

White paper

Insect technology.

A circular economy
solution ready to go
mainstream.

When will insects be a mainstream ingredient in food and animal feed?

Moving from niche to a wider market.

Insect technology can provide a sustainable alternative source of protein to meet the growing global demand in food and feed. It is also a circular economy solution that helps to reduce food waste. The industry is currently in the ramp-up phase and projected to grow rapidly in coming years. What will it take for it to meet its full potential?

Mariana Nieto de León, Lead Global Strategy 2025 initiative for the Insect Technology business, a circular economy-driven unit at Bühler

Our current food system is not fit to meet the demand of the world's growing population over the coming decades. By 2050, it is projected that we will need 250 million metric tons of additional protein a year.¹ Today, most plant-based proteins are used as animal feed for livestock to meet the demand for meat. This cannot be sustainably expanded as the amount of arable land per person is decreasing² and it takes four plant-based proteins on average to make one animal-based protein. We need an alternative approach.

Insect technology has the potential to play a key role in building more sustainable food and feed value chains. Insects are rich in proteins, they contain healthy unsaturated fatty acids, and they are a good source of vitamins and minerals. They are also widely available, and unlike many other common sources of protein, insect production requires no fertile land.

Circular supply for food and feed

In terms of environmental impact, as a direct food for human consumption, insects compare favorably with other animal proteins such as milk, poultry, swine and cattle, and with other meat analogues.³ As animal feed ingredients, their environmental impact is considerably lower than traditional feed sources such as soymeal and rapeseed cake in terms of land use and freshwater depletion.⁴

Furthermore, embedding insect production into the farming system can unlock the benefits of the circular economy and help solve another major challenge, that of food waste. Currently, around a third of food intended for human consumption is lost or wasted every year. Traditional waste management technologies turn food waste into energy through incineration or anaerobic digestion. In comparison, insects can upcycle organic residues – including consumer discards, agricultural residues and industrial byproducts – into quality products such as insect flours for human food, proteins and lipids for animal feed, as well as fertilizer suitable for agricultural and

horticultural use. Thus, they recycle nutrients directly back into the food value chain, while producing far less CO₂e compared to the traditional disposal strategies.

From niche to mainstream

The industry is, however, still in the ramp-up phase with products aimed at specialty markets attracting a premium price. For insect technology to achieve its full potential, the industry as a whole needs to develop and mature. It has already moved from pilot plants to industrial plants and will be able to exploit greater economies of scale with larger facilities bringing down costs. The next step is to optimize production. This is key, after all, soy has been optimized over hundreds of years to reach its current status. The introduction of next generation feedstock, such as kitchen waste, and the use of renewable energy to power facilities, the environmental impact will be even more beneficial.⁵

Given this potential, many researchers are projecting that the insect protein market will grow significantly in the coming years, moving through the ramp-up phase to become a mature market by 2030. According to a recent report by Rabobank, demand for insect protein as an animal feed and pet food ingredient could reach half a million metric tons by 2030, up from today's market of approximately 10,000 metric tons. This will reach a "turning point" for the industry, after which it will be easier to expand.⁶ In the next section, we look at what it will take for this to happen.

A tale of two markets

The two main markets for insect product – human consumption and animal feed – have very different characteristics and outlooks. Until there is wider acceptance for insect-based foods, the market for human consumption is likely to remain small. Insect technology is likely to be used increasingly for animal feed production. Pet food, aquaculture, chicken and pig feed are all areas that could see a significant increase in demand in the next ten years, according to Rabobank.⁷ How-

ever, even in this market, insect protein is today still a niche product due to its relatively high price compared to other feed ingredients and its limited availability.

"Insect technology is at a comparable stage to solid state disks when they were first introduced. They were very fast but only had specific applications. With higher demand and reduction of cost, they eventually replaced all standard hard drives in laptops," says Andreas Baumann, Head of Insect Technology at Bühler Group. "We are on a similar path with insects. Protein and lipids can be sold into the industry at a relatively high price due to the functional and environmental benefits. This will trigger a higher demand which will drive market penetration and price reduction. That will then allow for more applications, and over time, insects will become a bulk ingredient."

How will that transition happen?

With the market for insect technology in the feed sector in the ramp-up phase, the challenges are largely due to price sensitivity. To overcome this, besides process optimization and economies of scale, production costs can be reduced by creating more efficient ecosystems.

"Poultry production is much more segmented compared to the insect industry. Poultry farmers have access to chicken feed producers, businesses that specialize in the reproduction and supply of young animals, as well as centralized slaughterhouses. While in the past insect producers covered all these steps themselves, we now see segmentation starting in the insect industry too," says Baumann. "There are companies focusing on reproduction to supply young larvae to other companies that focus on the grow out of the animals. We are seeing decentralized farming models with centralized processing. These are all very positive signs that the industry is becoming more mature."

A further step that will unlock the industry will be the increased availability of cheaper feedstock. With better understanding of the nutritional requirements of the insects, feed formulation can be optimized allowing use of lower grade organic wastes and thus reducing feedstock cost. With an increase in suppliers of organic waste it will also be possible to take full advantage of insect technology's potential to contribute to the circular economy. Meanwhile, upstream, there need to be sufficient buyers of the product for various sectors.

Sustainable investment opportunities

The insect industry has already attracted considerable investment. To date, the majority has gone into funding start-ups. However, once the ecosystems up- and downstream have developed further, and there is more certainty around estimating both CAPEX and OPEX, investment in the industry will increase.

"The insect industry is already very interesting for investors today," says Olivier Utz, manager of a family office focused on the food industry and technology. "After a long phase of R&D, we are now seeing many initiatives attracting a lot of capital. One reason is that people understand that our current way of producing protein is not sustainable in the long run, so we need other solutions that are scalable. Investors are also attracted by the circularity of the insect industry."

But there are challenges. Companies need to be able to produce in a sustainable manner in terms of both quantity and quality and must have a robust supply chain. "We need to move to more industrial production, with quality processes and certifications. It also makes sense for food producers to source proteins locally, in the same continent or even the same country," he says.

Investors are so far targeting the market for animal feed, where demand exceeds supply. "It is a huge market, the regulations are in place and the players are pushing the authorities to introduce certifications," says Utz. "The race is now on to build facilities."

Utz believes that in the next two to five years, the industry will take off. "There still needs to be education for customers, for example pet owners, about the benefits of insects. And in terms of production, R&D is necessary to get the right feedstock and find the right recipe," says Utz. "It is still a new industry that needs to overcome a number of technical production challenges, but we see many tailwinds that will help it become stabilized and robust."

Bühler has been involved in the insect industry since 2013. After initial studies to evaluate insects as alternative source of protein, in 2017 the company established its own team to approach the market. Bühler supported Dutch insect production company Protix to build its insect protein facility and began a research program with ETH Zurich into rearing and processing technologies.

To continue exploring the potential of the industry, Bühler has now created the Insect Technology Center in Uzwil. Larvae growth trials can be carried out at a small scale with various feedstock to define the parameters for the highest larvae yield. Equally important, the Insect Technology Center provides training in rearing and processing techniques, increasing insect know-how.

As it moves into the next stage, Bühler is now building a full-scale industrial scale plant in Rethel, France for Agronutris, a French biotech company. The plant will be able to process up to 70,000 tons of organic residues using a high degree of automation to produce high-quality protein for the aqua culture and pet food markets.

Bühler will cover the following key stages of insect processing:

- Feedstock preparation based on organic residues to provide safe, palatable and nourishing feed to the larvae in a timely manner
- A fully automated larvae growth system with sophisticated climate control
- A processing line to efficiently transform the grown larvae into protein meal and lipids with consistent quality
- A frass (excrement) handling system for secure offtake of the rearing residues

Created in 2011, Agronutris is specialized in rearing and transforming insects into proteins for animal nutrition, with a focus on the black soldier fly. The company brings its expertise in entomology and the agroindustry together. Their aim is to produce high quality feed products for the aquaculture and pet food markets.

A deep understanding of entomology is essential, according to Mehdi Berrada, CEO and Co-Founder of Agronutris. It means knowing the best conditions in which to rear the insects, both biological (mating, egg laying, hatching, larval growth, metamorphosis) and technical (temperature, hygrometry, density, air treatment). This enables Agronutris to fully leverage the bioconversion potential of the larvae. Having mastered these processes, they are now ready to scale the business and have chosen Bühler as a partner to build their first large factory.

Berrada believes that scaling up and industrializing will have a significant impact. “Operating at scale will further increase our understanding of insect biology, genetics, nutrition and rearing conditions. This will help improve efficiency and, by definition, also the sustainability of our solution,” he says.

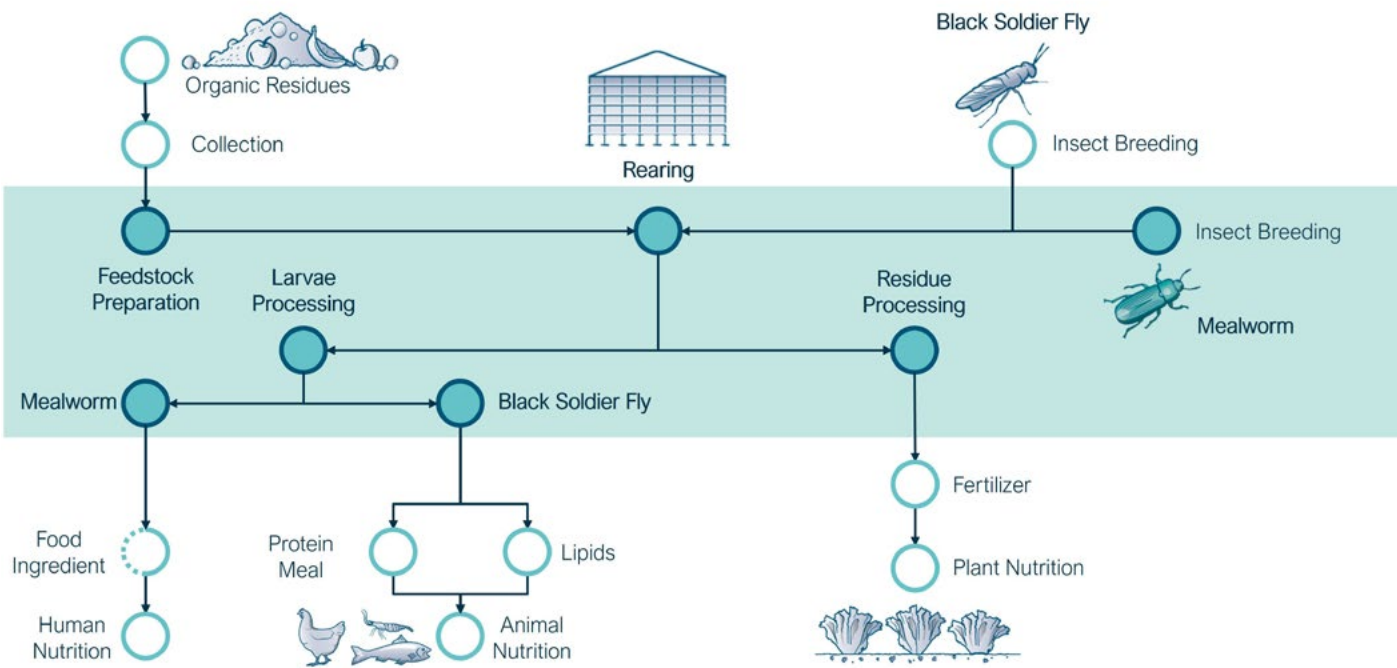
The industry is now developing fast, according to Berrada, with other players also building factories that can produce in thousands of tons. He welcomes the competition. “Major change is underway and is accelerating quickly,” he says. “Players are raising large amount of money to scale up the technology and clients see the improvements in our solutions. With several large players in the market, they will have the confidence that they can reliably get the capacities they require.”

Compared to the fishmeal industry or soya, the industry is still very small. But, step by step, Berrada is convinced it will develop from a premium to a mass market solution. “We are only at the beginning, but we are narrowing the gap with other ingredients,” he says. “Thanks to economies of scale and improvements in efficiency, our solution will be very competitive in the medium to long term. And in terms of sustainability, it will become an unbeatable solution.”

Conclusion

- Providing sufficient protein for the world’s growing population in a sustainable way will require different innovative approaches.
- Insect technology offers an opportunity to address this challenge at the same time as providing a circular economy solution for food waste by recycling nutrients that would otherwise be lost and bringing them back into the value chain.
- This solution is proven feasible and can be realized on a large scale in an economical way.
- The opportunities for growth are primarily in insect protein as an animal feed and pet food ingredient, as consumer acceptance of insect-based food remains low in developed countries.
- Process optimization, economies of scale, cheaper feedstock sources and a more developed ecosystem will unlock the potential of this industry.

Bühler’s Technology Scope



References

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- ⁶ de Jong, B., Nikolik, G. No Longer Crawling: Insect Protein to Come of Age in the 2020s. Rabobank Research February 2021.
- ⁷ Ibid.

Mariana Nieto de León – Lead Global Strategy 2025 initiative for the Insect Technology business, a circular economy-driven unit at Bühler



Mariana Nieto de León joined Bühler in 2017. After developing the Business Intelligence capabilities for the Insect Technology unit, she became Product Manager where she is responsible for the product planning and marketing activities, connecting business strategy, technical knowledge, and market needs. Before joining Bühler, Nieto de León worked as a Regulatory and Market Strategy Specialist within the Agrobiotechnology sector in Mexico and Central America. Mariana holds a MSc in Management, Technology and Economics from ETH Zürich and a BSc. Biotechnology Engineering from Tecnológico de Monterrey.

Andreas Baumann – Head of Market Segment Insect Technology



After his PhD in food process engineering, Andreas Baumann joined the corporate technology group at Bühler in 2010 and worked for many years on alternative proteins including pulses, algae and insects. In 2017, he became head of technology of the newly formed insect team at Bühler and was responsible for process developments to establish industrial solutions that deliver high-quality insect-based products. Since 2021, Baumann leads the insect technology team at Bühler, which is mainly located in Switzerland and China, in order to serve the global market with reliable process solutions.

Olivier Utz – Investor



Olivier Utz leads an international Family Office with investment focus on Food, Health, Technology and Sustainability. He previously supported a Private Equity firm and spent over 15 years with an international investment conglomerate with C-level and Board roles. He designed and implemented value creation plans and was extensively engaged in setup, M&A, growth, turnaround and portfolio management. He operated in Switzerland, Europe, the Middle East, West Africa, Asia and Americas across diversified sectors such as Industrial, Engineering, Energy, FMCG, Real estate and Technology. He holds an Executive MBA from IMD and a Master's degree in Business & Finance from Neoma.

Mehdi Barrada – Co-Founder, Agronutris



Mehdi holds a degree in finance from Paris Dauphine University and a Master's degree from ESCP Europe. He worked for 7 years as Deputy Director of the Rothschild investment bank before joining the Poult Group (renamed Biscuits International), where he held the positions of CFO, GM and CEO. During the 10 years he spent in the Group, Biscuit International became the European biscuit industry leader. In 2017, he joined an adventure to provide new solutions to global challenges and in 2018, together with Cédric Auriol, he founded Agronutris.

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