

Additional Questions from the F3 Webinar:
Single-Cell & Novel Proteins in Aquafeeds

All Panelists

1. What do you think the market for single-cell or novel proteins will look like in 2030? And in the 5-6mil mt fishmeal market, how much can be substituted by SCP or other novel proteins?
 - Mark Rottmann, iCell Sustainable Nutrition Answer: Hundreds of thousands of tons of SCPs from many different processes. The total demand for protein and aquaculture feeds and omega 3's will continue to grow, so the 5-6mil mt fishmeal will persist, but becomes a lower inclusion rate in the diets.
 - Dr. Peter Williams, Green Plains Answer: A recent market estimate is that by 2026 the global alternative protein market for animal feed application will be 3,172 kilo tons valued at \$4,500 mill. Diets for salmonids have already been produced without the use of fishmeal. Fish waste products will always be available for low concentration inclusion in diets for aquaculture. A mixture of different alternative proteins including grain-based proteins can be used to totally replace fishmeal. The success of single cell proteins will be dependent on the production of the products in commercially viable quantities, with resilience in the supply chain and totally regulatory compliant products.
 - Mike Cici, The Scoular Company Answer: Depending on market pressure both on the supply side and demand will decide but would hope larger and more economical to allow all in that supply chain (ingredient producer to end user consumer) to benefit financially and environmentally. As more novel & SCP ingredient products enter the market, increasing supply options, basic products will feel that market demand which will apply pricing pressure. So, FM pricing could soften to attract increased or same usage. FAQ feed ingredients will continue to be used per supply/available volume and pricing. SCP's & NP's could potentially replace or compliment FAQ proteins at a 15-20% inclusion. Again, the inclusion could be higher or lower depending on how formulating is done, i.e., least cost formulating.
 - Paul De Pauw, Unibio Answer: the substitution of fish meal by SCP is in my eyes a secondary discussion. The need for proteins will grow and SCP will occupy part of that new space that is created. The production of Fish meal will probably still grow a bit as well through an increased amount of co-products coming from the aquaculture sector.

2. Can you talk about the crude protein of your product or the amino acid profile? . How economical is it with cost benefit ratio in terms and comparison to insect based protein?
 - Mark Rottmann, iCell Sustainable Nutrition Answer: Ranges from 45-65% depending on how we run the process – but remember, we also have Nucleotides and other functional factors beyond just protein
 - Dr. Peter Williams, Green Plains Answer: Corn fermented protein has an excellent amino acid profile but is lower in lysine than for example soy-bean meal. Compared with the cost of insect protein the cost benefit ratio of corn fermented protein is vastly superior. One major advantage of the corn fermented protein is the economies of scale which combined with excellent nutritional characteristics makes the product highly cost effective.
 - Paul De Pauw, Unibio Answer: the cost-benefit of an SCP protein compared to insect protein is not only dependent on the EAA profile. That is one element. Other elements are production cost , availability, sustainability, etc. The

disadvantage of insect protein is that an insect only concentrates proteins and digestible energy. Insects don't create protein out of gaseous mineral sources of nitrogen and insects do not digest cellulose or lignin. So consequently inevitably a lot of co-products are created that have a much lower value.

Most of the current insect projects are based on protein concentration from existing industrial byproducts (like from the starch industry). Those co-products already have existing feed outlets. So all insects are doing is redirect the protein from one feed outlet (i.e. cattle or pig feed) to another (i.e. aqua feed.) Hence the sustainability profile of the existing insect operations is rather poor. Compared to this SCPs have a much greater volume and sustainability potential. SCP's create protein from anorganic nitrogen, which is a step change from what insects can do.

3. All the single-cell protein products are very interesting, however how would a feed mill choose between all of the products? Since all products are targeting replacement protein in the aquaculture diet, which will be the best solution/product to replace fishmeal?
 - Mark Rottmann, iCell Sustainable Nutrition Answer: The economics of FCR in the final diet will be the ultimate driver for use of any protein ingredient.
 - Dr. Peter Williams, Green Plains Answer: One of the major considerations of a commercial feed mill is the logistics of product supply. Can the mill obtain a reliable, consistent and commercial volume of the product. We can say that corn fermented protein with production in excess of 500k tons per annum at the end of 2021 is produced in commercially viable quantities, has resilience in the supply chain being produced from a number of different dry grind ethanol plants, has highly consistent composition produced from different plants and had redundancy in the supply chain.
 - Mike Cici, The Scoular Company Answer: As farmers have access to many different crops, and different genotypes of that same crop or plant yet each one will perform differently per that specific environment, i.e. geographic region, soil type, management or cultural practices, I believe one must fully understand these variables plus carefully review the available research in order to make that first step, then one should experiment on their own to determine what provides them the best performance at a cost they can accept. Cheap is not always the best answer.
 - Paul De Pauw, Unibio Answer: a feedmill will do what it always does, i.e. optimize its feed formulations based on the available basket of raw materials and the nutritional demands it wants to suffice. So SCP's will have to compete with other sources of nutrients. The expectation is of course that the world will simply need more protein to suffice the needs of its population and hence SCP's will be key to provide part of those additional needs.

4. Are nucleotides a concern with regard to inclusion of single-cell proteins to animal feed? What would be the safe limit of nucleotide inclusion in aquafeeds?
 - Mark Rottmann, iCell Sustainable Nutrition Answer: Nucleotides are beneficial at the lower inclusion levels – for each application and as more and more feed studies are completed, we will find the peak on the inclusion bell curve.
 - Dr. Peter Williams, Green Plains Answer: The nucleotides present in the fermentation yeast are only found in low quantities in corn fermented protein. The yeast cells are lysed during distillation and the nucleotides tend to partition with the liquid fraction and therefore do not appear in high concentration in CFP but are present in the residual DDGS. However, the majority of the yeast cell wall

materials are present in the CFP product.

- Paul De Pauw, Unibio Answer: Nucleotides are a concern in pet foods as larger doses could lead to physiological problems in pets that are often on the same pet food diet for very long periods. They are not a concern in other applications, on the contrary. There are positive metabolic effects reported for instance in fish and nucleotide derivatives are being marketed as additives to this segment.

Mark Rottmann

1. iCell uses water, for example from processing plants - how does it ensure that diseases like ASF or avian flu are not in the final product thereby ensuring that they are not transmitted in the feed to other producers who have no such diseases in their flocks or herds?
 - Mark Rottmann, iCell Sustainable Nutrition Answer: Running the SCP through a thermal or other process kill step, the same as any animal protein meal is the proven method for safe feed ingredient production.
2. How does integrating iCell with RAS facilities improve the land-based fish farming model? What benefits does it provide to the farmer, if any?
 - Mark Rottmann, iCell Sustainable Nutrition Answer: "Sludge" or the residual feed/feces in the bulk RAS water is a big processing issue, both from a cost standpoint and an environmental disposal standpoint – hauling it is expensive and finding a place to put it is also expensive and possible difficult – we eliminate the sludge and instead use it as organic material to grow our SCP's.
3. How about utilising waste water from the fish meal & fish oil industries in Central America or elsewhere?
 - Mark Rottmann, iCell Sustainable Nutrition Answer: YES! We've already proven it works – and we can handle the NaCl that is in the water – we have 2 commercially viable projects in development now – we are working on the funding to construct the projects.

David Tze

1. Is the production process the synthesis of proteins and nucleic acids by using CHON, as the basic building block of life? Are you going to be able to synthesize other biomolecules such as carbohydrates and lipids?
 - David Tze, NovoNutrients Answer: Our main production process is creating an intensive environment for the natural growth of certain bacteria. At the core of their growth and cell division is a naturally evolved chemosynthetic metabolism in which they use the chemical energy of hydrogen to fix carbon from CO₂. Of course, their growth also requires the rest of the acronym CHNOPS, which stands for carbon, hydrogen, nitrogen, oxygen, phosphorus, sulfur, representing the six most important chemical elements whose covalent combinations make up most biological molecules on Earth. We have developed increasingly industrial sources for such feedstock compounds, including various inorganic mineral salts, ammonia, and other inexpensive substances.

Peter Williams

1. What is the difference between corn gluten meal and CFP?
 - Dr. Peter Williams, Green Plains Answer: There are a couple of differences between corn gluten meal and CFP. The similarity is in the source of the protein

which is obviously corn protein. We have performed gel electrophoresis and compared the proteins from corn gluten meal and CFP. They are very similar but not identical. CFP protein has passed through a fermentation process and there are recognized nutritional benefits from passing a protein through a fermentation process. Furthermore CFP contains the additional benefits of the spent yeast components present in the product. Approximately 24% of CFP is formed of spent yeast components which have functional characteristics.