

## **“WHAT FARMED FISH EAT” DISCUSSED AT BOSTON SEAFOOD SHOW PANEL SESSION**

The question of “What Farmed Fish Eat” was the subject of the first panel session at the 2011 International Boston Seafood Show last month. A panel of experts in aquafeeds gathered to discuss recent advances in feed research and industry progress towards sustainability. The panel was moderated by Steven Hart, Director of Aquaculture at the Indiana Soybean Alliance, and included:

- Richard Nelson, Manager of Purchasing at Silver Cup Feeds, a fish feed provider
- Mike Hickerson, Director of Sales at Bell Aquaculture, a producer of farm-raised yellow perch in Indiana;
- Jeff Silverstein, Director of the Aquaculture Program at the Agriculture Research Service of the U.S. Department of Agriculture;
- Mike Cremer, Director of the Global Aquaculture Program with the U.S. Soybean Export Council. He also has experience in fish nutrition; and
- George Leonard, Director of Aquaculture Programming for the Ocean Conservancy, an environmental NGO.

Steven Hart began the session with a look at the growth of world aquaculture, which is currently around 7% per year. In 2011, farm-raised seafood became equal in volume with wild catch for human consumption. The traditional feed for fish has been a fishmeal-based diet for many years, and the ocean supplies of fishmeal are at their maximum sustained yield.

“This increased volume, obviously, is a major issue in feed formulation for aquaculture. The price of fishmeal has sky-rocketed and is at an all-time high. Because of that, the feed industry is looking for alternatives,” said Hart.

For example, in 2002, aquaculture used about 45% of the available fishmeal in the world. As recent as 2006, that was up to 57%, and that number is even higher now. Of particular concern is the Fish In:Fish Out ratio, which is how many pounds of fishmeal go into a pound of final farmed product. At the start of the aquaculture industry, those numbers were as high as 5:1, and have since improved to closer to 2:1 or even lower. Hart asserted, “If sustainable aquaculture is to grow at the rates needed to meet increased demand, that number’s going to have to come down a lot lower than even 1:1.”

Jeff Silverstein from Agriculture Research Service of the USDA then gave an overview of the USDA/NOAA Alternative Feeds Initiative and the Plant Products and Aquafeeds Group, an NGO alliance of researchers interested in developing primarily plant-based alternatives to fishmeal.

“As we’re looking for alternatives to the limited supply of fishmeal, we’re really trying to maintain what we call a “triple bottom line,” said Silverstein, which includes:

- The human health benefits of seafood – the good taste, the excellent protein source, and the excellent lipid or fat profile that we get from seafood;
- Alternative feeds that will maintain the economic sustainability of aquaculture. Identifying alternative ingredients and increasing that ingredient pool helps to maintain costs, as less expensive substitutions can be made when one ingredient climbs in price; and
- Maintaining environmental sustainability -- growing more fish with less impact.

The Alternative Feeds Initiative program focuses on a number of areas, such as:

- Understanding the nutrient requirements of the species that we grow. What are the amino acids and fatty acids they need for good health, and how can our diets deliver that? Species studied include trout, salmon, hybrid striped bass, pompano, cobia, and channel catfish.
- Alternative proteins such as soy, barley, and algal meals – all bio-fuel co-products, which provide an abundant supply of lower cost material.
- The composition and palatability of nutrients in those products, to ensure that the fish will eat it.
- Feed digestibility, and how much of the nutrients are available to the fish. Even if there's a lot of energy in the feed, if it's not digestible, the fish don't get anything from it.
- The functionality of the material --to ensure the feed stays together in the water until the fish eat it, characteristics such as water durability, expansion, ability to absorb oil, and others are studied.
- The growth rate of the fish on these ingredients, and the conversion rate of feed to flesh, Fish In:Fish Out.
- The quality of the resulting consumer product.
- Finally, in addition to feed research, the genetics and health of the fish, and how this all works together with the nutrients for a production system.

Silverstein also explained ways that the ARS partners with industry with cooperative research agreements. "Our work plans are reviewed with industry to make sure that the research we're planning is relevant, and that we're asking questions that are important for industry," said Silverstein.

"We work hard to get the information that we generate out to industry by making data from evaluations of hundreds of ingredients a year publicly available through websites," said Silverstein.

He also noted that the ARS research program has the unique capability of making commercial quality materials to test on a very small scale, which is a valuable resource for the feed industry.

Richard Nelson, then spoke about Silver Cup, which has been producing feeds in the United States for half a century, primarily for freshwater finfish. Silver Cup produces feed for both the food fish aquaculture industry, and a wide group of conservation and mitigation operations represented by state and federal governments, that grow fish for stock enhancement and various reasons.

"What's involved in a procurement process of buying raw materials?" Nelson asked. "I have to deal with about 90 to 100 different products grouped in generic classes: proteins, fats, carbohydrates, vitamins, minerals, some types of conditioning, groups of things that might affect the PH balance in feed, things that might provide antioxidant characteristics, mold inhibitions. And, there are some items that go into feeds that help us to actually make the feed itself. In some diets, there is also some pigmentation that goes in for coloring the fillets, which is not a "dye" – it's a natural microbe that is what salmon consume in the wild."

The analysis of the value of any particular product comes down to the bio-availability of the nutrients, such as amino acids, fatty acids, sugars, and carbohydrates. Nelson noted that because fish want protein and fat, much of the focus is on amino acid and fatty acid contributions to diets. Also of consideration is whether or not these products are readily available, and the economic viability of a feed

manufacturer being able to pass along the cost of those feeds at a level that a farmer can produce fish and market them.

Mike Hickerson from Bell Aquaculture, an inland yellow perch recirculating farm in Indiana, said that, “We want aquafeeds that will produce the quickest turn of weight on our fish so that I can sell them in a timely fashion.” Bell expects to produce about nine million yellow perch per year indoors, in freshwater tanks. The company is vertically integrated, raising fish from brood stock through to final processing in their own facility.

“We have been producing fish and processing fish for about the last two and a half years,” said Hickerson, “and we’re working with a couple of other products --blue gill and striped bass -- to see if we can broaden our market and take it one step further.”

The next panelist said that most people don’t know that the U.S. soybean industry has one of the largest aquaculture programs in the world. Michael Cremer from the U.S. Soybean Export Council explained that the soybean industry has a check-off program, where they set aside one-half of one percent of all soybean sales in the United States, to target funds for market development, including in aquaculture.

“We work with aquaculture producing countries around the world to develop sustainable production technologies and sustainable feeds and food safety issues,” said Cremer. “We’ve had a very successful program in developing sustainable soy-based feeds for most of the major production species around the world. We work very actively with not only the fish producers, but also the feed milling industries and other ancillary industries to develop that capability for sustainable feeds for this very significant and growing aquaculture industry.”

Cremer referenced projections from FAO and other groups for the requirement of another 40 to 100 million tons of seafood products that are all going to have to come from aquaculture. “It’s quickly quite obvious that, as valuable a resource as fishmeal is, there’s not enough produced in the world to adequately sustain feeds for this growing industry,” he stated. “So, we’re working very hard to find alternative protein sources for those feeds, and we’re positioning soy in those markets as one of those major components of aquaculture feeds for the future.”

When asked by Hart what is the biggest success story of USSEC’s Aquaculture Program, Cremer pointed to China. “When we first went into China, total aquaculture production in the country was maybe four million tons of freshwater production. There were no feeds produced there at all – they used all filter-based and manure-based production. That industry has grown into a 23 metric ton production industry that’s about 80% feed-based now. We’ve worked with the industry with the production sector, and with the feed manufacturing sector to develop all plant protein feeds for essentially all the major freshwater production species in China.”

Cremer said that there has also been success over the last decade in significantly reducing the amount of fishmeal that goes into a wide variety of marine species that are being cultured around the world. “Our ultimate target is to get that fishmeal inclusion down to about 15% of the protein requirement of those feeds,” he said, “by providing alternative ingredients that are much more sustainable and available on a global basis.”

As Steven Hart introduced the next panelist as the one NGO representative on the panel, he noted that the industry needs to partner with NGOs to develop sustainable aquaculture, as they help to define what sustainable aquaculture is.

Representing Ocean Conservancy, a national conservation organization headquartered in D.C., George Leonard said that, as advocates for wild, healthy oceans, “We approach the issue of aquaculture not from the industry side, but from the ocean side.” He stated that reason why many in the conservation community are concerned about aquaculture is the connection between the industry and the wild fisheries through the use of feed.

“If we want aquaculture to ultimately be true farming, then we need to figure out a way to break that link into aquaculture through the use of wild forage fish for feed,” said Leonard.

Fishmeal and fish oil comes from a whole range of forage fish species around the world, which are a critical link between sunlight and most of the other major large, charismatic mega fauna. “Whether it’s fish we consume like tuna and sharks and billfish, or also things like whales, dolphins, birds and a whole host of other species,” Leonard said, “these are critical in terms of functional ecosystems.”

Leonard said there was no silver bullet in terms of solutions to break that link. He posited that there are essentially four “R’s” of aquaculture with respect to a conservationist perspective on aquafeed: Reduce, Reform, Replace and Reevaluate.

We need to **Reduce** the use of fishmeal and fish oil inclusion rates in farmed species by increasing the feed conversion ratio (FCR). “There’s actually been a huge amount of progress in the last ten years, driven largely by the industry in terms of reducing inclusion rates of fishmeal and fish oil,” said Leonard. “I think we in the conservation community need to recognize that improvement. At the same time, it’s important that we struggle with the question of individual impacts versus cumulative impacts.” Even though the industry is making improvements, because industry at the global scale is outpacing the improvements at the individual level, there is continuing pressure on ocean ecosystems.

The second R is the **Reform** issue. “Many of us in the conservation side are not saying we can’t use any fishmeal and fish oil, or any forage fish in this industry,” said Leonard. “But, as a consequence, we need to make sure that the management systems for the capture of those wild forage fish are strong. In particular, we need to grapple with the concept of ecosystem-based management, which is leaving some forage fish in the oceans for those other species, and to think beyond single species management of those fish.”

The third R is the **Replacement** side of this issue. Leonard listed a diversity of alternative feedstuff categories that can replace fishmeal and fish oil, including:

- Plant-based proteins -- a wide diversity of suitable proteins and oils that can be derived from plant proteins.
- Seafood processing by-products -- the ultimate in recycling from an ecological perspective, if we use those by-products from sustainable fisheries, not those that may have some of their own environmental challenges.
- Oils and meals derived from single cell products -- macroalgae, microalgae, bacteria, and yeasts.

- Animal by-products --a diversity of animal products that could be used from a nutritional standpoint, but there are lingering concerns about disease transfer, and how the public will feel about the use of those products in wild fish.

The fourth R is **Reevaluate**. “We need to think very carefully about the environmental tradeoffs of one use of product for the other,” said Leonard. “We are concerned about the environmental impacts of the use of forage fish, but we do not want to be promoting things, either wittingly or unwittingly, that will result in a larger environmental footprint somewhere else that we haven’t really thought through carefully.”

Leonard stated that the Ocean Conservancy wants aquaculture to be a part of the solution, and if these challenges are not grappled with, it’ll be part of the problem. “Aquaculture really has to be part of our future seafood supply, and we want to make sure that we get it right so that we can have our fish and eat them, too.”

Following are highlights from the question and answer period with the panel.

**HART:** George, are feed alternatives the only way to improve the sustainability of aquaculture, or what are some other areas that Ocean Conservancy is working on?

**LEONARD:** While the feed issue is an important issue, there are ongoing concerns about environmental impacts associated with open net pen culture in general, and farmed salmon in particular. We need a comprehensive approach to addressing those issues, and the feed issue should be looked at in the context of that. There can be unintended consequences by changing feed diets that actually have impacts on the amount of waste released, for example. Some are on the positive, some on the negative side.

One of the other challenging major, which is very controllable, is the risk of disease transfer from open cage culture. There is an ongoing controversy around salmon farming, and there’s a very large body of research that suggests this is a legitimate concern, both from a theoretical standpoint, as well as data in the field. Many argue for land-based aquaculture as the only solution. Certainly, the kinds of things being done by Bell really help resolve a lot of these issues, but I think we also need to think creatively about where we go with respect to ocean aquaculture, and not necessarily polarize those issues.

**HART:** Richard, from the feed industry’s standpoint, when people start talking about sustainable products and food safety, how does Silver Cup go about assessing raw materials for use in aquaculture in relation to those two points?

**NELSON:** A whole movement in the food industry that is heavily affecting agriculture is the higher level of food safety testing and traceability.

My company is part of the Skretting Group, which has a program for being able to trace raw materials from lot control of where they were produced, how we acquired them, how they were mixed into feeds, and where those feeds went. We have the ability to tell both our client and a government agency, if that would ever come to it, where those materials came from. However, as any good HACCP

program would have it, you want to be able to recognize critical paths where problems can occur, and deal with them as soon as they occur.

There's a long list of actual microbiological testing for toxins that have been identified as likely to occur, and any particular feed ingredient is tested for those. That's in addition to testing for qualitative evaluations for bioavailability of nutrients themselves. The industry is only going to go in one direction, and that's for higher and higher standards.

**HART:** Jeff, can you give us an example of a major breakthrough that ARS has had in the development of alternative feeds?

**SILVERSTEIN:** Just last year there was a new vitamin mix released by ARS called Vitamix 702. This is important because the last formulation of a vitamin mix – and this goes in with all the other ingredients to make sure that the micronutrients are available to the fish – was about 40 years ago.

Because of new processing methods, extrusion methods for making feed, there's more heat applied and expansion, and there are new ingredients being used. As you reduce the amount of fishmeal, you need to supplement for the micronutrients fishmeal carries. This new vitamin mix is critical to some of the new diets and new pelleting methods. This was a culmination of research by ARS and many others.

**HART:** Mike Cremer, in the U.S., shrimp is the number one consumed type of seafood in the country. Can you tell us about what work you've been doing and what work's been done globally to address the sustainability issues with shrimp farming?

**CREMER:** Most of our efforts have dealt with the feed sustainability side of the shrimp industry. We've had a major effort for several years now to develop plant protein-based diets with a high level of soy for marine shrimp, specifically Vannamei. We're in the process now of transferring that technology out to industry through on-farm feeding demonstrations to show the value -- both the economic and the productivity value – of those plant protein-based diets for shrimp. We have ongoing feeding demonstrations in Southeast Asia, China, and in a number of countries in Latin America.

**HART:** George, what type of promotion or work do you do around these alternative feeds in aquaculture, and how do you get that to both industry and the consumer end?

**LEONARD:** I can identify three things that we've been doing on this front.

One is work that I got started when I was the Science Manager for the Seafood Watch program in California. We were the guys that put out the card with the red, yellow and green lists, which you love if you're on the green list and hate if you're on the red list. Part of that work was developing very specific criteria about sustainable fisheries and aquaculture, with specific Fish In:Fish Out numbers in the aquaculture piece. We ended up having a dialogue with Neil Sims from Kona Blue in Hawaii around that issue. He got very intrigued about how he could improve where his score fell on the card. That resulted in a very productive relationship that resulted in him altering his feed, such that we thought it was in a more sustainable place. He used a series of alternatives to fishmeal and fish oil and reduced those

numbers so that the math worked out. I think that kind of collaboration between industry and NGO is a useful one.

At Ocean Conservancy, I'm a steering committee member on one of the aquaculture dialogues being run by the World Wildlife Fund. This is the SCAD, the Seriola Cobia Dialogue, which would essentially be the first dialogue for an offshore farm species. In that work, one of the criteria is feed. I think there's been a pretty good dialogue between industry members and conservation folks on that issue.

If you step back from that dialogue to the work that WWF is doing on the host of the dialogues, there's a lot of cross-talk among the dialogues about whether there should be some sort of universal standard, if you will, on the feed side. I think that work is both collaborative and necessary at the broadest of levels.

**HART:** Mike Hickerson, have your customers been asking what you are doing to reduce the amount of fishmeal in your feeds, and do you think this is going to become an even bigger focus of your business and the industry in general in the coming years?

**HICKERSON:** A few customers, some distributors and large restaurants will ask what we're doing as far as our fishmeal is concerned. We're very open about what we do and tell them a lot about the Soybean Alliance and some of those additions that we've made.

But, really, it's not a huge issue with them. We have a product that's very good and sells very well and has been very successful.

**AUDIENCE QUESTION:** Richard, what's the latest on sourcing by-products from fish processing? What's the availability and which kinds of by-products are working well or not working well? What other sort of alternative proteins are you finding most promising right now?

**NELSON:** We've been sourcing fish by-products for a long time, but not all of the wild catch industry has been capable of producing the fishmeal and oil as by-product from processing waste. There is work going on in Alaska, for example, to try to vastly increase the number of those factory ships that catch and process fish for human consumption. That would increase what could be called waste material, but really is nutrient material that can be available for processing. The problem is how do you store that on a ship and get it back to a land-based operation to be able to process it. One of the big solutions is to process it at sea, just like they do with the main products that they are processing.

What tends to happen to some of those meals, though, is that they're very high in bone, and high in ash which is somewhat of a pollutant, phosphorus mainly.

To segue to alternatives, we're very pleased with the direction that industry is going in terms of producing vegetable concentrates. Some of them have made their way into the food industry quite some time ago, like soy protein concentrate. They've been able to remove most of the carbohydrate from that material, and because carbohydrate is not something that fish really need, and in some cases, is actually anti-nutritional, we like the soy concentrate products.

Finally, there are co-products from bio-fuels that are now being produced with grain and seed protein material. They extract all the sugars out of the grains and increase protein levels, and that type of product fits right into my mix.

A bigger challenge is lipid replacement. Because fish oil is a primary source of Omega 3 fatty acids, which are not only a nutrient requirement of the fish itself, but we also want to pass along those valuable nutrients to the human consumer. So, we're really jazzed about the emergence of the algae industry, and again, the co-products involved. The big input of algae development right now is in fuels. There are emerging industries that are producing algae to extract the oil, which is high in Omega 3's, particularly DHA. That can be a replacement of fish oil that we have to remove from the diet.

**HART:** Mike Cremer, can you talk about the work the soy industry is doing in developing alternative lipids that can help address the human health issue?

**CREMER:** We're helping fund research to look at whether we can adjust the lipid regimes in diets over the life of the species that are produced. For example, if you can substitute less expensive and more readily available plant lipids for the majority of the fish's productive cycle in an aquaculture system, and then finish off the diet with fish oil that's more expensive and less readily available, that gives you the Omega 3 fatty acid balance you want in that finished product for human consumption. Then, you're addressing the issue of both sustainability in terms of product availability, and the human health issue at the same time.

We're also looking at the potential in the future for new soy oil opportunities that would provide those Omega 3 fatty acids. From my perspective, working around the world in the global aquaculture industry, I think that the lipid issue is maybe the most critical issue we're facing right now for aquaculture feeds.

**NELSON:** As was mentioned before, the availability of wild pelagic fish, forage fish, as a source of fishmeal, is finite. It's capped. And, over time, it's going to decrease. So what happens when you have a growing aquaculture industry worldwide that is going after a finite resource? Well, price tends to be the first thing that responds to that demand. We in the feed industry obviously have to deal with this all the time. We're once again going through another cycle where prices on fishmeal and fish oil are at almost industry highs right now. The last time this occurred was three years ago in 2008.

The bottom line is that's probably not going to go away. That's always going to continue to plague the industry. As much as we like to cooperate and work with the NGOs on the issues of sustainability, I have to say that, just like everything else in our lives, economics is a big driver. That will have a big influence on the feed industry to look at alternatives very rapidly.