Additional Questions from the F3 Webinar: Soy Ingredients in Aquafeeds

All Panelists

1. Thank you for the interesting talk, I think that Soy (as mentioned by Lukas) will be used indefinitely by aquaculture. However, we are seeing mandates from major aquaculture companies (biomar, mowi, skretting) and retailers (in the EU certainly) about either **reducing the use of or validating sustainability of soy products especially through increased audits... I was wondering if the panelists could comment on this?** Is it in their opinion a reasonable position? Has it made a difference to their operations? Do they hope to see a number of these special mandates reduce in future?
    - Lukas Manomaitis, USSEC Answer: I stand by the assertion that soy will continue to be a key ingredient for aquaculture for the long term for a simple reason. As far as land-based proteins go, soy is the key protein source due to its high protein density, global production area and volume, widely understood characteristics, global availability, and competitive cost. In all ingredients and byproducts (in fact everything humans produce) we will need to see better traceability and attention to sustainability. What you are seeing now in regards to questions about soy is being driven by the need by the aquaculture industry to drill down and highlight and encourage sustainability across the entire production chain. This is not a special mandate in my mind, it is something that everyone should have already been doing as a good business practice and as a responsible global industry. I suspect that the real impetus for this was the discovery of slave labor-type conditions on fishing boats that were supply fish for fishmeal/oil production. Companies began to realize that something that was "out of their control" could still have a significant negative impact on their operations and business. So it is reasonable to expect companies will pay more attention to everything that is required to keep operating. It has made a difference in operations, you can see this easily by the new directors of sustainability and advertising focus on sustainability as a key value to companies. Getting back to soy this is why the US soy industry developed the Sustainable Soybean Assurance Protocol (SSAP), to help address concerns by buyers about how the soy they purchased was produced. The efforts of the Round Table on Responsible Soy (RTRS) and Proterra are other examples. Particularly in the past few years where Brazil has been singled out for destruction of the Amazon to increase planting as it has become more visible – literally with news organizations show satellite photos of massive fires. Will this mean that companies will move away from soy entirely? I don't believe so, as soy is too useful an ingredient for aquaculture, but we will see more attention to the sustainability aspect as a key issue (for other ingredients as well).
    - Dr. Suresh Menon, Menon Renewable Products Answer: Soybeans consume tremendous amounts of water and energy from growing to harvest and post processing. In time, with the human population consuming this grain source there will be increasing pressure on this resource and will become classified as unsustainable. This is our projection. As soon as we start clearing land to grow

more of this grain it is proof that it is becoming unsustainable. We predict this ingredient will be replaced by processing agriculture waste byproducts in near future.

- Hannah Lucas, Benson Hill Biosystems Answer: Benson Hill appreciates the leadership of retailers and feed companies in addressing consumer and industry value for environmental stewardship. Soy is an extremely productive and efficient land-based protein source, and its sustainability has appropriately come under scrutiny from land use change, particularly in South America. Sustainability is core to Benson Hill's values, and we intend to be part of the solution. In addition to our ingredients being Non-GMO certified and effective in aquaculture rations without extensive processing, our grower partners in North America are among the most efficient producers and there is no associated land use change. Through their efficiency and strong logistics our products can reach anywhere in the world with an extremely low footprint as quantified by LCA.
  We will continue to improve our products by boosting protein and reducing anti-nutritional factors to boost feed conversion efficiency. In partnership with our farmers, we plan to encourage adoption of regenerative agriculture practices, such as no-till and cover cropping. By our focus on efficiency and promoting soil carbon sequestration as a drawdown solution we believe there is a path to net-zero feed ingredients. We are excited to realize this vision with dedicated partners such as Biomar, Mowi, and Skretting.
- Zhijun Hu, Jiangsu Fuhai Biotech Company Answer: The resources on the earth are always insufficient. We should utilize plant protein to be more efficient. Biotech may be helpful.

2. In diversification of fish feeds and management of locusts, I have been thinking of the use of **locusts as fish feeds**. What lessons can we learn first from the experts on the potential of this feed source, and as we think of reducing related problems from locust invasions?
    - Lukas Manomaitis, USSEC Answer: I mentioned that the future of aquaculture (and in fact all livestock) production is for more flexibility. This is why I anticipate that we will have a wide diversity of ingredients being brought into the feed complex for aquaculture as we move away from the former mainstays of FM and FO (or marine aquatic animals in general). There will still be some key ingredients, like soy, but to meet the nutritional requirements other ingredients will need to be used. Aside from cost, this will be decided partly on availability (what can the feedmills get locally and what has to be imported), quality (both the physical/chemical quality as well as a clear understanding of the nutrient package in each ingredient), consistency (an ingredient that is widely inconsistent by batch is frustrating to use), and of course sustainability (a key issue that is only going to become more important). You mention locusts, but insect meal of any source (or "microlivestock") will have a place. I believe locust meal has already been used, for example in Pakistan, for feeds, and locusts are also used as human food. This is just another example of the variety of ingredients we might use in

aquaculture formulations. As long as we understand them well and can quantify the nutrient and use characteristics almost any ingredient can be put into a database and feed formulation program for possible use.
As an aside, as this was a very specific question, I assume that this is asking about using locust meal (not actual locusts) as an ingredient in aquaculture feeds. If planning to use locusts from a swarm to make locust meal, before investing a lot in this, make sure to understand the nutrient quality and parameters of locust meal and make an economic analysis of whether it is worthwhile. Second, make sure that the locusts are obtained without contaminants, i.e. pesticides or chemicals. Finally, unless there is a plan to breed locusts as an ingredient source, remember that the use will likely be transitory as this is not a crop, but something (a swarm) that happens every once in a while. This is why ingredients like soy are so useful and are a key ingredient in aquafeeds. A feedmill can get soy anytime, has the knowledge how to use different soy products in formulations, can obtain it in whatever quantity desired, and can usually purchase it at a very competitive price. I wouldn't want to invest a lot to process a novel ingredient that has an erratic supply like waiting for a locust swarm. That being said, in specific situations novel ingredients like locust meal might make sense as part of the formulation.

- Dr. Suresh Menon, Menon Renewable Products Answer: We do not have experience utilizing this ingredient and have not seen enough data on commercial scale published
- Zhijun Hu, Jiangsu Fuhai Biotech Company Answer: Some ideas look good but may be difficult to apply at a larger commercial scale.

3. When you assess this alternative ingredient, **do you consider the impact of soy on fish health under extreme environmental conditions**? For example heat stress or hypoxia.
    - Lukas Manomaitis, USSEC Answer: I am not sure that this is a concern specific to an ingredient, or soy. Soy is no longer an alternative ingredient, it is a common key ingredient in most aquaculture formulations. Fish/shrimp health and aquaculture health management in general is a key area that aquaculture fails on a lot. Too many push production systems too hard for too long, and biology eventually catches up. This is not about an ingredient impacting the health, but about managing a production system to provide the right environment and feeds for optimal results. Feeds can be functional and help in health management, for example boosting certain vitamins, fatty acids, phospholipids, etc. during (or better before) potential stressful conditions. It is also about understanding the organism being cultured, making sure that the feeds are formulated to that species and life stage, and considering how the culture system conditions are managed for that species. But a poorly run or managed production system without attention to a health management approach will almost certainly lead to issues, no matter what the feed or ingredients are.

- Dr. Suresh Menon, Menon Renewable Products Answer: We design experiments to alternate inclusion of soy, poultry meal and other ingredients that can replace fishmeal in controls to consider its effects. Due to digestibility factors it is very hard to outperform fishmeal except in the case of utilizing MrFeed®. Extreme conditions such as disease challenges, temperature changes, pH changes all affect enzyme regulation in animals. Introducing high levels of soymeal due to its anti-nutritional factors require adding certain other ingredients to offset enzyme imbalance.
- Zhijun Hu, Jiangsu Fuhai Biotech Company Answer: Ingredients can't solve everything. We should consider directly applying medicine for special symptoms. Soy peptide may be helpful.

4. **How do algae proteins or peptides compare with those of soy proteins or peptides as fish feed?** The former would be more sustainable due to their high productivity and land and energy use per unit protein.
    - Lukas Manomaitis, USSEC Answer: I noted before that there is likely a role for a wide variety of ingredients in aquaculture. **Soy happens to be a useful one because of its characteristics and price.** Algal products have a lot of utility as well, and in fact might have a greater role in aquaculture formulations if it was not for the price. At present algal proteins and algal oils are still fairly expensive, and often the value goes to direct human consumption rather than livestock. I come from the USA and I largely believe in a (managed) capitalist approach to this, the market will decide what makes sense in a given situation. (The "managed" means that there are going to be other issues other than price that impact choices, i.e. sustainability, etc.) USSEC has worked to show the utility of algal products in combination with soy products (often algal oils). I note that often the algal producers are not looking at this the same way, offering a "total solution" using only algal products, but I don't agree with that approach. Just as we don't believe soy is the only solution we don't believe that algae is the only solution. There is a place for many ingredients in aquaculture based on utility, geography, availability and price. I obviously believe strongly in the value of soy in aquaculture, and feel that value will continue to be competitive moving into the future. But soy can't do it alone, we need to see other ingredients enter the feed complex as we expand the industry and need more and more feeds.
    - Dr. Suresh Menon, Menon Renewable Products Answer: Not all proteins are equal and not all peptides are equal either. Overall certain peptides do much better than soy proteins or fishmeal due to their structures. Although algae can be grown due to high productivity, its digestibility is a big concern. Digestibility of peptides from algae is an issue in the GI tract. To dry the algae and extract peptides through a separation process is very expensive and hence not scalable anyway. Various algae also carry metabolites whose studies are limited at this time.
    - Zhijun Hu, Jiangsu Fuhai Biotech Company Answer: The cost of Fatide as a soy peptide is very competitive. Would you like to compare?

Zhijun Hu

1. Could you please let me know how much iron content in enzyme-treated soybean?
    - Zhijun Hu, Jiangsu Fuhai Biotech Company Answer: 150 mg/kg, method BS EN ISO 17294-2 2016 mod, by eurofins, 2020-3-23.

2. How does the higher content of iron in enzyme-treated soybean have an adverse effect on aquatic animals?
    - Zhijun Hu, Jiangsu Fuhai Biotech Company Answer: The iron content of soy may be higher in South American but lower in the U.S. Usually we purchase soy from the U.S. We don't add any iron in the process. The data in our product looks normal. We have used about 40% Fatide in the feed formulations of shrimp and largemouth bass when growing for 2 months, and haven't found any adverse effect.