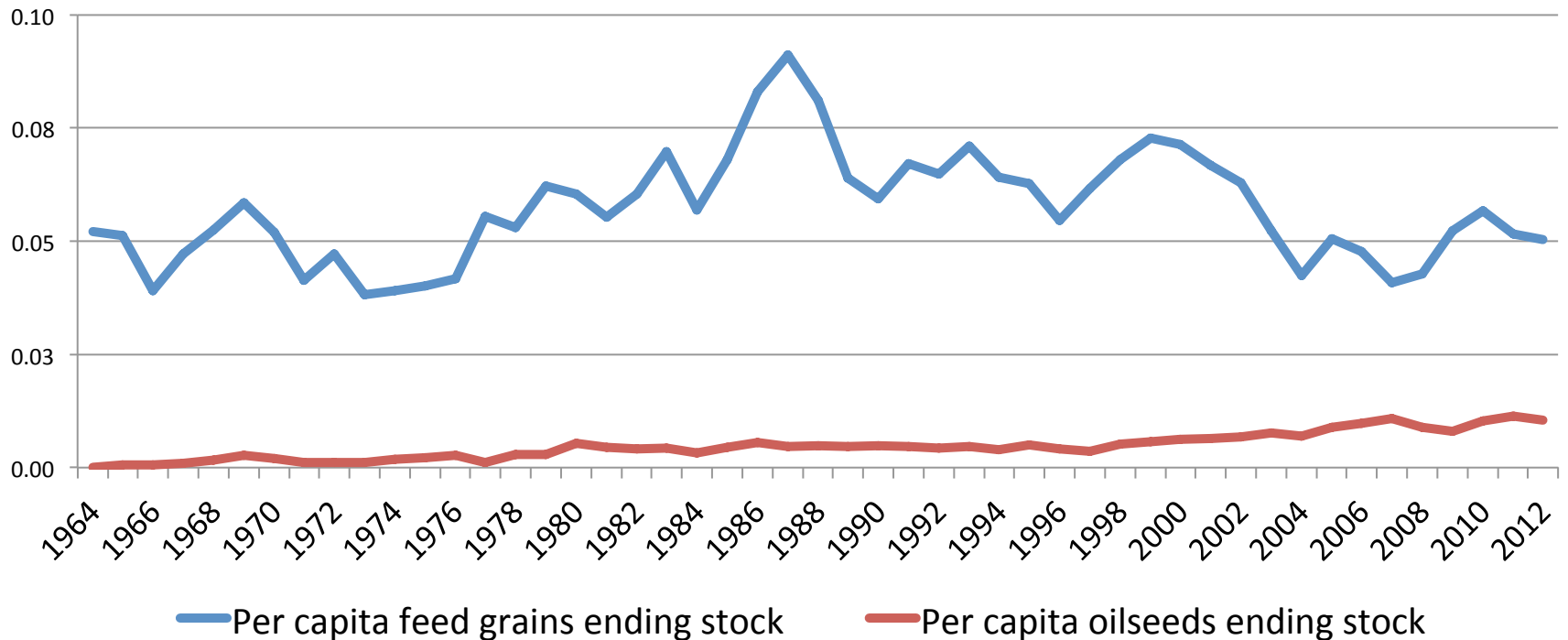


Source: USDA PSD, UN Populations Division

- Global consumption of corn, soybeans and wheat has increased 291%, 768% and 170% respectively to 870 million MT 260 million MT and 680 million MT.
- Per capita soybean consumption has been growing significantly (by 302% to 37 kg/ person since 1964) thanks to increasing demands from industrial sector and animal feed sector, while per capita corn and wheat consumption reached 123 kg/ person (growth of 81%) and 96 kg/person (growth of 25%) respectively in 2012.
- Global harvested acreage has increased by 33% to 913 million hectares in 2012 from 689 million hectares in 1964.
- Global harvested acreage on a per capita basis has dropped 38% to estimated 0.13 ha/person in 2012 from 0.21 ha/person in 1964.
- **Note:** The crops include barley, corn, millet, oats, rye, sorghum, wheat, mixed grain, rice and oilseeds (copra, palm kernel, cottonseed, peanut, rapeseed, soybean, sunflower seed).

Market volatility driven by uncertainty of available supply

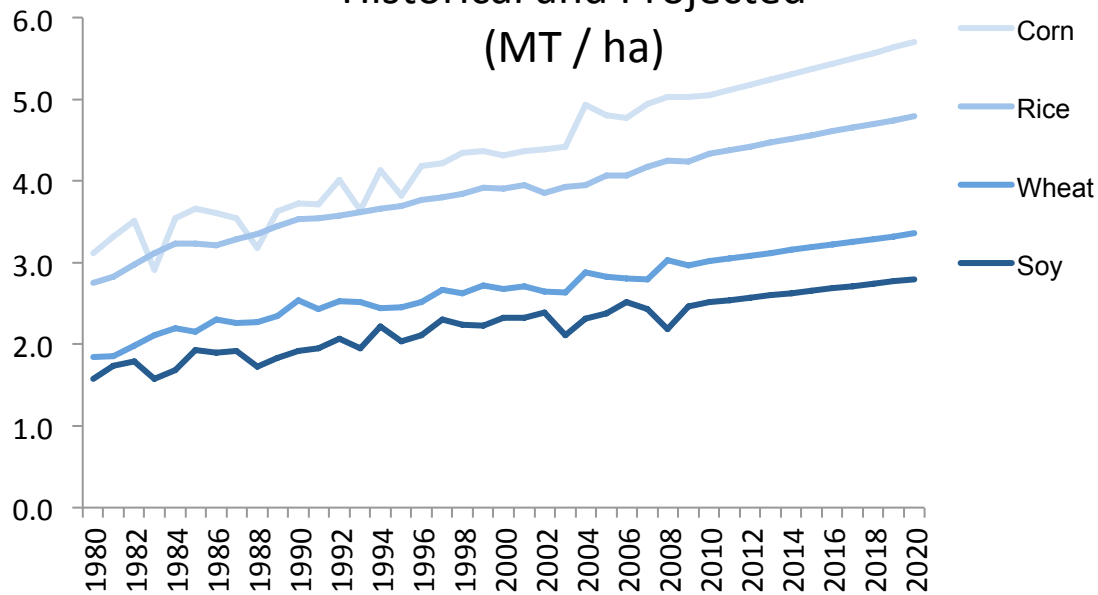
Historical global per capita feed grain and oilseed ending stocks (MT) (1964 – 2012 proj.)



- Global feed grains ending stock has grown by 108% to estimated 354.7 million MT in 2012 from 170 million MT in 1964 while it has decreased by 4% to 0.05 MT/ person in 2012 on a per capita basis.
- Global oilseeds ending stock has grown over 42 times to estimated 73.9 million MT in 2012 while on a per capita basis, it has grown by less than 20 times to estimated 0.01 MT/ person in 2012.

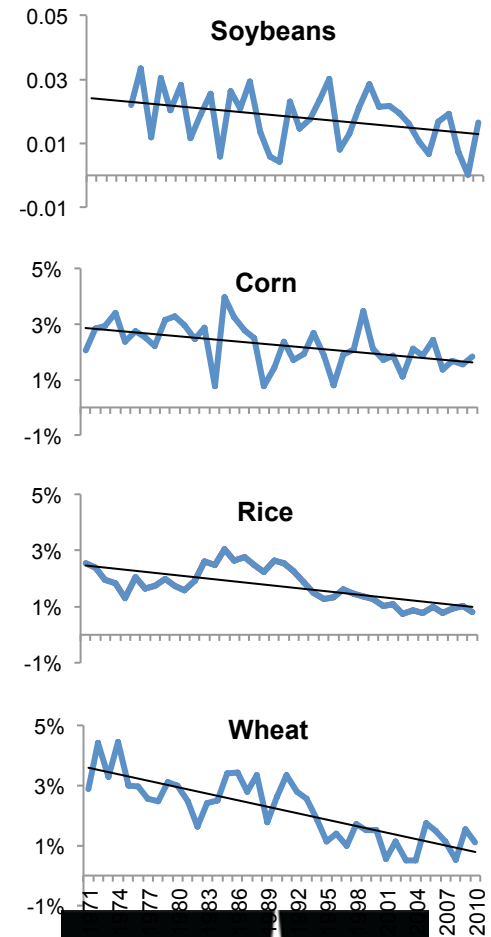
Declining yield gains in major crops – can trend be reversed?

Global Yields for 4 Major Crops
Historical and Projected
(MT / ha)

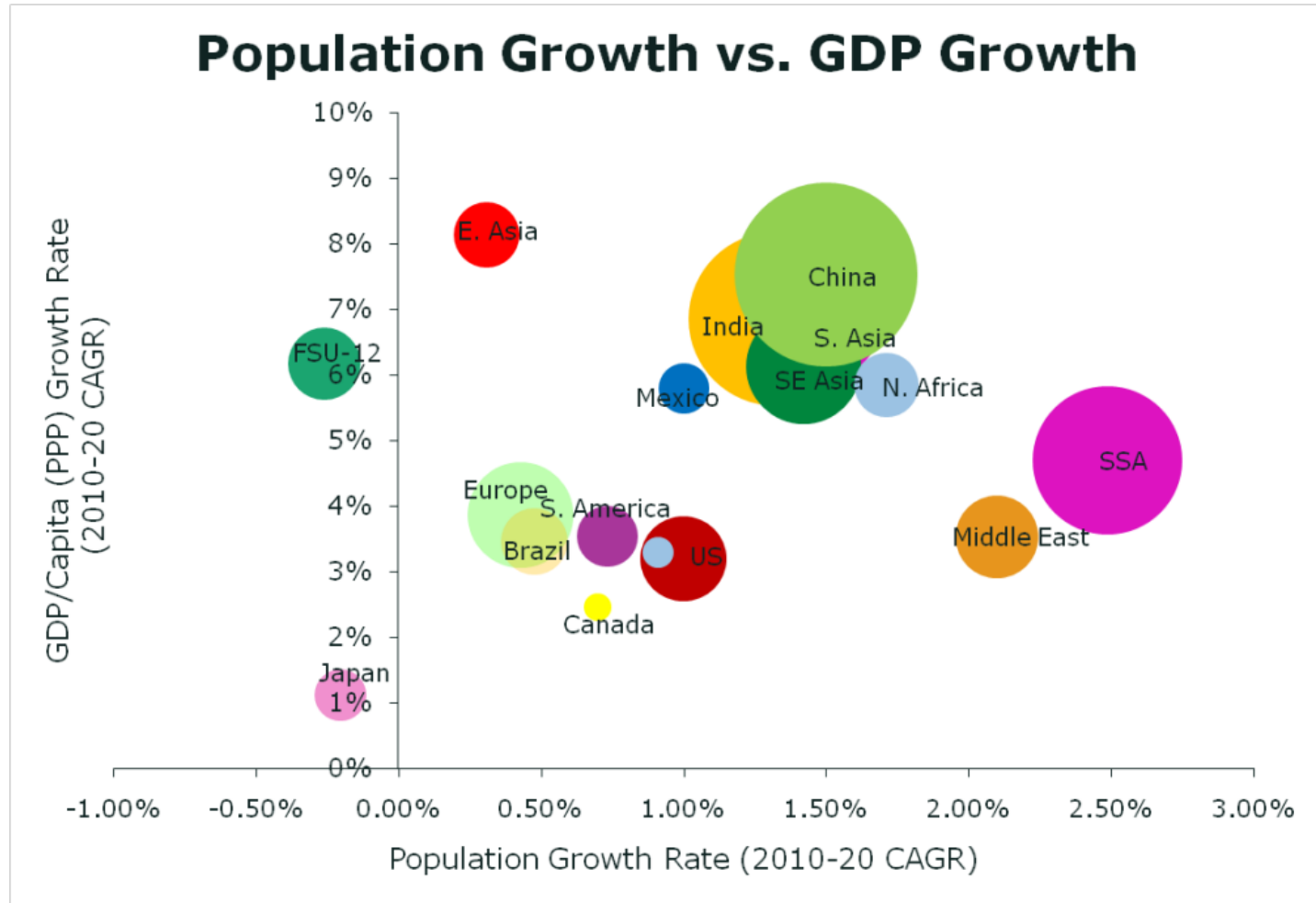


Source: USDA; HighQuest Analysis

Trailing 10-Year Yield Improvement

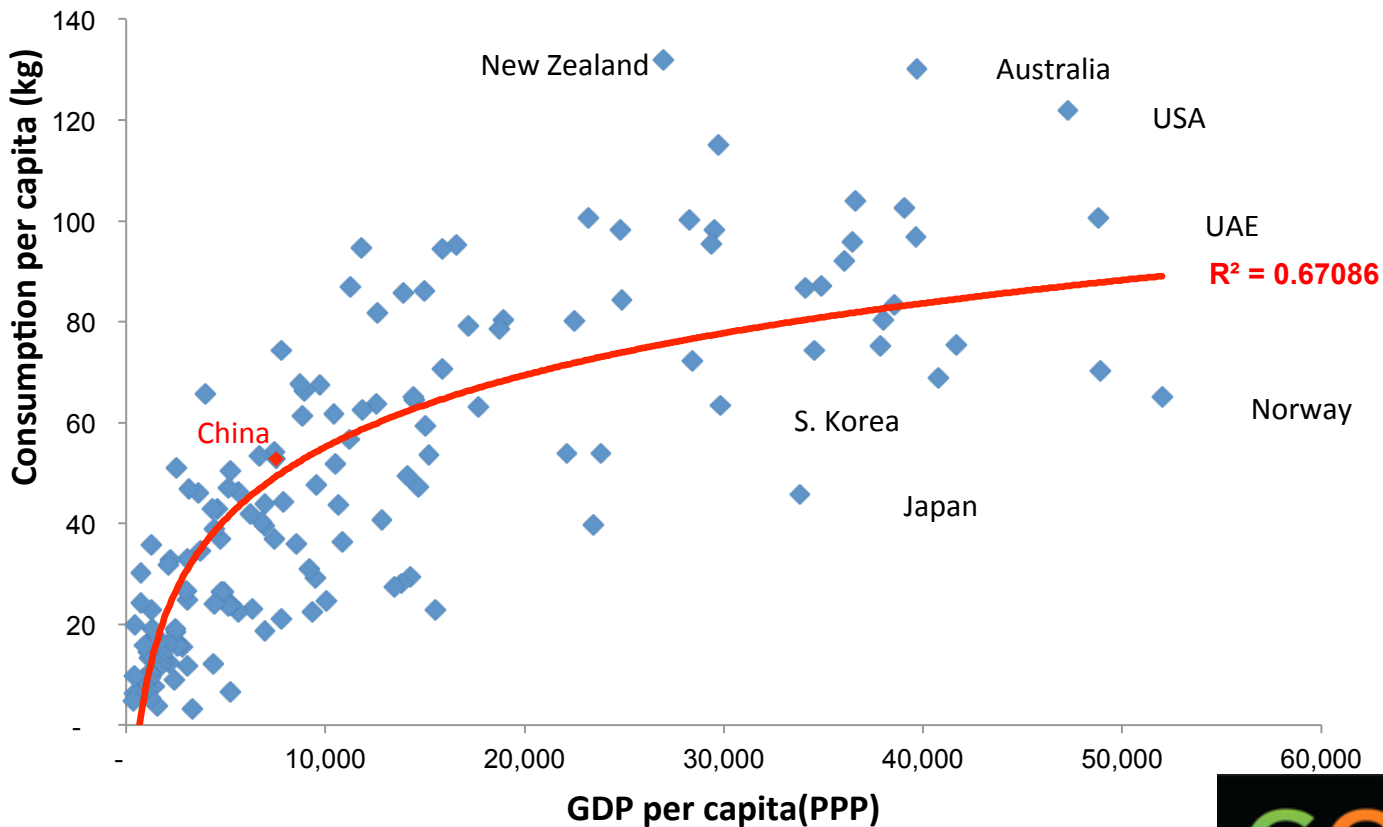


Demand for commodities driven by rapid GDP/capita growth in developing and emerging markets



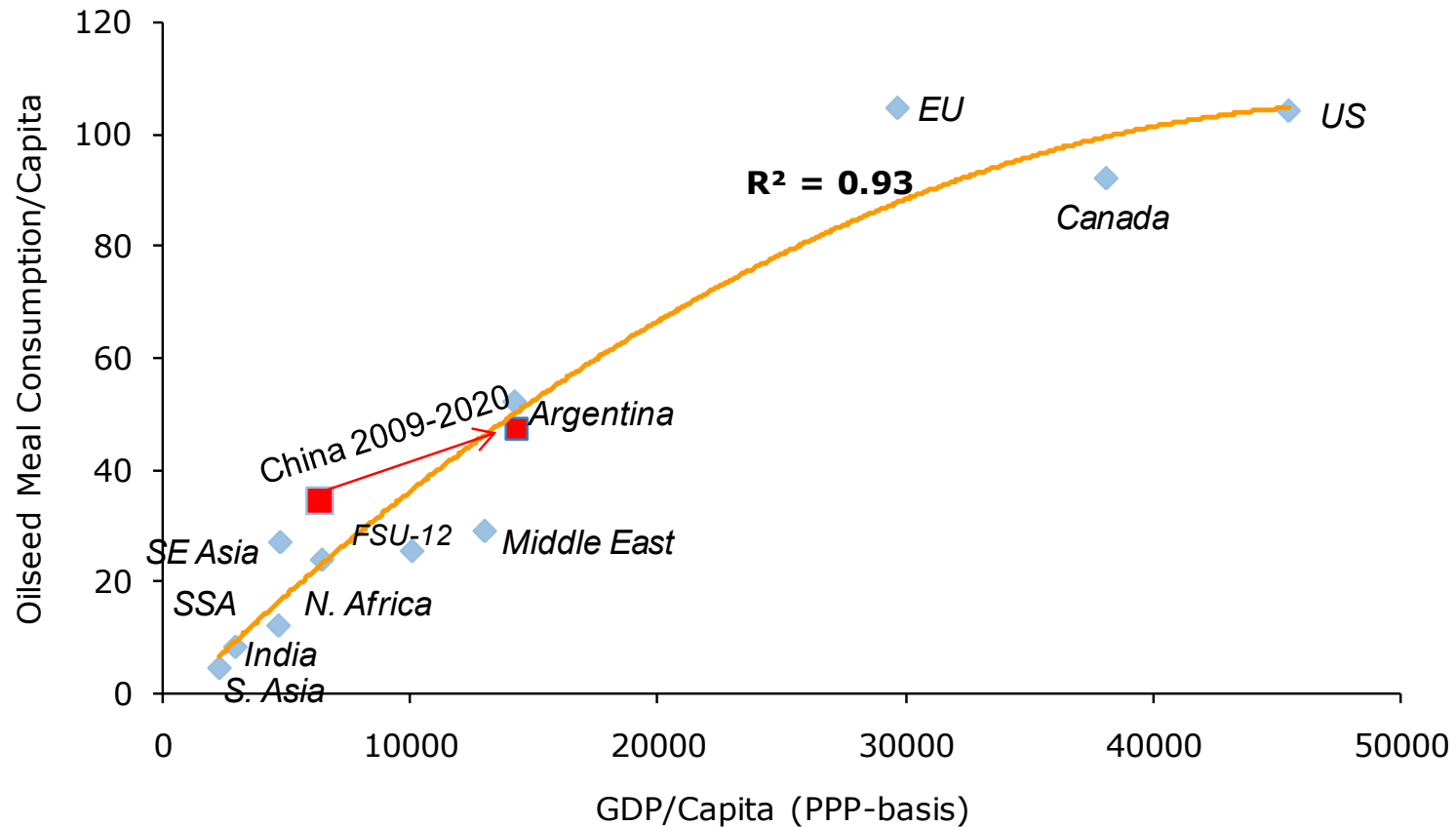
Animal protein consumption highly correlated with per capita GDP

Animal Protein Consumption(kg) Per Capita vs. GDP Per Capita(PPP basis) - 2010



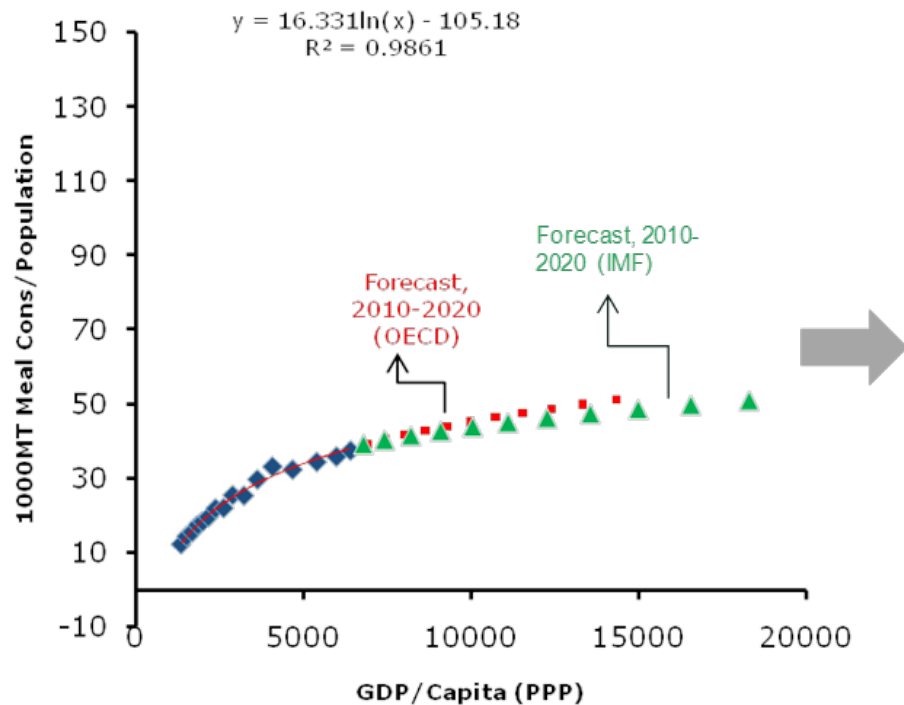
Higher GDP driving demand for oilseed meal

**2009 Oilseed Protein Meal Consumption/Capita vs.
GDP/Capita (PPP-basis)**



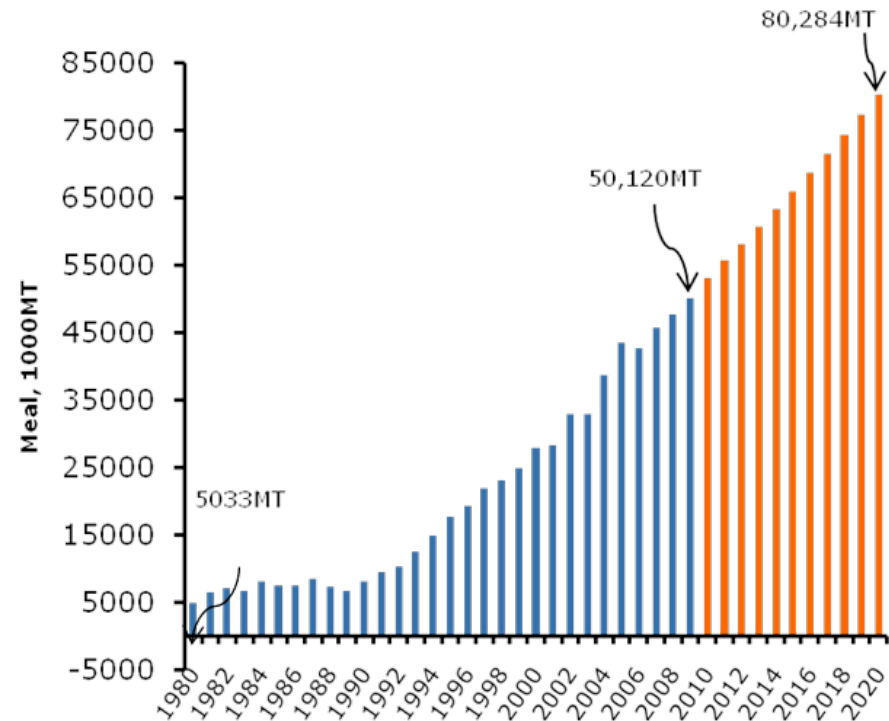
China – meal demand forecast to increase 60%

**Meal Consumption/Capita
vs. GDP-PPP/Capita
(1994-2009 actual/ 2010-2020 forecast)**



Source: OECD, IMF, USDA, HighQuest Analysis

**Meal Consumption
(1000MT, 1980-2020F)**

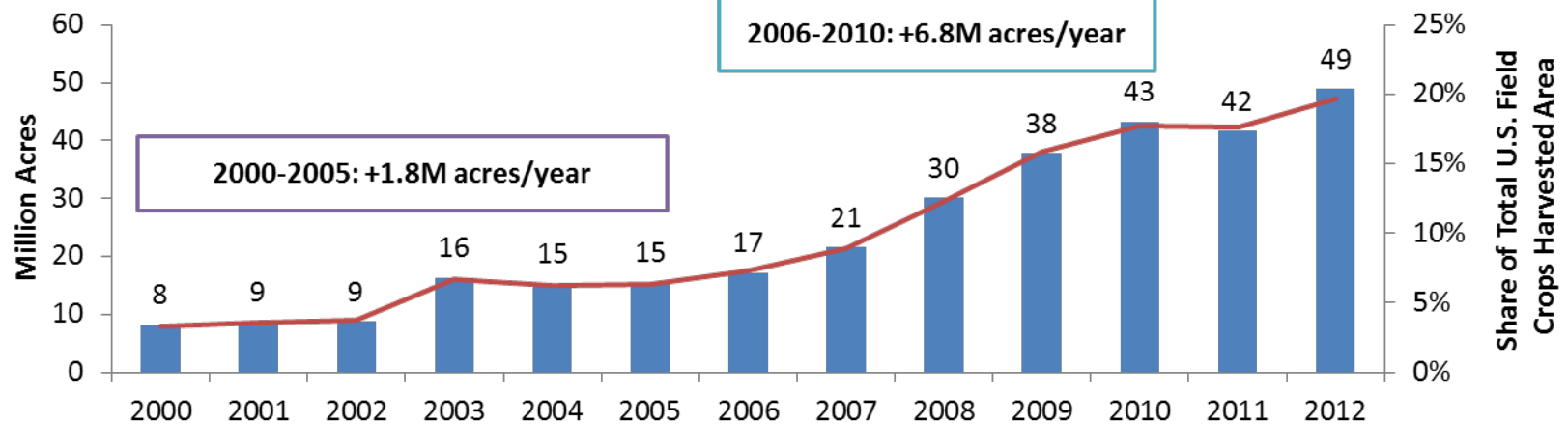


Over the past 15 years, meal consumption in China has had a 99% correlation with GDP per capita. Based on this correlation and OECD projections for future GDP growth in China, HighQuest projects that Chinese meal consumption will increase 60% by 2020.



Impact of exports to China and ethanol production on US farmland use

U.S. Acres Required for Corn and Soybean Exports to China and Ethanol Production 2000-2012



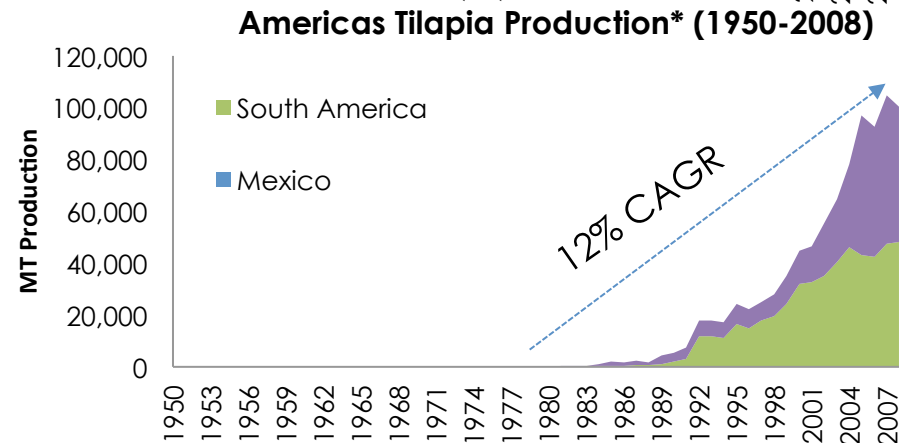
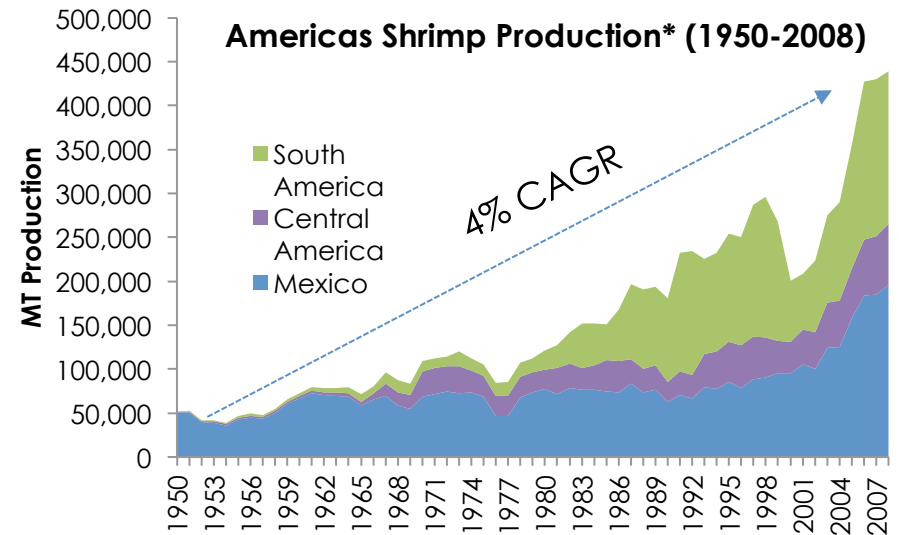
*Assumes a conversion rate of 2.65 gallons of ethanol per bushel corn and 31% of corn recovered through the production of DDGs (DDGs-adjusted). To mitigate the impact of yield anomalies on acreage requirement, estimates are based on 3-year trailing average yields.

Sources: USDA NASS, USDA GATS, USDA ERS, American Petroleum Institute, HQP Analysis

Tilapia and shrimp production in the Americas

While tilapia production in the Americas is smaller than shrimp production, it is ramping up quickly.

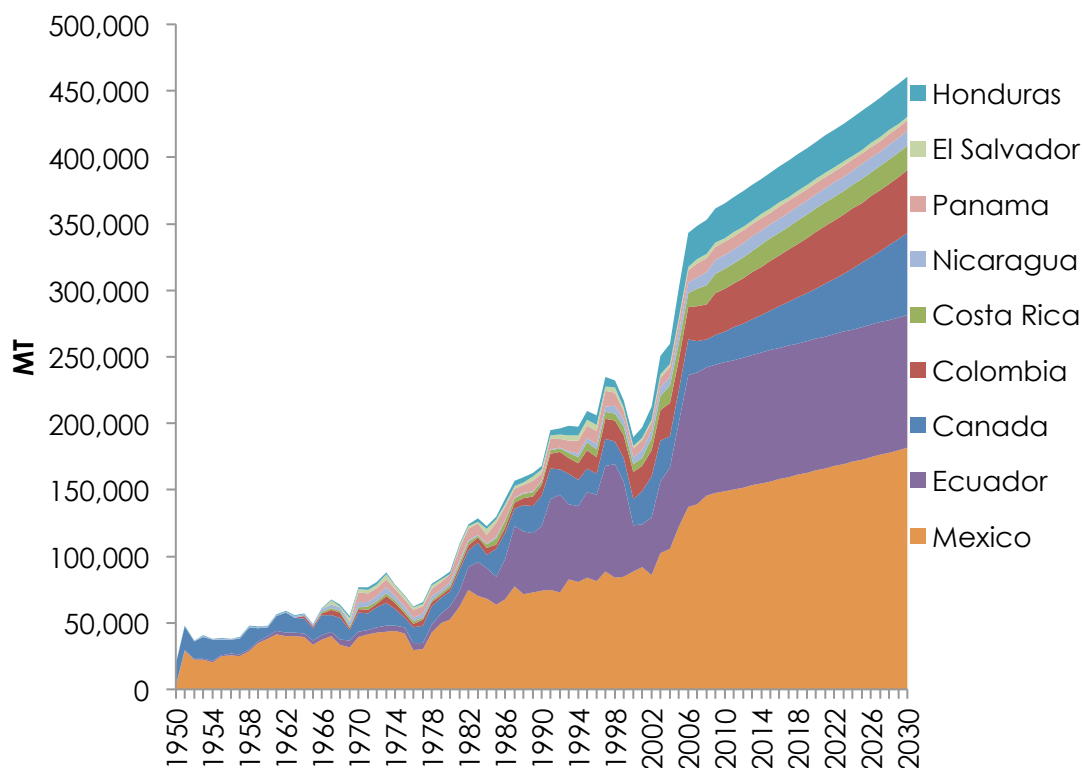
- From 1971 through 2008, Central and South America have experienced a 4.9% CAGR increase in shrimp aquaculture production.
- Mexico has experienced a 17% CAGR in shrimp and tilapia aquaculture production during the same period.
- Central America has experienced a 3% CAGR in shrimp production during this period while South America has experienced an 11% CAGR increase.



Source: FAO, HighQuest Analysis

Soybean meal demand for aqua feed in the Caribbean Basin and Canada

**Caribbean Basin and Canada
Soybean Meal Usage for Aqua feed
1950-2030F**



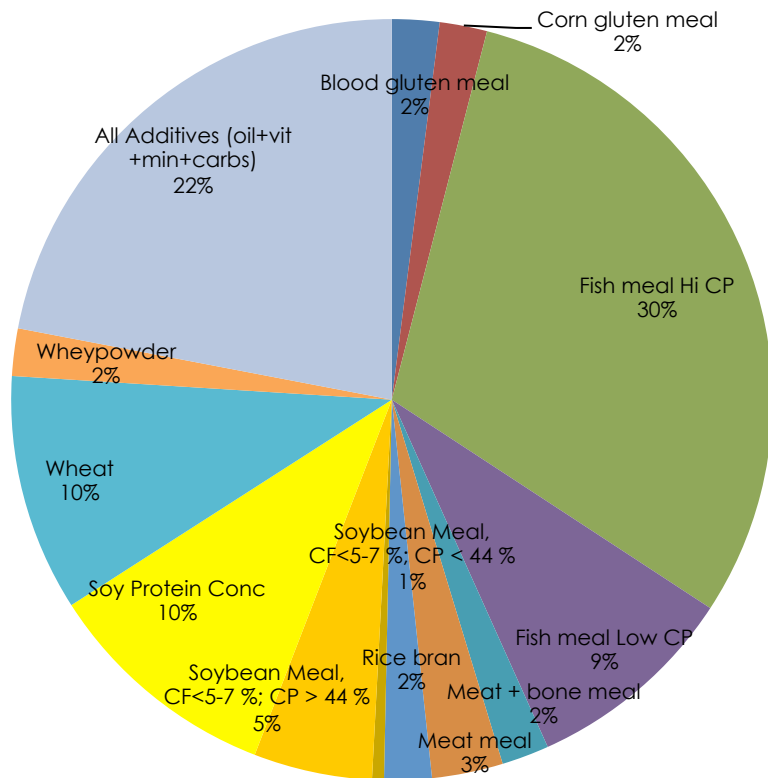
- Soybean meal required for aquaculture rations in the Caribbean Basin and Canada will continue to increase to over 450,000 tons per year by 2030.
- US suppliers can expect to supply most of the additional soybean meal required by these regions due to landed price competitiveness, preferential trade relationships and the positive marketing of US soybeans and soy bean products throughout the region.

Source: FAO; HighQuest Analysis

Salmon feed rations

Salmon feed rations are becoming less dependent on fish meal, using soy isolates and meals as replacements.

Salmon Feed Rations



- Salmon feed is **likely to reduce its dependence on fish meal for protein content.**
 - **Soybean isolates and new varieties of conventional and GM soybeans are being developed** to replace the amino acids that are predominantly provided by fish meal.
 - These new varieties of soybeans are not yet commercially available.
- Fish meal or oil is currently needed to provide salmon with Omega-3 fatty acids, methionine and cystine.
 - **Soybean meal will still grow a viable fish stock, however the Omega-3's touted as the primary health benefit of salmon consumption is dependent on the amount of Omega-3 fatty acids in the diet.**
- **Soybean meal is unpalatable** to Chinook salmon and most carnivorous fish at certain stages of development.
 - **Development in additives are being tested.**
- There are lectins present in SBM that reduce nutrient absorption in salmonids, however lectins can be deactivated by treatment during processing.
 - Trypsin inhibitors also present in SBM inhibit some protein absorption.

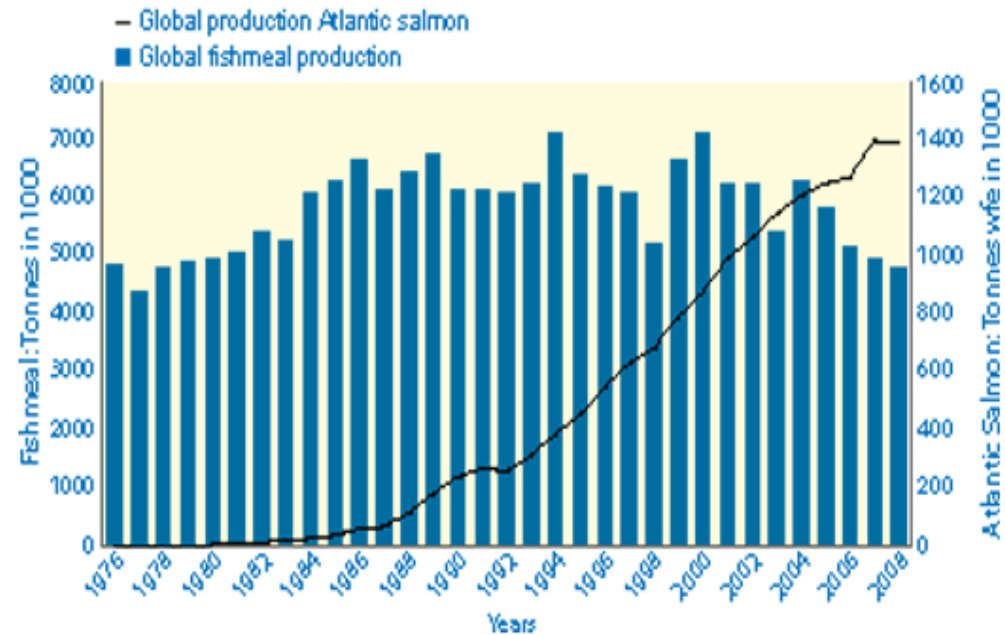
Source: Jan Van Eys, PhD

Salmon feed rations

Currently, **farmed salmon require only 39% fish meal and oil in their diet compared with almost 80% less than a decade ago**. This percentage is expected to continue decreasing.

- Despite a stagnant supply of fish meal, salmon production has been increasing. Soybean meal and other protein substitutes are increasingly being formulated into rations for farmed salmon in an effort to reduce costs and compensate for the decreasing supply of fish meal.
- **A minimum of 15% of the feed ration for salmon needs to be composed of fish oil as this is the main source of omega-3-fatty acids, which is an important marketing characteristic of salmon.**
 - Commercial rations could reduce the use of fish oil further if a plant based or other plausible source of omega-3-fatty acids were discovered.
 - Currently there are no restrictions on nor monitoring of the levels of Omega-3's present in salmon.

Stable fishmeal production, increasing salmon production

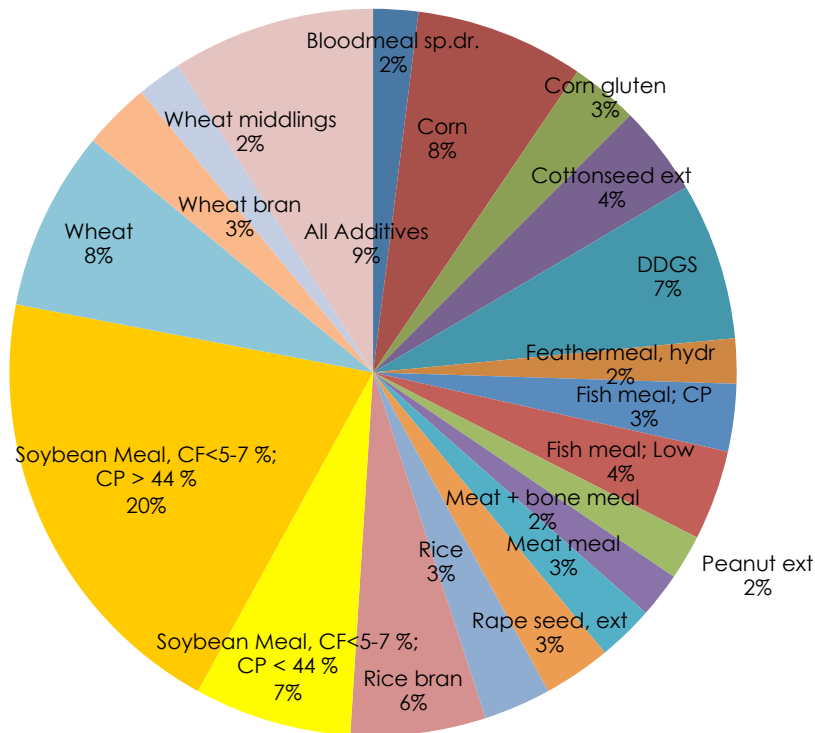


Source: Marine Harvest

Tilapia feed rations

Tilapia are herbivorous fish and therefore require little animal protein in their diet; soybean meal currently accounts for 27% of tilapia commercial rations.

Tilapia Protein Feed Rations



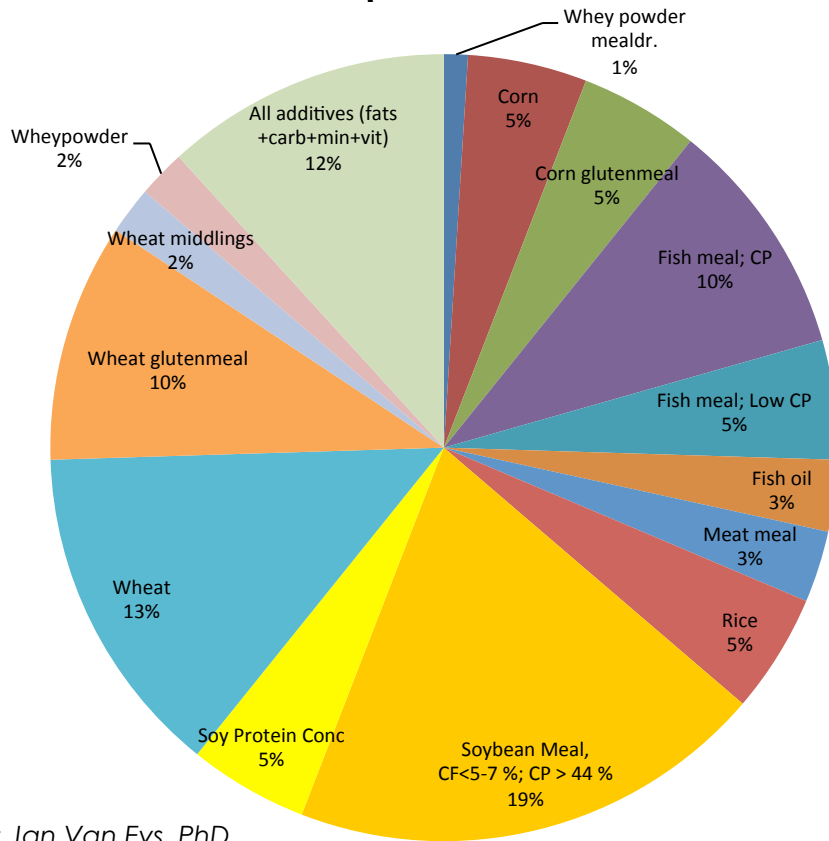
- As tilapia are herbivorous, there are several viable plant protein options that can be used in tilapia feed.
 - **Experiments have been conducted testing various alternatives such as algae, insect meals and plant fodder that is readily available depending on location.**
 - For example, in Mexico **wheat** is used on tilapia feed rations as it is a readily available and an abundant crop.
 - **Other locally sourced feeds may include pig manure or other natural fertilizers that promote the growth of algae** and other organisms that tilapia consume.
 - Tilapia require minimal fish meals and oils in their diet for optimal development.

Source: Jan Van Eys, PhD

Commercial feed rations for shrimp

Commercial shrimp feed consists of 24% soybean meal (incl. soy protein concentrate).

Shrimp Feed Rations



- High-quality shrimp feed is essential as these organisms have highly sensitive response systems.
 - For this reason, **most all shrimp production uses commercial feed rations.**
 - As any fluctuation is the amount of soybean meal used to feed shrimp can be disruptive to nutrient absorption in the digestive tract and cause loss in the shrimp population, typically there is **not much variation in the use of soybean meal.**

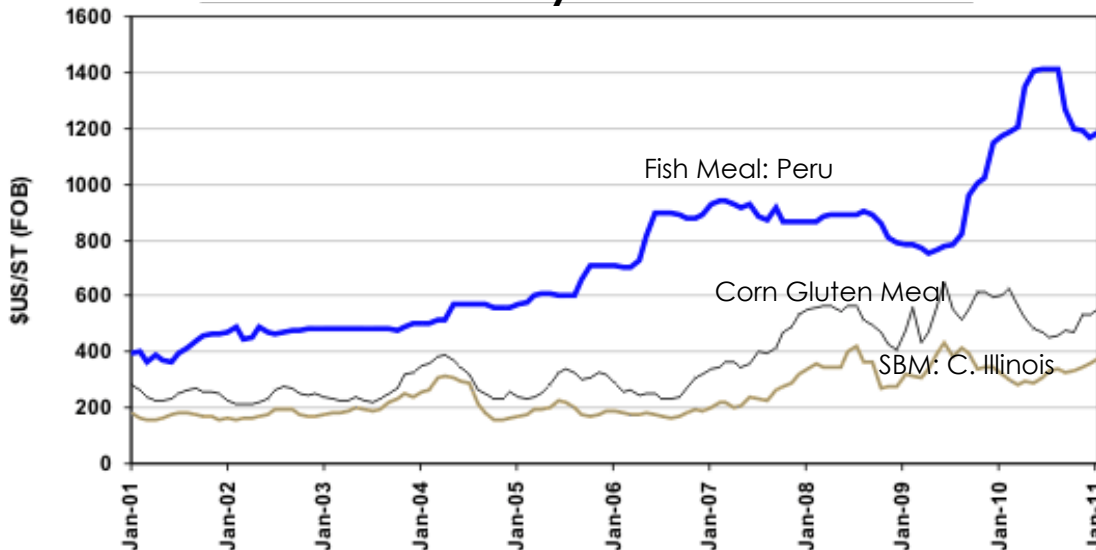
Source: Jan Van Eys, PhD

Protein meal - historical prices

Fish meal prices are expected to continue rising as restrictions on wild catch remain in place and constrains the total fishmeal supply.

- Soybean meal prices are approximately 30% of the FOB cost of fish meal; \$410 / MT for soybean meal compared to \$1420 / MT for fish meal.
- The price of fish meal has been extremely volatile over the past 3 - 4 years, ranging between \$900 - \$1900/ton due to shrinking stocks.
- Fish meal prices will continue rising as fishing bans are implemented and wild fish populations continue depleting due to over fishing.
- **Current fish meal stocks cannot support the growing aquaculture industry and it is unlikely that new sources of fishmeal will be discovered.**
- Advances in developing new amino acid profiles for soybean meal will determine whether soybean meal will be able to completely substitute for fish meal as a feed ingredient in aquaculture production.

Fish Meal vs. Soybean Meal Prices



Source: The Jacobsen; HighQuest Analysis

Alternative protein meals in aquaculture feed

Specialty soybeans and soy isolates will increasingly replace fish meal and other animal proteins.

Alternative feeds for both carnivorous and herbivorous fish are being explored based on the recent increases in feed ingredient prices, particularly soybean meal and fish meal.

- Herbivorous feeds substitutes for tilapia include algae, paraphytin and other grains or oilseed meals including copra, rapeseed, jatropha.
 - **Jatropha** is being researched heavily to be made commercially available, however soybean meal currently has a better nutritional profile and has not acted as a full substitute in most aqua feeds.
 - **Algae** research is being conducted based on ideal nutrition profiles along with how to make the algae commercially available. There are algal oils currently being used in the human food market that contain Omega-3's, however these oils are not economically efficient to extract and therefore are mainly being used in the human food market where retail prices for the products are much higher than fish feeds.
- Alternative feeds for carnivorous species include:
 - **Copepods** can be grown on substrates such as woodchips while also acting as a filtration system, thus this is potentially a low cost way of providing feed (this is not yet a commercial viable option but is being researched as such).
 - **Insect meal** is not commercially available, but could provide a high quality nutrition source for a wider variety of amino acids than vegetable proteins provide.
 - **Fish by-products** include fish heads, tails, entrails, etc. Fish by-products are difficult to use on a large scale as they require expensive container shipment. Fish meal prices would have to continue to rise to make this worthy of investment. In Alaska alone there are 1MMT of fish byproducts produced per year. This is the entire fish meal demand of US fish farm operations and could feed one billion fish. However, the cost to gather and process fish by-products is not competitive with wild caught fish meal prices.

Informed decision making for global agricultural investing

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