

Fish 2.0 Market Report: Fish Feed

An Investor Update on Sustainable Seafood



Fish Feed: Market Tensions Create Opportunities for Innovations

The fish feed industry is primed for a major disruption. A combination of market factors—including decreasing supply, growing demand, and dissatisfaction with current alternatives—is creating an urgent need for innovative new products. The opportunity lies in generating a sustainable source of protein with the required marine-based nutrient profile that satiates not only the needs of the \$144 billion fish farming industry, but also those of the broader \$7 trillion global agriculture industry.

Fish farming, also known as aquaculture, is the world's fastest-growing agriculture sector. Fish feed is an integral component of fish farming: 46% of farmed fish require some form of feed to grow, while the remainder subsist on natural food sources. Fish feed production must increase 8–10% annually to keep pace with aquaculture, but in reality it's declining. Sources of marine-based proteins, a vital feed input traditionally sourced from small, wild fish, are diminishing due to overfishing and climate change.

A new, sustainable solution could support the global fish feed industry's anticipated growth from its current value of approximately \$75 billion to \$123 billion by 2019.

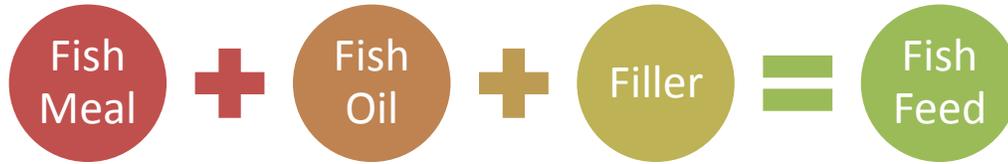
Investors can find opportunities in businesses that are developing new protein sources and complementary technologies, including:

- **Unconventional marine-based protein sources** (such as algae, seaweed, krill, and single cell proteins from microbes and bacteria) as feed inputs
- **Non-marine-based protein sources** (such as insects) as feed inputs
- **Fish farmed for feed**
- **Fish waste innovation**

What Is Fish Feed and How Is It Made?

Almost half (46%) of global aquaculture production relies on *fish feed*, usually in the form of pellets made from a protein and a binding agent. Fish feed is used for fish. *Aquaculture feed* or *aquafeed* is similar but can be used to raise non-fish aquatic species.

Figure 1. Fish Feed Ingredient Structure



Fish Meal

A commodity made from ground, dried fish, and usually produced from forage species such as anchovy and menhaden. Traditionally, feed for carnivorous fish is 30–50% fish meal. Peru is the largest fish meal producer, and exports most of its product to China.

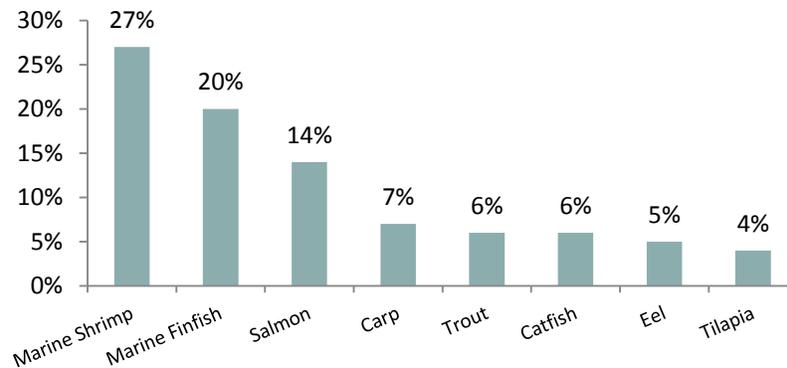
Fish Oil

An ingredient made from oily fish tissue. Approximately 75% of the global fish oil supply is used for fish feed. Chile is the largest fish oil producer. Norway and Denmark are the largest importers of fish oil, which is largely destined for the farmed salmon industry.

Filler

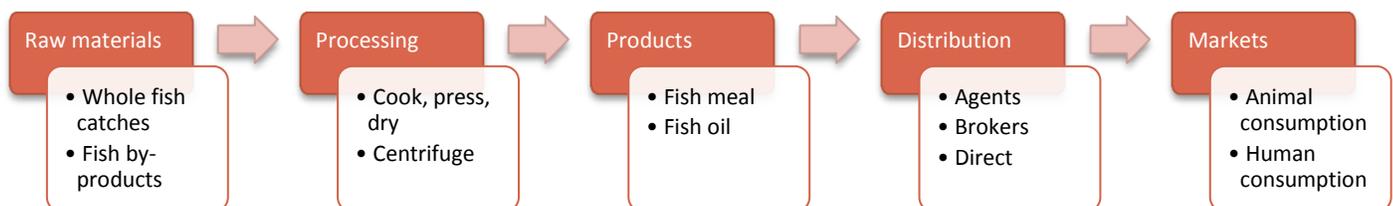
A component of fish feed used to provide proteins and carbohydrates plus vitamins and amino acids, and which binds ingredients into pellets. Wheat is commonly used as a binding agent in shrimp feed. In others, soy may be added as a protein or other additives may be used.

Figure 2. The Percentage of Fish Meal Required in Feeds for Particular Species Varies Greatly



Source: “Aquaculture: global status and trends.” Bostock et al. *Phil. Trans. R. Soc. B* 2010 365 2897–2912; DOI: 10.1098/rstb.2010.0170. Published August 16, 2010.

The Value Chains for Fish Meals and Oils Are Similar



Source: Shepherd, C. J. and Jackson, A. J. (2013), Global fishmeal and fish-oil supply: inputs, outputs and markets^a. *Journal of Fish Biology*, 83: 1046–1066. doi: 10.1111/jfb.12224

Market Challenges and Opportunities

Rising Prices and Volatility Are Disrupting the Concentrated Fish Feed Industry

The prices of fish feed’s key commodity components, fish meal and oil, have increased by more than 260% and 300%, respectively, over the last 20 years.

- China is the largest producer and consumer of fish feed: it accounts for 52% of worldwide feed production and consumes roughly 75% of the global total for its domestic aquaculture operations.
- Peru’s anchovy industry produces 40% of the world’s fish meal and oil by volume; however, it is the most volatile of all large-scale food and agriculture businesses. In 2014, the El Niño weather pattern forced the Peruvian industry’s closure, resulting in revenue losses of \$1 billion.
- Outside of China, four companies currently hold a 35% share of the feed industry, though none has more than 12%. Major feed companies include Ewos, BioMar, Nutreco, Biomin and Cargill. These companies are actively seeking alternatives to fish feed inputs; for example, Skretting (owned by Nutreco) has allocated significant portions of its \$20 million research and development budget to evaluate protein substitutes such as algae, grain and insect meal.

Growing Demand and Dwindling Supply Are Forcing Development of a New Solution

Fish feed prices have increased exponentially over the last decade as demand has outstripped supply.

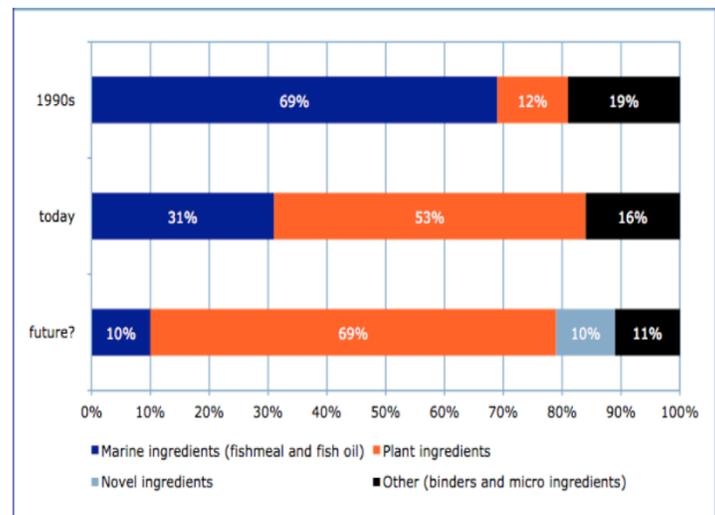
- The feed industry is unable to increase production capacity because stocks of traditional inputs, such as anchovy and menhaden, are declining. Overfishing of small species in the key production regions of Latin America and Europe has caused sources to drop to unsustainable levels, and some species will likely never fully recover.
- Compounding the shortage, fish meal and oil are used not only for aquaculture, but also as an ingredient in common foods. Pet and human food product industries compete with aquaculture for the raw materials used in fish feed.
- Furthermore, the aquaculture industry’s dissatisfaction with current alternatives keeps unmet demand high. These alternatives, which include plant-based sources, animal by-products and vegetable or nut meals, all lack the requisite marine-based protein profile and have varying constraints with respect to cost, supply and sustainability.

Fish Meal’s Status is Shifting from Commodity to Strategic Ingredient

There is a major tension in the fish meal production market: while supply is declining due to overexploitation of fish stocks, demand is increasing from the growing aquaculture industry. According to a recent Rabobank report, fish meal is expected to shift from a commodity feed input to a “strategic marine protein” that commands a premium price.

- Fish meal production has reduced by one-third since the late 1990s and it is expected to further decline.
- Other demand sources, such as pet food and human food industries, pay a premium for fish meal ingredients, increasing pressure on the aquaculture industry.
- Feed producers have reacted by dramatically shifting feed composition since the 1990s. As demonstrated in Figure 4, cheaper plant-based alternatives now account for more than half of salmon fish feed inputs, and fish meal has been reduced by 55%. However, the industry regards these plant ingredients as having anti-nutritional factors, and so must use them in moderation.

Figure 3. Dramatic Shift in Fish Feed Components



Source: Rabobank; EWOS

Investment Opportunities in Fish Feed Markets

Businesses developing new fish feeds still face some important challenges as the industry transitions to new feed ingredients. Investors can get in on the ground floor of the rapidly growing industry.

Challenges	Opportunities
<ul style="list-style-type: none"> Financing access Compromise over product inputs (e.g. overuse of soy) Market acceptance of novel feed ingredients 	<ul style="list-style-type: none"> Sustainable protein solution for the agriculture industry Cost-effective feed Improved supply chain control

According to the recent Rabobank report “The Appeal of Fishmeal” by G. Nikolik, the most promising areas for investment include the following novel ingredients. These substitutes will alleviate the pressures on traditional fish meal sources and will satiate the broader agriculture industry’s need for inclusion of fish meal in animal feed mixtures.

- Algae and Seaweed:** These marine plants possess nutrient profiles very similar to those of small wild fish. Opportunities exist in scaling operations and new technology to cost-effectively grow algae. Numerous emerging businesses in this area are developing innovative processing technologies to capitalize on this unique resource.
- Insects:** Similar to algae and seaweed, insects, particularly those from a marine environment, are a promising fish meal alternative. Currently, costs are too high to make them a viable alternative, but new technologies are developing with promising early results.

- Krill:** Meal made from krill can substitute for fish meal in fish feeds—but a sustainable supply is needed. Opportunities lie in scaling krill-farming operations.
- Farmed Species:** Fish, marine worms, mussels and similar aquatic animals can be used as fish feed inputs. Opportunities exist in fish-farming technology and scaling current farms to achieve low costs. In particular, farming species that require lower feed input, such as tilapia, holds great potential.
- Trimming:** Currently the industry sources 35% of fish meal from *trimmings*, a by-product of processed fish. The majority of fish sold on the global market is unprocessed. As value-added products of seafood proliferate, there will be an opportunity for utilization of fish trimmings. Gathering by-products requires novel methods and sources—for instance, fish markets or restaurants. Furthermore, for the trimming market to expand, so must refrigeration and storage capacity. From a production perspective, China and Thailand currently dominate the trimmings market.

Key Sources

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