

# Executive summary

## Background

In 2007, the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of Agriculture (USDA) began a detailed and inclusive consultation with independent experts, government researchers, stakeholders, and the general public to gather and distill information on alternative feeds for aquaculture. The driver for this effort was, and continues to be agency and stakeholder interest in speeding up the development and commercialization of viable alternatives to the fish meal and fish oil used in aquaculture. The goal of the NOAA-USDA initiative is to identify and prioritize research to develop feeds that will allow the aquaculture industry to increase production in a sustainable way that does not put additional pressure on limited wild fisheries, that maintains the human health benefits of seafood, and that minimizes negative environmental effects of the use of alternatives. For this development to be realistic, the alternative also has to be economically viable. Thus we considered a triple bottom line in our evaluation of alternatives. These bottom lines take in to account the economic, environmental and human health implications (Figure 1) of alternative feed ingredients.

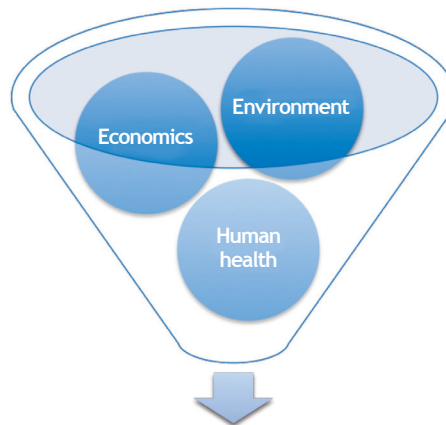


Figure 1

## Feeds for Healthy Sustainable Aquaculture

North America is the world's largest and most advanced producer of formulated animal diets (followed by the European Union and then China). As a world leader in this area, development and approaches



to fish feeds that happen in the United States will help drive change worldwide. It is important to note that even though the US has a relatively small aquaculture sector, developments in aquaculture feeds and advances in technologies and ingredients will have world-wide importance and impact. Currently, the production of feeds for aquaculture worldwide is the most rapidly expanding market in the animal feeds production sector increasing 6-8 percent per year. Aquaculture feeds could represent significant export opportunities for the US feeds sector and their suppliers.

In the United States and worldwide, the development and commercialization of alternative feeds are crucial to the expansion of sustainable finfish and shrimp aquaculture production. Currently, fish meal and fish oil are largely made from small pelagic or reduction fisheries such as anchovies, menhaden, and sardines and from the trimmings of fish processing (both from wild-caught and aquaculture sources). Although the world production of fish meal and fish oil has been relatively constant for the past 20 years, the percentage consumed by aquaculture has risen, now accounting for 60 to 70 percent of the annual production of fish meal and 80 to 90 percent of the annual production of fish oil. Feed for chicken, pork, and pets account for most of the rest, with an increasing percentage of fish oil now going to humans. Pelagic fish are also consumed directly by humans and are used to bait lobster, crab, and fish traps and hooks in commercial and recreational fisheries. As stocks of pelagic or reduction fisheries used for feed, direct consumption, and bait are limited and already fully utilized, alternate sources of protein and oil are needed for aquaculture feeds. As a potential indication of limited supply, the price of fish meal roughly tripled between 2002 and 2010, and supply remains limited while the demand for fish feed ingredients is expected to continue to rise (Figure 2). At the same time, prices for farmed salmon and shrimp have been steady or even declined.

Environmental considerations may also limit supply. Pelagic fish provide important ecosystem benefits to the marine environment. Although most industrial fisheries are well regulated by catch limits, increased demand for use of forage fish in direct human consumption, for bait, for use in aquaculture and agriculture could provide an incentive to over exploit these fisheries, with negative consequences for the marine environment. Also, changes in fisheries management may further limit supplies of forage fish available. In particular, fisheries managed according to single



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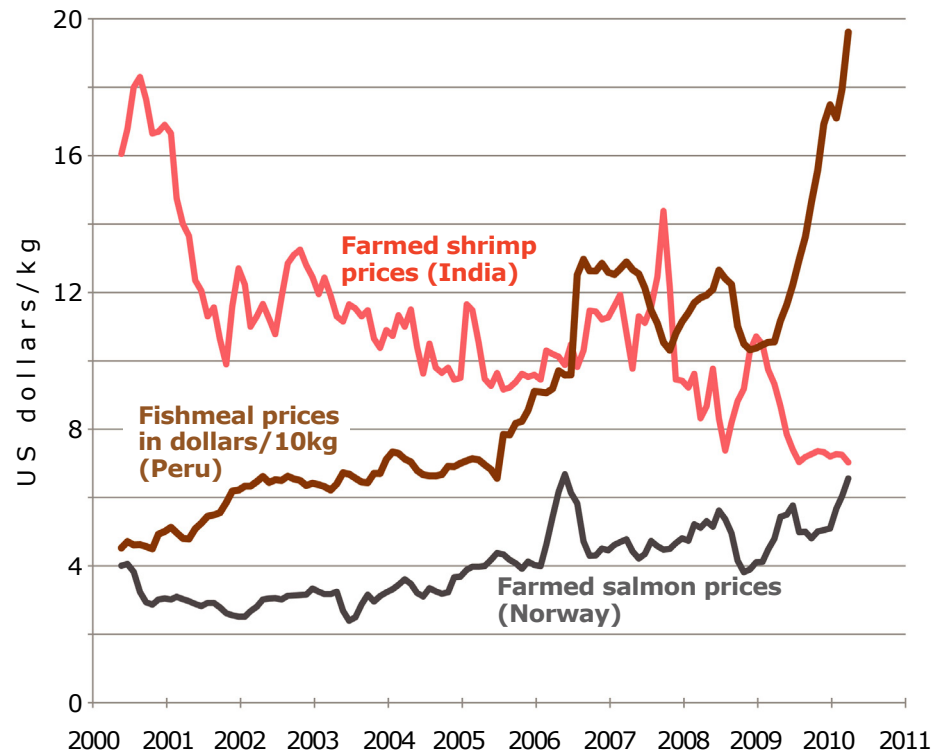


Figure 2  
Changes in prices of fishmeal, farmed salmon, and farmed shrimp from 2000-2010.

species sustainable yield measures may not be sustainable from an ecosystem perspective if the importance of forage fish to other animals in the ecosystem is not accounted for. Catch limits or quotas may be reduced to leave a greater supply of forage fish in the oceans to support ecosystem functions.

Developing alternatives to fish meal and fish oil is a global challenge for several reasons. Fish meal and fish oil are worldwide commodities. Asia consumes the majority of fish meal, Europe (especially Norway) is the dominant consumer of fish oil, and South America produces the bulk of both fish meal and fish oil. Fish meal and fish oil are commodities that are traded worldwide. The US is a small player in this market with little control over prices or quantities sold. In addition, the concentrated nature of the product makes supply vulnerable to perturbation, as evidenced by the 2010 earthquake in Chile.





The United States is a small net exporter of fish meal and oil. In 2007 the United States used about 190,000 metric tons of fish meal and 38,250 metric tons of fish oil. Net exports were about 65,500 metric tons of fish meal and 31,000 metric tons of fish oil. Consumption in the United States is mostly for feeds for all types of livestock and pets. A portion of the catch of menhaden, sardines, herring, and anchovies are used for bait for commercial and recreational fishing, fish oil tablets for human consumption, and fertilizer. The majority of fishmeal produced in the United States comes from menhaden, caught in the Gulf and Atlantic followed by meal made from the processing wastes of whitefish caught for human consumption from Alaska. US stocks caught for fish meal and oil production are well regulated under strict management plans mandated by federal law and are not overfished.

This global challenge also represents an opportunity for US agriculture products, seafood processors, and other alternative feed ingredient producers, particularly in supplying Asia where most aquaculture production occurs. The opportunities for US feed and feedstuff suppliers could be significant, and the United States is well poised to take advantage of this opportunity due to our strong agriculture production sector, quality fish nutrition labs, and developed feeds infrastructure.

In November 2007, NOAA and USDA launched the Alternative Feeds Initiative with a solicitation for public comments on several specific questions related to alternative feeds for aquaculture. The questions, which were published in a Federal Register notice included the following:

1. Where should the federal government focus its research efforts in the area of alternative feeds for aquaculture? Are there specific areas that the federal government should not address?
2. What are potential alternative sources of protein and oil for aquaculture feeds? For example, are there specific opportunities for greater use of seafood processing waste and other agricultural by-products in aquaculture feeds? Are there specific obstacles to using these alternatives as alternative dietary ingredients in aquaculture feed?
3. What type of treatments or processes show promise for improvement of existing aquaculture feedstuffs and for developing new feedstuffs? How soon could these technologies be commercialized?



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4. Fish meal and fish oil contribute important human nutritional components to aquaculture feeds such as omega-3 fatty acids. If the aquaculture feeds industry seeks to replace fish meal and fish oil with alternatives, how can the nutritional benefits of farmed seafood be maintained or enhanced? For example, what technologies exist for producing omega-3 fatty acids?

Following the initial public comment phase, NOAA and USDA assembled expert panels to address these same four questions and to identify other issues for consideration in the preparation of a rational, fact-based plan to identify and prioritize research and development needs. The initiative's first panel was composed of scientists with expertise in feeds and feed ingredient research, fish and human nutrition, bioenergy, processing, agriculture, and related areas. The second panel was composed of stakeholders from academia, industry, non-government organizations, and government who had expertise and/or interest in the topic. Government officials with responsibility for research, funding priorities, regulations, and policy observed panel workshops.

In addition to answering the Federal Register questions, panels were asked to identify constraints and concerns about feed ingredients—those currently in use and those that might be used in the future. Panels were also asked to identify possible solutions to the challenge of replacing fish meal and fish oil in future feeds, identify key research and technological challenges associated with developing viable alternate protein and oil sources, and predict the future of feeds for aquaculture—specifically, the challenges and changes that aquaculture will face and the developments that will affect both producers and consumers in next 5 years and in the next 25 years.

A brief summary of panel findings and conclusions follows. Several researchers and other experts were also asked to develop short case studies to highlight specific advances being made in the development of alternative ingredients. Those case studies are included right after the summary of findings.

