AQUATIC LIFE INSTITUTE

Insect Agriculture

January 2023

Foreword

Through our Certifier Campaign, Aquatic Life Institute (ALI) strives to hold seafood certification labels and their aquaculture standards accountable: products labeled as “sustainable” or “responsible” must include vigorous, reliable, and innovative animal welfare considerations. We engage with certifiers around the world to help develop and implement positive welfare practices and requirements wherever possible. Feed composition in aquaculture is a pillar of welfare in which we advocate for change due to the amount of external aquatic animals being “reduced” to dietary components of aquafeed such as fishmeal and fish oil (see Blue Loss). Insect-based meal has been proposed as a viable alternative to these marine ingredients, however, we urge seafood certifications to prohibit the use of insects in feed considering the use of it as a sustainable, welfare-friendly replacement is uncertain at this time.

Summary

Widespread industry uptake of farming insects for use as aquafeed to sustain carnivorous fish farms could pose a variety of risks. Considering the availability of plant-based alternatives, insect agriculture for aquafeed does not prove beneficial from a risk-benefit analysis.

We recognize that insect-based aquafeed shows potential to supplant feed derived from aquatic animals (fishmeal and fish oil). The Aquatic Life Institute (ALI) has campaigned for the use of "alternatives" to fishmeal and fish oil components in feed composition based on welfare, environmental, economic, and biosecurity concerns. An analysis of the best available evidence, however, shows that despite the market potential of insect meal as a viable alternative, this branch of industrial animal agriculture could embody or enhance each of these risks in a new domain.

Black fly larvae, a commonly farmed insect, weigh ~0.07 grams. This is orders of magnitude less than the typical "reduction fish" (e.g. wild-caught anchovies), weighing ~150g. Therefore, let's assume that it would take ~2143 black fly larvae to replace each reduction fish. Our estimate for "Blue Loss", or aquatic animals fed to farmed aquatic animals, suggests that around 1.8 trillion aquatic animals are either reduced to fishmeal and fish oil products or used as live feed in aquaculture. The FAO estimates that 25-100% of aquafeed could be replaced by insects.[1] To substitute the biomass of fish used for aquafeed, around 9.8 quadrillion black fly larvae would be required. This is 5269 times more than the total estimate of aquatic animals currently used for aquafeed. For every 0.018% of the market for aquatic animals replaced by insect agriculture, the total number of animals in the aquafeed supply chain would likely double.

The number of animals involved in insect farming could rapidly change the face of the industry. In October 2019, French insect farm company Ynsect received 372 million dollars in series C funding, promising to use the funds to produce a factory with an annual product of a million tons of larvae by 2023.[2]

---

[1] Makkar HPS, Tran G, Heuze V, Ankers P (2014) "State-of-the-art on use of insects as animal feed." Animal Feed Science and Technology, vol. 197, 1-33.
[2] "World's Largest Insect Farm To Open, With Record Investment", Forbes, available at: https://www.forbes.com/sites/alexledsom/2020/10/06/largest-insect-farm-in-the-world-to-open-with-372-million-investment/?sh=5192dec0788c (Accessed 2021-01-21)

The output of this farm alone will be 14 trillion insects per annum. If the FAO is correct, and this output is used as a replacement for FMFO, this will increase the number of animals in the fish food chain by 700% in the short span of two years.

The best available evidence suggests that the subcortical neural networks present in invertebrates are sufficient to meet the requirements of suffering.[3] The advent of a new domain of factory farming, including tens of trillions of animals whose welfare is very poorly understood, translates to a potentially catastrophic outcome for the animal welfare movement. Even though it appears black fly larvae possess less sentience than vertebrate finfish, we are not convinced that they are five thousand times less sentient. The introduction of insect agriculture into the food system has the potential to dramatically increase the amount of animal suffering required to produce aquafeed and farmed fish.

Economics:
It remains to be seen whether the industrialization of insect farming for aquafeed can become economically sufficient. Ynsect states on its website that it intends to feed "wheat bran" to its insects, recycled from agricultural waste.[4] However, a review of the literature shows that different industrial residues appear to have a better feed conversion ratio potential for insects than wheat bran.[5] A 2020 study shows that the higher the protein content of the substrate, the higher the protein content of the larvae, by up to 20%.[6] Whether or not the industry can effectively scale the repurposing of agricultural waste remains to be seen.

Even if producers can deliver on the promise of rearing insects entirely on human food coproducts/agricultural waste, the acquisition and processing of these coproducts will not be without cost. As the industrialization of insect agriculture intensifies, we can reasonably expect the value insect farmers extract from these coproducts to command a price from the farmer. One would expect the cost of the high-protein coproducts to be greater in a competitive marketplace than the low-protein coproducts, leading to price competition for the 'best' insect feed.

As the economic landscape of arable farming changes, we can expect the fees paid by insect farmers for industrial substrates to become an essential coproduct of their production. If the insect industry pays 10% of the cost of production for crops with

---

[3] Low, Philip, et al. "The Cambridge declaration on consciousness." *Francis crick memorial conference, Cambridge, England*. 2012.
[4] http://ynsect.com/en/faq-2/
[5] Bordiean, Anna, et al. `Growth Potential of Yellow Mealworm Reared on Industrial Residues." *Agriculture* 10.12 (2020): 599.
[6] Rumbos, Christos I., et al. "Evaluation of various commodities for the development of the yellow mealworm, Tenebrio molitor." *Scientific Reports* 10.1 (2020): 1-10.

high-protein coproducts, then insect farming will be subsidizing crop production, becoming a causal factor in the environmental impact of arable farming.

Uniquely high levels of processing cost required for this feed is also an area for consideration. This is a trophic pyramid without precedent: arable coproducts are farmed and processed, and then fed to insects, which are farmed and processed, to be fed to fish, which are farmed and processed. *Salmonidae* represent the only infraclass of obligate carnivores that we farm. The direct human consumption of *Salmonidae* products will ultimately require six levels of processing. The introduction of an extra trophic level to the farming system has the potential to outweigh any costs saved.

Jevons effect

Even if the insect industry lowers the overall cost of aquafeed, there is no guarantee that this will lower the number of fish farmed or used in the supply chain. The Jevons effect,[7] named after economist William Stanley Jevons, is a term used when the increased efficiency of one factor (here the cost of feed) leads to its increased utilization. If insect companies are able to save farmers 40% of the cost of their feed, this economization will give producers the resources to farm more fish. This, in turn, will subsidize the procurement of less efficient sources of aquafeed, such as reduction fisheries. This pattern is well evidenced in the agriculture industry.[8]

When it comes to fish caught for fishmeal, demand simply outweighs supply. An article written by Open Philanthropy's Lewis Bollard, calls attention to this issue. "Insects will likely just fulfill some of the huge unmet demand for fishmeal, enabling aquaculture to expand faster. In fact, that's what the EU predicts[9]: It thinks that if insect farming takes off, "aquaculture production [will] increase by 1.1%, driven by the increased supply of insect meal…"[10]

So, rather than being a "sustainable" and "efficient" alternative to fishmeal and fish oil products derived from reduction fisheries, insect farming could ultimately serve as a driving force in expanding aquatic factory farms. Instead of preserving wild-caught fisheries' stock, protecting the marine environment from industrial capture intrusions, and minimizing carbon emissions/natural resource depletion, exploring further insect farm development could in fact serve as the contrary to sustainable development goals.

Consumer attitudes

---

[7]York, Richard, and Julius Alexander McGee. "Understanding the Jevons paradox." *Environmental Sociology* 2.1 (2016): 77-87.
[8] Polimeni, John M. *Jevons paradox and the myth of resource efficiency improvements*. Earthscan, 2008.
[9] "Documents - Agriculture and rural development - European Union." https://agriculture.ec.europa.eu/documents_en.
[10]Bollard, L., (2021). The Perils and Promise of Insect Farming. Farm Animal Welfare Newsletter 22 August. https://www.openphilanthropy.org/farm-animal-welfare-newsletter-archive. Open Philanthropy, San Francisco, USA.

It currently takes the biomass equivalent to 120 anchovies to bring a farmed salmon to harvest weight. If the salmon are fed insect meal directly, it will require ~72,000 black fly larvae to bring a salmon to harvest weight. There are a number of factors here which might cause consumers to reject entomophagic fish (fish that eat insects). More than 75% of all salmon is sold in the EU and the United States, where there is a cultural shift away from eating animal products. The doubling rate of vegan diets is ~4 years, with ¼ of people in the USA reducing the amount of meat they ate in 2019.[11] In the UK, this number is closer to 40%.[12]

The intended market for insect feed are customers who are likely to reject the idea of eating insects, and to be more conscious of how many animals were used in the production of the meat products they consume. A salmon that is fed plant-based protein has the potential to appeal to these 'reducetarian' consumers. As diets in these key EU-American markets move towards 'less but better' meat, plant-based aquafeed is more appealing for consumers, industry, and the animals themselves.

Biosecurity

The link between agricultural intensification and disease is well established.[13] The dense environment of thousands (or in this case, trillions) of animals in close proximity is a perfect breeding ground for pathogens. The story of novel zoonoses increasing the costs of factory farming is also well-known. Densely populated stocks develop infections and blanket treatments are then applied, externalizing the true cost of the treatment, as antimicrobial resistance (AMR) decreases the efficacy of the treatment each time it is used. As time wears on, that externalized cost is paid for in stock loss as the antimicrobials fail. Virtually every farming industry is limited by novel zoonoses with AMR.

Conclusion

A truly progressive protein solution would reduce the number of animals in the food chain. A September 2020 study showed that yeast biomass contains levels of growth-limiting amino acids comparable with those found in fishmeal and soy protein.[14] Solar Foods, a start-up company using solar power and genetically engineered microbes to turn simple nutrients into complex proteins, received a €4 million grant from the Finnish government to open a factory. A March 2020 study

[11] McCarthey and Defoster, "Nearly One in Four in U.S. Have Cut Back on Eating Meat", Gallup, January 27th 2020.
[12] https://www.rspcaassured.org.uk/media/1759/the-rise-of-the-reducetarian-rspca-assured-report.pdf
[13] Jones, Bryony A., et al. "Zoonosis emergence linked to agricultural intensification and environmental change." Proceedings of the National Academy of Sciences 110.21 (2013): 8399-8404.
[14] Agboola, Jeleel Opeyemi, et al. "Yeast as major protein-rich ingredient in aquafeeds: a review of the implications for aquaculture production." Reviews in Aquaculture (2020).

demonstrated that, when fed in combination with hydrolyzed proteins, plant-based aquafeed can be fed to salmon at a ratio of 80% without limiting growth.[15,16]

Insect agriculture is still very much in the experimentation phase. It remains unclear whether this industry could ever become economically sensible, and there are a number of negative outcomes that could contribute to already unsustainable systems. A prohibition of the practice at this nascent stage has a very real chance of dissuading further investors from funding additional research into developing the largest factory farming project of all time in terms of animal lives.

[15] Egerton, S., et al. "Replacing fishmeal with plant protein in Atlantic salmon (Salmo salar) diets by supplementation with fish protein hydrolysate." Scientific reports 10.1 (2020): 1-16.
[16] Hardy, R. W. Utilization of plant proteins in fish diets: effects of global demand and supplies of fishmeal. Aquaculture Research 41, 770–776, https://doi.org/10.1111/j.1365-2109.2009.02349.x (2010)