EUROGROUP FOR ANIMALS

Insect farming: a six-legged problem

Report

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Introduction

From promise to peril: the worrying trajectory of the EU's insect farming sector

Since 2013 and the release of the Food and Agriculture Organisation (FAO) "Edible insects: Future prospects for food and feed security" report (van Huis, 2013), which highlights the potential of insects as a provider of sustainable proteins for a growing population, interest in insect farming has been increasing across the world.

In the European Union (EU), the sector has encouraged the development of numerous start-ups, has tapped into both public and private funding and, since 2017, has been aided by the progressive lifting of restrictions in European regulations governing the sector. Nine species of insects are currently allowed for food or feed production in Europe, the most farmed being the black soldier fly (*Hermetia Illucens*), the yellow mealworm (*Tenebrio Molitor*) and the house cricket (*Acheta Domesticus*). Insect proteins are touted as a revolutionary solution for the problems in our agricultural systems, including by upcycling food waste into nutritious green proteins and contributing to a circular bioeconomy.

However, this enthusiastic narrative relies mostly on the 2013 FAO report, some initial and very partial Life Cycle Assessments (LCAs), and several unsubstantiated claims. Much less attention has been given to critical voices, or even the FAO's further report in 2021, "Looking at edible insects from a food safety perspective" (FAO, 2021). Eight years after the first publication, this report highlights that "the sustainability aspects and environmental impacts of upscaling insect production has not yet been given due consideration" (FAO, 2021) and calls for caution on many aspects, including food safety, genetic manipulation, and biosecurity risks.

Today, the significant investments made in insect farming have not yet delivered sustainable and scaled-up protein production, as actors in the sector call for more support and even fewer regulatory barriers to achieve results. Yet, in the last decade, a certain number of concerns have been raised regarding insect farming, calling for a more thorough assessment of its sustainability and safety credentials, and of its real potential, before further loosening regulations to encourage its expansion in the European Union.

This report explores the different parts of this six-legged issue, and provides a review of the insect farming sector's potential as a food revolution, its sustainability and circularity credentials, and the risks induced by its development.

Executive summary

1: Insects and sustainable food systems

Insect farming has been promoted as a revolutionary alternative to animal proteins, attracting significant investments. However, this industry has primarily targeted feed production for industrial farming, rather than human consumption, thus adding more animals into the supply chain. This approach supports intensive farming practices that have detrimental environmental and health impacts. Insect proteins, as animal feed, could potentially greenwash intensive farming, increasing consumption of animal products under the guise of sustainability.

2: Insects and their environmental impacts

The portrayed environmental impact of insect protein is often misleading. While early assumptions, inspired by comparisons with beef, suggested significant benefits, more recent Life Cycle Assessments (LCAs) indicate that insect protein production can have higher environmental impacts than the conventional feed ingredients like soymeal and fishmeal it aims to replace. These impacts are exacerbated by producers feeding their insects mostly on these cereals and other ingredients that could be used directly to feed farm animals or people, thus adding an additional and inefficient step in the food chain.

3: Insects and circularity

Claims that insect farming contributes to a circular economy by upcycling food waste are frequently overstated. Although the concept of converting food waste into valuable insect protein is appealing, the reality of insect farms is more complex. Logistical challenges, food safety regulations, and economic considerations often compel producers to rely on conventional crops and byproducts instead of true food waste. Concerns regarding the safety of the waste streams and insect production byproducts (such as frass - insect excrements, left over substrate and insect body parts used as fertiliser) also call for strong regulations to protect human, animal and ecosystem health.

4: Insects and biosecurity threats

Insect farming presents notable biosecurity risks that must be carefully managed. The high-density farming of, particularly, non-native insect species is of significant concern, especially when these species are genetically manipulated to enhance productivity. Such practices increase the risk of accidental releases into the environment, where these non-native insects could establish populations, disrupt local ecosystems, and affect food production. The ecological impacts could be profound and far-reaching and, thus, require rigorous safeguards and regulatory oversight to mitigate potential damage.

5: Insects and food security

Insect farming has been presented as a potential contributor to long-term food security in Europe. However, the industry's dependence on conventional feed crops, offshoring of production, and reliance on imported insects undermine this claim. The shift of major European insect producers to regions with lower production costs, such as Southeast Asia and North America, diminishes the sector's contribution to European food security.

6: Insects and animal welfare

The welfare of farmed insects is a critical yet neglected issue. Recent evidence suggests that some insect species, including farmed ones, may be capable of experiencing pain and suffering, necessitating welfare measures in the sector. This concern is made even more pressing considering the scale of insect farming, which involves trillions of animals that currently have no comprehensive species-specific standards in place to protect their welfare. This topic still lacks research, consideration from policymakers, and, beyond statements of intention, concrete measures from the insect farming industry.

Conclusion

Insect farming in its current form in the EU does not align with the revolutionary claims made by its cheerleaders. The sector primarily supports existing intensive farming practices, with limited environmental, circularity, and food security benefits. Comprehensive assessments and regulatory measures are needed to address the environmental, food safety, biosecurity, and welfare concerns associated with insect farming before further expansion is encouraged in Europe.

1: Insects and sustainable food systems

Over the last decade, insect farming has been promoted as a revolutionary food solution: an alternative protein to animal products that has a much lower environmental impact. Its enthusiastic narrative has gained it a place in the EU's sustainable agrifood policy (European Commission, 2020), as well as investments from European funds. Yet how much of this original pitch has turned into a clear reality in the European Union? **Under scrutiny, insect farming appears to support rather than replace the current farming practices that have negative effects across several areas.**

The grim reality of industrial farming in Europe

Today, most of the animals farmed in the EU are reared on factory farms, including broiler chickens, pigs, and fish. The intensive farming model is known to be very damaging to animal welfare, as well as detrimental to the planet and our health, as it relies on a number of unsustainable practices including the widespread use of antibiotics and high stocking densities.

Industrial farming does not make efficient use of farmland, and frequently pollutes natural habitats and resources (Eurogroup for Animals, 2023b). Due to the vast amounts of water and land it requires, and the harmful ways in which they are used, soils and waterways are often damaged, leading to the eutrophication of aquatic habitats.

Current dietary trends in the EU also uphold the factory farming model, putting a strain on the planet and affecting public health. **Evidence shows European diets are heavy in animal products, and exceed by two to four times the recommended intake** (European Commission, n.d.). Not only is this trend responsible for 42% of the environmental

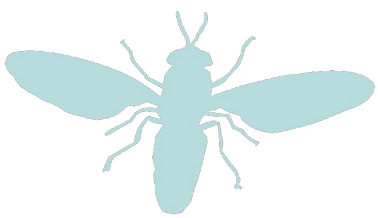
impacts of an EU citizen's consumption - crossing many of the planetary boundaries that aim to ensure a habitable planet (Sala & Sanye, 2022) - but research clearly shows it is unhealthy. Numerous studies have highlighted that diets heavy in animal products are a leading cause of non-communicable diseases (NCDs), such as cardiovascular diseases, certain cancers, diabetes, and obesity (ECDA, EPHA, NCD Alliance, n.d.; Gateway European Commission, n.d.).

Animals reared on intensive farms are often mistreated, neglected, and housed in miserable conditions, in environments lacking enrichment and preventing them from expressing their natural behaviour. Their diets are poor, their conditions stressful, and their slaughter inhumane. Eurogroup for Animals has repeatedly reported on these conditions (Eurogroup for Animals, 2023c), and the 2023 Eurobarometer on Attitudes of Europeans towards animal welfare (European Commission, 2023) revealed that 91% of EU citizens agree it is important to protect farm animal welfare. There is an urgent need for farm animal welfare to be protected, taking into account the Five Domains model (Eurogroup for Animals, 2021).

Who ends up eating insects?

Insect protein as a substitute for meat has been branded as a groundbreaking solution to achieve the much-needed transition to a sustainable food system in Europe. **However, despite industry claims, insect farming in the European Union is not being developed primarily to produce food for humans, but rather feed for the animals being reared on industrial farms.**

An analysis of company funding data (Eurogroup for Animals, 2023b) (see Figure 1 below) shows that **companies that produce insects for food for human consumption raised 20 times less money than those producing insects for feed for factory farmed animals in 2024,** demonstrating a clear orientation of the industry towards feed production. In fact, major financiers like Rabobank or the European Circular and Bioeconomy Fund clearly state that "the current potential of insect-based foods for human consumption is limited" (De Jong, 2021) and that they "bank on the market for animal feed as the more immediate business and growth opportunity for the insect industry" (European Circularity and Bioeconomy Fund, n.d.).



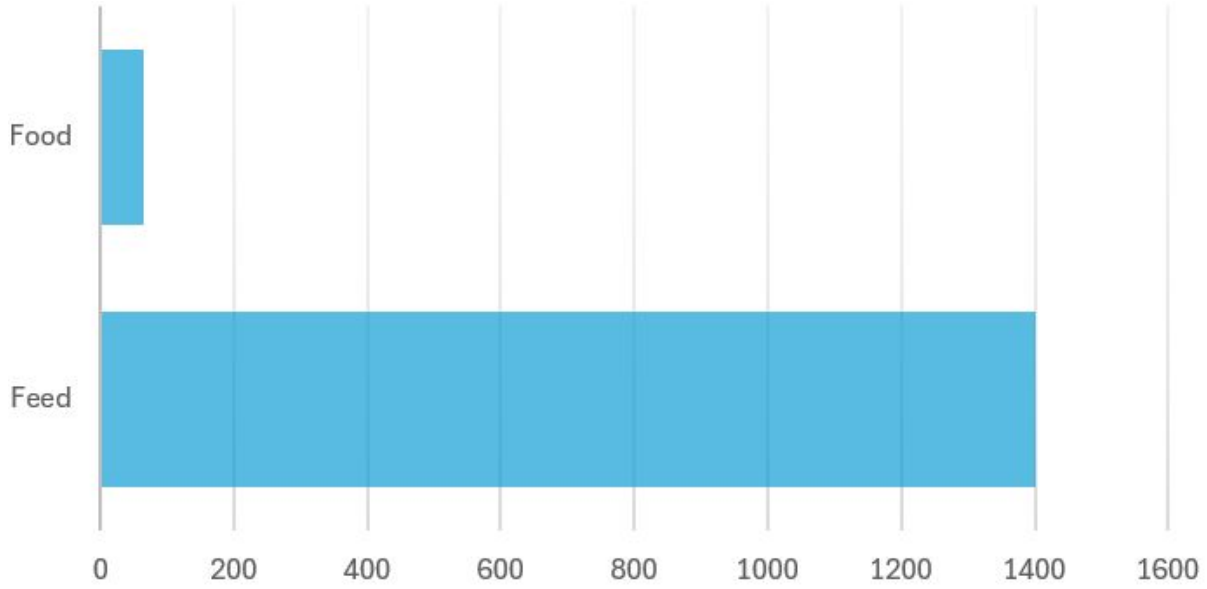


Fig. 1 - Average funding of Dealroom.com analysed insect producing companies in food and feed markets, in millions of dollars, July 2024 (Dealroom.Co | Alternative Protein List, 2024).

The reasons for this are manifold. Insect products are not well accepted by European consumers (Onwezen et al., 2021), concerns regarding their safety lead to lengthy market authorisations, and their price makes them uncompetitive compared to the products they could replace. Ultimately, the feed market appears much more interesting for insect protein producers, as volumes in this industrial market are greater, allowing for bigger production facilities and a faster-paced cost reduction curve.

Feeding the future or greenwashing the past?

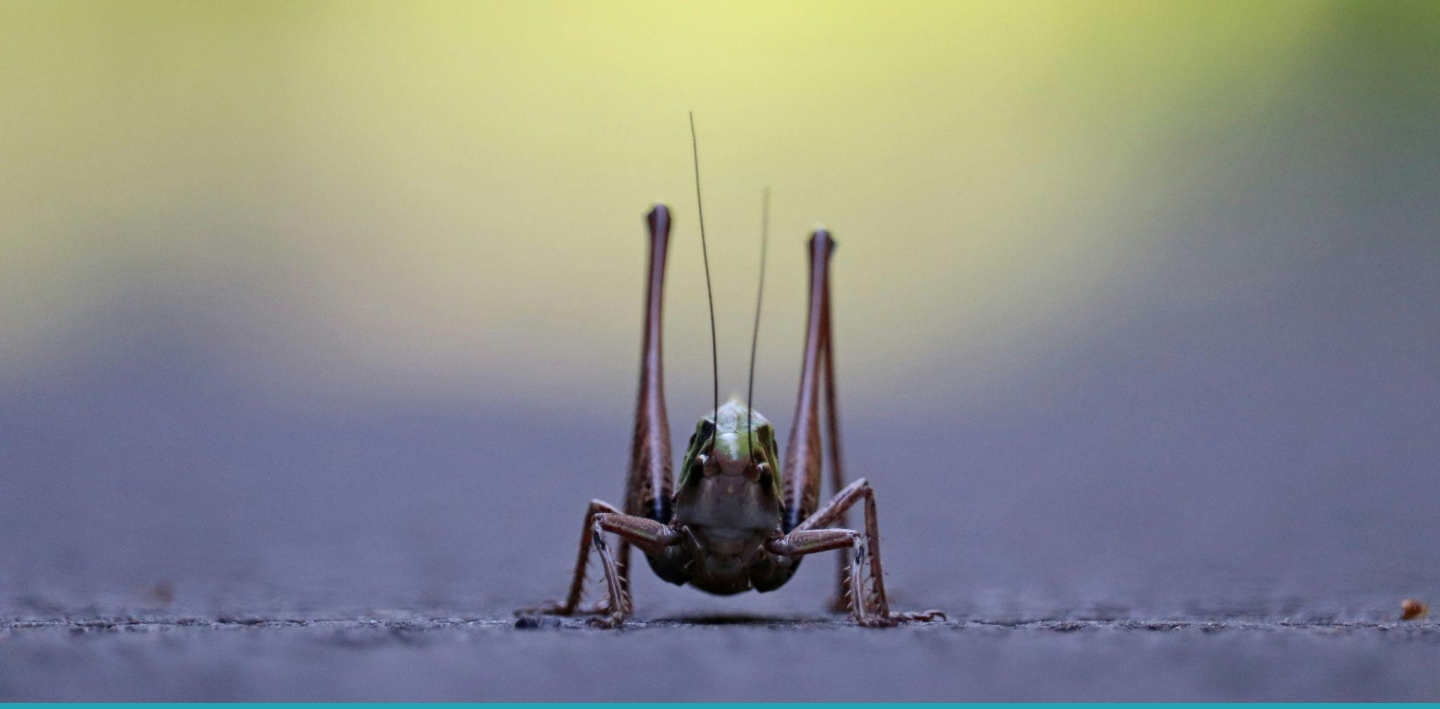
As a feed industry, insect protein is not a pioneering alternative to meat for human consumption, but rather encourages the intensive farming of other animals. The European Commission's Agricultural Outlook forecasts that an increased supply of insect meal and lower prices could well support current levels of animal production if the practice is fully commercialised and existing restrictions are lifted, highlighting that "aquaculture production [will] increase by 1.1%, driven by the increased supply of insect meal" (Directorate-General for Agriculture and Rural Development (European Commission), 2020).

Animal products branded as sustainable or circular because they are fed with insects could also lead to an increase in consumption of animal products overall. These "rebound effects" are due to consumers perceiving the products as having a lower environmental footprint, and thus deciding they can increase their overall consumption

of animal products. In turn, this enhances the environmental impacts, and animal welfare consequences, of their production. In the end, insect proteins as feed run the risks of greenwashing intensive animal farming as a whole.

Conclusion

As a predominantly feed-focused industry, insect farming supplies the current – and mostly intensive – animal farming sector, instead of serving as an alternative protein to support more sustainable food systems in the EU. Increased intensive animal farming is both cruel for the animals and will offset any sustainability or environmental progress made in Europe's agri-food system. **It thereby risks hindering EU sustainable agrifood policy, and the transition towards sustainable and more animal welfare-friendly food systems in Europe,** such as those highlighted in the conclusions of the Strategic Dialogue on the future of EU Agriculture, calling for an Action Plan for Plant-based Foods (European Commission, 2024).



2: Insects and their environmental impacts

Insect protein is often associated with low environmental impacts, and portrayed as a greener alternative to animal sourced food. Early comparisons of insect protein to beef have led to the assumption that insect protein would have a lower environmental impact than most food, including the feed compounds it largely competes with. However, a thorough review of these sustainability claims reveals a much less clear-cut picture.

Better than beef but worse than the rest?

Most of the early Life Cycle Assessments (LCAs) done on insect protein considered it only as a replacement for meat. This is, for example, the case of Oonincx & de Boer (2012), the main study on which the 2013 Food and Agriculture Organization's (FAO) report (van Huis, 2013) draws its conclusions. This initial study, not done in industrial conditions, also fails to consider the impact of several energy-intensive stages of insect protein production (such as drying and processing), and may have led to the false assumption that insect protein would also have a low environmental impact in other conditions.

However, later research has found **scaled insect production's environmental impact to be closer to chicken farming** (Cavallo & Califano, 2024). A more recent and comprehensive review of the environmental impact of the insect production chain demonstrates that substituting compound feed production with insect-sourced feeds would only be environmentally beneficial when extremely efficient production systems are used. These "extremely efficient production systems" (Smetana et al., 2023), which refer to insects grown on waste or low-cost feeds and rely on side-stream heat and

alternative energy sources, are a far cry from the current operations of the biggest insect-producing companies.

Indeed, most European insect producers do not rely on food waste to feed their insects, as it makes less economic and logistical sense. According to the industry association International Platform of Insects for Food and Feed (IPIFF), producers use a mixture of different ingredients instead. Of these, former foodstuff is only employed by 37.5% of insect producers, while more than half use "co-products from agrifood industries", and about three-quarters use fruits, vegetables, and cereals (IPIFF, 2018). These are resources that could be fed to chickens, pigs, or humans, and thus do not contribute to lower environmental impacts. Additionally, around a third of insect producers use commercial feed, which includes soy.

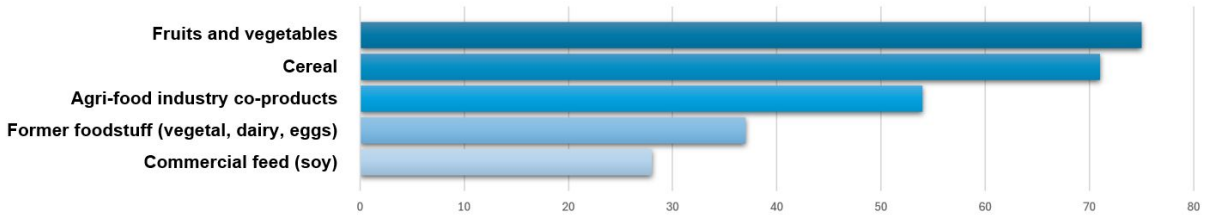
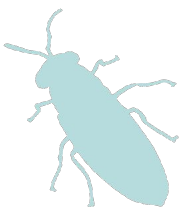


Fig. 2 - Substrates used by insect producers (percentage of producers using each substrate) (IPIFF, 2018)

Even the use of food waste and available side-streams could be environmentally detrimental. A 2019 study in Norway (Liverød, 2019) on insect-based feed under commercial production of yellow mealworms and black soldier flies using locally available side-streams and waste resources found that black soldier fly meal has the highest environmental impacts, above soybean meal and rapeseed meal. **The study found that black soldier fly meal produces 191% more CO2 and is 20 times more energy-intensive than soybean meal.**

Furthermore, the capacity of insect protein to lower the overall environmental impact of animal farming will always be marginal. Indeed, insect meals cannot replace the entirety of farm animals' diets. **Because of nutritional limitations, insects can only replace up to 25-30% of fish diets and up to 10% of broiler chickens** (chickens raised for their meat) **and pig diets** (Gasco et al., 2023). Thus, farms would still have to rely heavily on other feed sources.



Another form of animal nutrition, pet food, is a promising sector for the insect farming industry, as pet owners are likely to pay higher prices for their cats and dogs than for themselves. In addition, there have been less restrictions on the use of insects to feed animals that will not end up in the human food chain. In this context, insect proteins have once more been promoted as a much greener alternative to other pet food ingredients.

However, conventional pet food production already sources meat from byproducts that are not processed into edible food for humans (exactly the type of products that insect farmers would ideally feed their insects on). Insect protein in pet food, therefore, does not replace meat that would otherwise have been sold for human consumption (Pet Food Institute, 2020), and most ingredients used in pet food already have a lower environmental footprint than insects, including animal byproducts (Acuff et al., 2021).

Conclusion

The potential of insects as a sustainable replacement of usual feed compounds is very limited. **Not only does insect protein fare worse than most feed in many cases, but it also fails to significantly lower the overall environmental impact of meat production.** As pet food, insect protein also proves to be a poor replacement for ingredients that already have a low environmental footprint. Beyond the easy comparison to beef meat, insect protein turns out to be just another form of environmentally damaging animal production, with high energy and water use.

3: Insects and circularity

Insect farming has also been touted as a valuable addition to building a "circular economy" (an economic system in which materials or products are reused and regenerated) in the European Union. However, its claims of upcycling food waste and producing green fertilisers are exaggerated, as the feasibility and desirability of both are questionable. While the insect farming industry association IPIFF calls for "the authorisation of former foodstuffs, containing meat and fish for the breeding of insects at the EU level" (IPIFF, 2024), concerns regarding the safety of including potentially hazardous waste streams in animal production should lead policymakers to rigorously evaluate the costs and benefits of all circularity proposals.

The many challenges of harnessing food waste

The insect farming sector claims to be circular, based on its possible use of food waste and agricultural byproducts as substrate for farmed insects. Yet, if roughly one fifth of the food produced in the world goes to waste (UNEP, 2021), not all of it can be used to feed insects. To be competitive and benefit from using food waste, insect producers have to find waste streams that cannot be used as livestock or fish feed directly, that are readily available geographically, consistent in their nutrient contents, and sufficient in quantities throughout the year. All of the above must also be accessible at a reasonable cost. Meeting all of these conditions is a tall order, leading producers to rely on cereals and byproducts that could be used for other farm animals, or directly for human consumption (IPIFF, 2018).

Biohazards and health concerns: what's at risk with other waste streams?

The other waste streams that could qualify as feed for insects are banned due to health concerns. When farmed, insects can contract diseases and pathogens from the substrates they are reared on, representing a health risk for the animals and subsequently for humans (Zurek & Gorham, 2008). Numerous studies have demonstrated that, during the farming process, "insects can be infected by or become hosts for biological hazards such as bacteria, parasites, fungi and viruses" (Precup et al., 2022). Key pathogens to monitor include *Bacillus cereus, Clostridium spp., Salmonella spp.* and *Staphylococcus spp* (Pinarelli Fazion et al., 2023; SUSINCHAIN Project, 2022), as well as *E. coli* and *L. monocytogenes*. The intake and bioaccumulation of heavy metals by farmed insects has also been pointed out as a health concern (Traynor et al., 2024).

These are more than mere hypotheses. A 2019 study (Gałęcki, 2019) on insect farms for the pet industry in Germany and Central European countries **detected parasites in 81% of examined facilities.** 35% of the parasites were infectious for animals, and 30% infectious for humans. There is, furthermore, little information on how scaled-up facilities - producing tens of thousands of individual insects at high densities and in very confined spaces - may facilitate, stimulate or amplify the emergence and spread of pathogens and diseases. As another form of intensive animal farming, insect rearing is not immune to these risks, as has been demonstrated in lab settings (Duffield et al., 2021) and on cricket farms in South Korea (Kim et al., 2024).

The promises of insect frass

The residue from insect production, which includes leftover substrates, insect excrements and body parts, known as "frass", is branded as a green and safe fertiliser. However, pathogenic *E. coli* and *Salmonella* has previously been found in untreated frass. While heat treatment may solve this issue in some cases, and is required for the placement of frass on the market, both of these pathogens were still discovered in treated yellow mealworm frass and Jamaican field cricket frass (Praeg & Klammsteiner, 2024).

Another key point in the circularity claims of the insect farming sector, frass could well turn out to be dangerous for plant health. Indeed, according to FAO, "contaminants in substrates can be excreted and may end up in the soil when frass is applied as a fertilizer" (FAO, 2021). This can be the case when "insects are raised for waste management and their frass is collected for use in agriculture" (FAO, 2021).

Some studies also suggest that frass from black soldier fly larvae grown on food waste can hinder the growth of maize (Alattar et al., 2016), contribute to excessive nitrite accumulation (Watson et al., 2021), and thereby present little environmental benefits in addition to endangering plant health. Overall, as the environmental benefits of frass

"vary significantly depending on the substrate used to grow larvae" (Gebremikael et al., 2020), it is difficult to determine with certainty that frass would contribute to a circular economy.

Conclusion

From the logistical challenges of harnessing food waste to the potentially detrimental impact of frass on agriculture, the circularity claims of insect farming are questionable. Furthermore, the safety concerns associated with the use of untreated and unchecked waste streams and frass runs the risk of disseminating pathogens in the food chain and environment.

4: Insects and biosecurity threats

One of the most popular arguments in favour of insect farming is its supposed positive impact on the environment. Yet, its potential consequences on biodiversity and wild insect populations raise questions. High-density insect farming poses the risk of insect releases, especially if the farmed species are reared in facilities without proper containment measures. Insect releases can have dire consequences on ecosystems, food security, and human health due to the potential spread of insect-borne pathogens. Consequences can be all the more severe if the insects are not native to the region and are genetically manipulated to become bigger and improve their survival rate.

Insect farming runs the risk of disrupting ecosystems

The scale-up and competitiveness of the insect farming industry implies the multiplication of large insect farms, as well as the selection of species and concentration of insects at very high densities. The species farmed are often non-native, and, as pointed out in a 2021 study, "in areas without regional or national pre-entry regulations, post-entry monitoring guidelines and early response programmes to address escapee species" (Bang & Courchamp, 2021).

All these factors raise the question of what happens in case of insect release. A 2019 study, cited by the European Commission's own experts (EU platform on sustainable finance: Technical working group, 2021), cautions that "the risk of commercial insect species becoming locally invasive should not be easily discounted, especially since **the cost of invasive species to natural and production systems are enormous"** (Berggren et al., 2019). The short lifespans and development cycles of the species selected for

farming are ideally suited for rapid dispersal if they were to be released in natural ecosystems. For example, the black soldier fly's "industrial production in regions where the insect is not native, like northwestern Europe, could lead to permanent establishment, which might entail environmental risks" (Spranghers et al., 2017).

Insect releases could have an even bigger impact due to the genetic manipulation of farmed insects

At the same time, the insect production industry is turning to genetic breeding and genetic selection, with producers admitting their competitiveness in the sector is dependent on their insects growing bigger and faster (Barrett & Fischer, 2023). For this reason, industry leaders like Ÿnsect (Ynsect, 2023), Beta Bugs (Beta Bugs Ltd, 2024) and others are all investing in insect genetics. Insect genetics company FreezeM has also developed a "Black Soldier Fly Larvae Titan": a bigger strain of black soldier fly, with a higher feed conversion ratio (FreezeM, 2024). Some academics have also relied on the CRISPR/Cas-9-based gene-editing techniques to increase size and develop winglessness in black soldier flies (Zhan et al., 2020). These gene editing techniques can turn into hereditary changes, as has been highlighted by a FreezeM co-founder (AgfunderNews, 2024).

Inevitably, if left unchecked, these new genetic strains will end up in the wild. Already, "evidence of hybridisation" was observed between wild and commercial strains of black soldier fly in nature, "likely as a product of escaped flies from commercial, or amateur farms" (Generalovic et al., 2023) as reported by the authors of a 2023 study. They stress that this release of commercial flies in the wild "poses conservation concerns" (Generalovic et al., 2023). It is easy to see how such a scenario could entail far more dire consequences.

Catastrophic consequences for a likely scenario

The release of thousands (if not hundreds of thousands) of insects due to a facility breach could have a tremendous impact on nearby ecosystems, especially if the insects are selected, or genetically modified, to grow and feed at very high rates. Moreover, the changing climate increases the capacity of invasive alien species to establish. Released insects could lead to the spread of antibiotic-resistant bacteria into the environment, posing a risk not only to the environment but also to human health. They would pose an additional threat to native biodiversity (Council on Animal Affairs, 2018) and the already struggling wild-living insects that are essential for the ecosystem, such as pollinators.

At a time when wild insect populations are in decline - in part due to the loss of their habitats to industrial agriculture and pesticide use - the development of another form of factory farming that contributes to the great damage caused by these intensive systems is worrying. The threat of genetically-selected farmed insects being released is another bad sign for the capacity of wild insects to support the ecosystems we depend on.

5: Insects and food security

Insect farming has been presented as a provider of long-term food security in the European Union. Notably, this claim is supported by a promise of domestically produced insect meal to replace imported feed compounds, such as soy meal. However, extensive scrutiny of the realities of insect farming sheds doubt on the sector's real contribution to European food security.

Insect farming exacerbates the food/feed competition

Many European producers feed their insects on conventional crops and byproducts that could be used directly for animal feed or human consumption, rather than on waste streams. Indeed, the logistical challenges of utilising food waste, the other use of agricultural byproducts, the health regulations designed to ensure the safety of the insect supply chain and cheaper costs tend to lead insect producers to rely on crops that could be used directly to feed farm animals. According to the industry's data, around 75% of producers use fruits, vegetables, and cereals (IPIFF, 2018), while a former insect company producer confessed that "many of the feedstocks used for insect production today would otherwise be used as animal feed" (Badeski, 2023).

This creates an additional trophic level in the food chain and logically increases the dependency on imported crops. For FAO, the development of insect farming, "if this substrate is similar to the diet fed to livestock, [...] may again lead to competition for the same resources" (FAO, 2021). In addition to further exacerbating the competition of crop use for food and feed, insect farming as a feed industry in its current form supports conventional industrial farming practices and the extensive amount of land, water, and other resources it requires. This further offsets the prospect of insect farming helping Europe achieve self-sufficiency.

EU supported companies are already offshoring

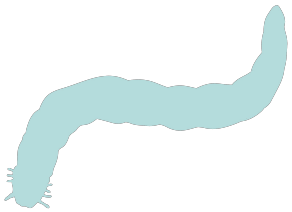
Additionally, if insect farming is to contribute in a significant way to the EU's food security, the majority of insect-related businesses should be based within the continent. The EU and Member States have invested financially, including in specialised research, to help the insect farming sector develop and deliver on its promises. However, in recent years, many of Europe's major insect producers have announced plans to expand production in North America and Southeast Asia, foreseeing a potential move to offshore to other geographies. Such plans include Ÿnsect's and Protix' plans to move to the US (Tyson Foods, 2023; Ynsect, 2022), as well as InnovaFeed's move to Illinois (Innovafeed, 2024) and Southeast Asia (Les Echos, 2022).

On the whole, Europe and North America are poor environments for the industry. Former insect company founder Micheal Badeski highlights that, to succeed, the industry needs "a willingness to accept that some geographies such as Europe and North America simply cannot be cost competitive in the long run with other ones such as Southeast Asia without enduring subsidies" (Badeski, 2023). This is due to labour and energy costs being high in Europe, and to there being more appropriate climatic conditions elsewhere.

While these companies have been supported by both EU and national funds, this flight of European talents and expertise would cancel any benefits to the EU's food security. In other words, "offshoring insect farms may jeopardise Europe's food sovereignty" (Ryba, 2024).

A dependency on imported insects

Moreover, a 2020 analysis of the European edible insect market noted that 65% of companies selling insect products for human consumption in Europe were importing whole insects from Asian countries, to be reprocessed or resold (Traynor et al., 2024). This is corroborated by the industry's own data, showing that the majority of companies that sell insects for human consumption do not produce and slaughter the insects themselves (IPIFF, 2020). In addition to failing to strengthen the EU's food security, this dependence could pose the threat of 'food fraud' (when food or related items, such as food packaging, are deliberately misrepresented, tampered with and/or otherwise) on the EU's insect supply chain (Traynor et al., 2024).



The threats of accidental releases

As mentioned under "5. Insects and biosecurity risks", the release of farmed insects into landscapes they are not native to could cause major disruptions to our ecosystems. Along with posing a biosecurity risk, this occurrence would likely have an extremely damaging effect on our food systems as well, with a 2019 study revealing that **invasive species have already been the cause of a 14% reduction in global food production** (Berggren et al., 2019).

Conclusion

Touted as a solution to the EU's food security crisis, the insect farming industry in its current form might actually end up worsening it, especially if the main European-grown companies offshore their production to other parts of the world. **This would lead to the EU increasing its dependency on imported feed.** The reliance of insect retailers on insects reared in third countries, as well as the potentially damaging effects of accidental insect releases, further hinder the ability of this industry to help food security in the EU.

6: Insects and animal welfare

The insect farming industry is already rearing trillions of animals per year (A. Rowe, 2020) - more than any other livestock rearing initiative in human history - and its planned expansion could mean it rears tens of trillions of insects by 2030. This sheer number begs the question of the farmed insects' capacity to suffer, and to have welfare needs. Luckily, while animal welfare science has long averted the question of invertebrate animals, recent evidence can inform us on the sentience of these disregarded animals, and on the measures that can be taken on farms to ensure their welfare.

Can insects feel pain?

In 2023, Eurogroup for Animals coordinated with researchers a Scientific Declaration on Insect Sentience and Welfare (Eurogroup for Animals, 2023a), summarising the latest evidence on the topic. It must be remembered that the capacity of animals to feel positive or negative emotions, or to feel pain, has historically been wrongly dismissed. Sentience outside of mammals, doubted for a long time, is now understood to exist in birds, fish (Lambert et al., 2022), reptiles (Lambert et al., 2019), and cephalopod molluscs (Low, 2012). **A recent review of the evidence for pain in cephalopod molluscs and decapod crustaceans** (Birch et al., 2021) **also supports the plausibility of invertebrate sentience in arthropods, like insects.**

A 2022 review of the neurobiological and behavioural evidence consistent with pain found strong evidence (six out of eight criteria) for pain in two orders of insects (Diptera [flies] and Blattodea [cockroaches]) and early evidence in other orders, while no group of adult insects was found to conclusively fail to meet a criterion for pain recognition (Gibbons et al., 2022). For comparison, decapods only satisfy five criteria in the same

framework (Birch et al., 2021) and this result was still deemed sufficient to protect them via the United Kingdom Animal Welfare (Sentience) Act 2022.

These findings resonate with the evidence of insect species demonstrating avoidance learning, risk aversion, motivational trade-offs, site-specific grooming of injuries, and protection from further damage (Elwood, 2023). In the New York Declaration on Animal Consciousness in 2024, numerous recognised scientists stated that "the empirical evidence indicates at least a realistic possibility of conscious experience in all vertebrates (including reptiles, amphibians, and fishes) and many invertebrates (including, at minimum, cephalopod mollusks, decapod crustaceans, and insects)" (Andrews et al., 2024).

Early developments of welfare protection

Such evidence, along with the sheer scale of insect farms, call for the implementation of species-specific welfare measures to protect farmed insects. Currently, no comprehensive and species-specific model of insect welfare is implemented on farms. Studies on the black soldier fly (Barrett, Chia, et al., 2023), yellow mealworm (Barrett, Godfrey, et al., 2023), and cricket welfare (E. Rowe et al., 2023), as well as the Brambell's model of the Five Freedoms already acknowledged by insect producers (IPIFF, 2019), can be used to develop these measures. The definition of precise, evidence-based, and implementable species-specific welfare measures is essential, as well as support for further research to address outstanding questions that may allow for the development of updated welfare measures based on the Five Domains.

These measures, depending on each species and lifestage, may include (but are not to be limited to): instantaneous slaughter methods, use of recommended anaesthetics or stunning prior to slaughter or depopulation, avoidance of pre-slaughter starving without safety justifications, bans on inappropriate or hazardous feeding substrates, provision of adequate nutrition and hydration for all life stages, banning of genetic manipulation that prevents the expression of natural behaviour (such as the inability to fly or physiological overgrowth), appropriate rearing densities, avoidance of stress-inducing light for photophobic species, species-appropriate temperature and humidity levels, and disease monitoring, prevention, and treatment protocols.

Benefits from the development of insect welfare measures

Beyond improved life conditions for the animals reared on insect farms, the development of welfare measures could also have health benefits. To address the major concern of food safety linked with insect farming, welfare standards can serve as a compass. Indeed, some waste streams that are associated with poor welfare performance can also induce health risks. This is notably the case for some types of

manures, but also for municipal-scale food waste, which was found to cause up to 99% early mortality on cricket farms (Lundy & Parrella, 2015).

Regarding the genetic manipulation of farmed insects (found to potentially induce welfare concerns), a ban or prior assessments could serve in preventing other risks such as the environmental and economic consequences in the case of accidental insect releases.

Conclusion

While the history of human-animal interaction has taught us not to easily dismiss the capacity of any animal to feel pain, recent evidence suggests insects may well be sentient and have welfare needs. Industry stakeholders and policymakers need to move beyond early assumptions to fully research and protect insect welfare on farms, especially as this could also entail health and biosecurity benefits.

Eurogroup for Animals' asks

The European Union needs to make it clear for companies and citizens when insect proteins are not contributing to more sustainable food systems and to a more circular bioeconomy, by:

- Reconsidering the role of insect farming in the EU's sustainable agrifood policy;
- Halting investments and support for insect protein production when it contradicts EU goals, and further offset the competition of crops for food and feed;
- Developing sustainability guidelines for the insect farming industry;
- Providing clear labelling on the sustainability of animal products that are fed insects;
- Supporting plant-based foods and alternative proteins that deliver clear environmental benefits and contribute to more sustainable food systems.

The European Union needs to help ensure that insect farming does not expose the food chain and ecosystems to contamination, by:

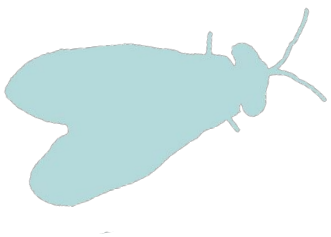
- Upholding the ban on manure and unsafe waste streams as feed for insects;
- Imposing safety checks on insect farms that use food waste, or that commercialise frass or other insect byproducts;
- Ensuring rigorous frass heat treatment protocols, and excluding frass from the EU Fertiliser regulation if its negative effects on plant and ecosystem health are confirmed;
- Providing clear labelling for allergenicity risks on food, feed, and pet food products that include insects;
- Assessing the risk of the insect species farmed becoming invasive during any new farm establishment;
- Having all farms take a regular biosecurity check, and capping rearing densities of farmed insects;
- Banning the genetic selection and manipulation of insects when the strains developed are at risk of exposing ecosystems to gene pollution;
- Providing clear rules on the transport of live insects and eggs.

The European Union needs to ensure that insect farming does not jeopardise efforts to achieve food security in the EU, by:

- Halting European investment and support for insect companies that offshore production outside of the EU;
- Imposing high standards for imported insect products, both as feed and food;
- Taking measures to lessen the exposure of the insect supply chain to food fraud.

The European Union needs to help producers protect insect welfare on farms, by:

- Mandating the European Food and Safety Agency (EFSA) on studying the sentience and welfare needs of insects, and especially insect species that are currently being farmed;
- Supporting research to develop an insect welfare assessment tool;
- Conditioning the authorisation of any new insect species, or any new genetic strains of allowed species, to a comprehensive welfare needs assessment;
- Providing clear welfare rules to protect insect welfare on farms, including mandatory veterinary visits on insect farms, a cap on rearing densities, allowed feed, temperature and humidity conditions, and humane and instantaneous slaughter methods.



References

Acuff, H. L., Dainton, A. N., Dhakal, J., Kiprotich, S., & Aldrich, G. (2021). Sustainability and Pet Food: Is There a Role for Veterinarians? *The Veterinary Clinics of North America. Small Animal Practice*, *51*(3), 563–581. https://doi.org/10.1016/j.cvsm.2021.01.010

AgfunderNews. (2024). *From novelty to necessity? The evolution of insect farming*. https://agfundernews.com/from-novelty-to-necessity-the-evolution-of-insect-farming

Alattar, M. A., Alattar, F. N., & Popa, R. (2016). Effects of microaerobic fermentation and black soldier fly larvae food scrap processing residues on the growth of corn plants (Zea mays). *Plant Science Today*, *3*(1), Article 1. https://doi.org/10.14719/pst.2016.3.1.179

Andrews, K., Birch, J., Sebo, J., & Sims, T. (2024). *Background to the New York Declaration on Animal Consciousness*. nydeclaration.com

Badeski, M. (2023). *Investment Insights for the Insect Industry—Perspective from an Exited Founder*. https://www.linkedin.com/posts/michael-badeski_investment-insights-for-the-insect-industrymbadeski-activity-7137334442422874112-Cxtn

Bang, A., & Courchamp, F. (2021). Industrial rearing of edible insects could be a major source of new biological invasions. *Ecology Letters*, *24*(3), 393–397. https://doi.org/10.1111/ele.13646

Barrett, M., Chia, S. Y., Fischer, B., & Tomberlin, J. K. (2023). Welfare considerations for farming black soldier flies, Hermetia illucens (Diptera: Stratiomyidae): a model for the insects as food and feed industry. *Journal of Insects as Food and Feed*, 9(2), 119–148. https://doi.org/10.3920/JIFF2022.0041

Barrett, M., & Fischer, B. (2023). Challenges in farmed insect welfare: Beyond the question of sentience. *Animal Welfare*, *32*, e4. https://doi.org/10.1017/awf.2022.5

Barrett, M., Godfrey, R. K., Schnell, A., & Fischer, B. (2023). *Farmed Yellow Mealworm (Tenebrio molitor; Coleoptera: Tenebrionidae) Welfare: Species-Specific Recommendations for a Global Industry*. OSF. https://doi.org/10.31219/osf.io/e92kw

Berggren, Å., Jansson, A., & Low, M. (2019). Approaching Ecological Sustainability in the Emerging Insects-as-Food Industry. *Trends in Ecology & Evolution*, *34*(2), 132–138. https://doi.org/10.1016/j.tree.2018.11.005

Beta Bugs Ltd. (2024, March 12). *Beta Bugs Leveraging Sustainable Genetic Technologies to Improve the Black Soldier Fly*. https://www.betabugs.uk/leveraging-sustainable-genetic-technologies-to-improve-the-black-soldier-fly/

Birch, J., Burn, C., Schnell, A., Browning, H., & Crump, A. (2021). Review of the Evidence of Sentience in Cephalopod Molluscs and Decapod Crustaceans. *General - Animal Feeling*. https://www.wellbeingintlstudiesrepository.org/af_gen/2

Cavallo, C., & Califano, G. (2024). Editorial: Alternative protein source for a sustainable and healthy nutrition. *Frontiers in Sustainable Food Systems*, *8*. https://doi.org/10.3389/fsufs.2024.1451483

Council on Animal Affairs. (2018). *Invertebrates as production animals* [Publicatie]. Ministerie van Landbouw, Natuur en Voedselkwaliteit. https://english.rda.nl/publications/publications/2018/09/03/the-emerging-insect-industry

Dealroom.co | Alternative Protein list. (2024, July 19). https://app.dealroom.co/lists/12883

Directorate-General for Agriculture and Rural Development (European Commission). (2020). *EU agricultural outlook for markets, income and environment 2020-2030*. Publications Office of the European Union. https://data.europa.eu/doi/10.2762/252413

Duffield, K. R., Hunt, J., Sadd, B. M., Sakaluk, S. K., Oppert, B., Rosario, K., Behle, R. W., & Ramirez, J. L. (2021). Active and Covert Infections of Cricket Iridovirus and Acheta domesticus Densovirus in Reared Gryllodes sigillatus Crickets. *Frontiers in Microbiology*, *12*. https://doi.org/10.3389/fmicb.2021.780796

Elwood, R. W. (2023). Behavioural Indicators of Pain and Suffering in Arthropods and Might Pain Bite Back? *Animals*, *13*(16), Article 16. https://doi.org/10.3390/ani13162602

EU platform on sustainable finance: Technical working group. (2021). *PART B – Annex: Full list of Technical Screening Criteria*. https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/210803-sustainable-finance-platform-report-technical-screening-criteria-taxonomy-annex_en.pdf

Eurogroup for Animals. (2023a). *Scientific declaration on insect sentience and welfare | Eurogroup for Animals*. https://www.eurogroupforanimals.org/library/scientific-declaration-insect-sentience-and-welfare

Eurogroup for Animals. (2023b, April 25). *External costs of animal sourced foods in the EU | Eurogroup for Animals*. https://www.eurogroupforanimals.org/library/external-costs-animal-sourced-foods-eu

European Commission. (2024, March 13). *Strategic Dialogue on the future of EU agriculture*. https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/main-initiatives-strategic-dialogue-future-eu-agriculture_en

FAO. (2021). *Looking at edible insects from a food safety perspective*. FAO. https://doi.org/10.4060/cb4094en

FreezeM. (2024). *Unveiling the Enigmatic World of the BSF Larvae*. https://www.freezem.com/unveiling-the-enigmatic-world-of-the-bsf-larvae/

Gałęcki, R. & Sokół, R. (2019). *A parasitological evaluation of edible insects and their role in the transmission of parasitic diseases to humans and animals*. https://doi.org/10.1371/journal.pone.0219303

Gasco, L., Renna, M., Bellezza Oddon, S., Rezaei Far, A., Naser El Deen, S., & Veldkamp, T. (2023). Insect meals in a circular economy and applications in monogastric diets. *Animal Frontiers*, *13*(4), 81–90. https://doi.org/10.1093/af/vfad016

Gebremikael, M. T., Ranasinghe, A., Hosseini, P. S., Laboan, B., Sonneveld, E., Pipan, M., Oni, F. E., Montemurro, F., Höfte, M., Sleutel, S., & De Neve, S. (2020). How do novel and conventional agri-food wastes, co-products and by-products improve soil functions and soil quality? *Waste Management (New York, N.Y.)*, *113*, 132–144. https://doi.org/10.1016/j.wasman.2020.05.040

Generalovic, T., Sandrock, C., Roberts, B., Meier, J., Hauser, M., Warren, I., Pipan, M., & Jiggins, C. (2023). *Cryptic diversity and signatures of domestication in the Black Soldier Fly (Hermetia illucens)*. https://doi.org/10.1101/2023.10.21.563413

Gibbons, M., Crump, A., Barrett, M., Sarlak, S., Birch, J., & Chittka, L. (2022). Chapter Three - Can insects feel pain? A review of the neural and behavioural evidence. In R. Jurenka (Ed.), *Advances in Insect Physiology* (Vol. 63, pp. 155–229). Academic Press. https://doi.org/10.1016/bs.aiip.2022.10.001

Innovafeed. (2024, April 18). *Innovafeed Expands to U.S.; French Agtech Firm Opens Insect Innovation Center in Decatur, Ill.* https://innovafeed.com/en/innovafeed-expands-to-u-s-french-agtech-firm-opens-first-insect-innovation-center-in-decatur-illinois/

IPIFF. (2018). *IPIFF vision paper on the future of the insect sector—Survey of IPIFF members*.

IPIFF. (2019). *Ensuring High Standards of Animal Welfare in Insect Production*. https://ipiff.org/wp-content/uploads/2019/02/Animal-Welfare-in-Insect-Production.pdf

IPIFF. (2020). *Edible insects on the European market*.

IPIFF. (2024). *IPIFF Contribution Paper on 'The Future of the Common Agricultural Policy'. Opinion of the Committee of the Regions – Commission for Natural Resources*. https://ipiff.org/wp-content/uploads/2024/05/IPIFF-Contribution-Paper-CoR-The-Future-CAP-21_03_2024.pdf

Kim, E., Koo, H., Kim, J., Baek, J. H., Kim, C., Park, K., & Yoon, J. (2024). *Crisis in South Korean cricket farms: Occurrence of Gryllus bimaculatus densovirus and its spread*. https://doi.org/10.1163/23524588-00001151

Lambert, H., Carder, G., & D'Cruze, N. (2019). Given the Cold Shoulder: A Review of the Scientific Literature for Evidence of Reptile Sentience. *Animals*, 9(10), Article 10. https://doi.org/10.3390/ani9100821

Lambert, H., Cornish, A., Elwin, A., & D'Cruze, N. (2022). A Kettle of Fish: A Review of the Scientific Literature for Evidence of Fish Sentience. *Animals: An Open Access Journal from MDPI*, *12*(9), 1182. https://doi.org/10.3390/ani12091182

Les Echos. (2022, September 20). *Innovafeed lève 250 millions pour devenir le leader des protéines à base d'insectes*. https://www.lesechos.fr/start-up/deals/innovafeed-leve-250-millions-pour-devenir-le-leader-des-proteines-a-base-dinsectes-1794629

Liverød, T. (2019). *Livsløpsvurdering av insektproduksjon basert på norske ressurser* [Master thesis, NTNU]. https://ntnuopen.ntnu.no/ntnu-xmlui/handle/11250/2624654

Low, P. (2012). *Cambridge Declaration on Consciousness*. https://fcmconference.org/img/CambridgeDeclarationOnConsciousness.pdf

Lundy, M. E., & Parrella, M. P. (2015). Crickets Are Not a Free Lunch: Protein Capture from Scalable Organic Side-Streams via High-Density Populations of Acheta domesticus. *PLOS ONE*, *10*(4), e0118785. https://doi.org/10.1371/journal.pone.0118785

Onwezen, M. C., Bouwman, E. P., Reinders, M. J., & Dagevos, H. (2021). A systematic review on consumer acceptance of alternative proteins: Pulses, algae, insects, plant-based meat alternatives, and cultured meat. *Appetite*, *159*, 105058. https://doi.org/10.1016/j.appet.2020.105058

Pet Food Institute. (2020). *Pet Food Production and Ingredient Analysis*. https://www.petfoodinstitute.org/wp-content/uploads/20200310-Pet-Food-Report-FINAL.pdf

Pinarelli Fazion, J., Marzoli, F., Pezzuto, A., Bertola, M., Antonelli, P., Dolzan, B., Barco, L., & Belluco, S. (2023). A systematic review of experimental studies on Salmonella persistence in insects. *Npj Science of Food*, *7*(1), 44. https://doi.org/10.1038/s41538-023-00223-0

Praeg, N., & Klammsteiner, T. (2024). Primary study on frass fertilizers from mass-reared insects: Species variation, heat treatment effects, and implications for soil application at laboratory scale. *Journal of Environmental Management*. https://www.sciencedirect.com/science/article/pii/S030147972400608X?via%3Dihub

Precup, G., Ververis, E., Azzollini, D., Rivero-Pino, F., Zakidou, P., & Germini, A. (2022). The Safety Assessment of Insects and Products Thereof As Novel Foods in the European Union. In L. Scaffardi & G. Formici (Eds.), *Novel Foods and Edible Insects in the European Union: An Interdisciplinary Analysis* (pp. 123–146). Springer International Publishing. https://doi.org/10.1007/978-3-031-13494-4_7

Rowe, A. (2020). *Insects raised for food and feed—Global scale, practices, and policy*. Rethink Priorities. https://rethinkpriorities.org/publications/insects-raised-for-food-and-feed

Rowe, E., López, K. Y. R., Robinson, K. M., Baudier, K. M., & Barrett, M. (2023). *Farmed Cricket (Acheta domesticus, Gryllus assimilis, and Gryllodes sigillatus; Orthoptera) Welfare Considerations: Recommendations for Improving Global Practice*. OSF. https://doi.org/10.31219/osf.io/c4qp3

Ryba, R. (2024). *Offshoring insect farms may jeopardise Europe's food sovereignty*. OSF. https://doi.org/10.31235/osf.io/6wq4f

Smetana, S., Bhatia, A., Batta, U., Mouhrim, N., & Tonda, A. (2023). Environmental impact potential of insect production chains for food and feed in Europe. *Animal Frontiers*, *13*(4), 112–120. https://doi.org/10.1093/af/vfad033

Spranghers, T., Noyez, A., Schildermans, K., & De Clercq, P. (2017). Cold Hardiness of the Black Soldier Fly (Diptera: Stratiomyidae). *Journal of Economic Entomology*, *110*(4), 1501–1507. https://doi.org/10.1093/jee/tox142

SUSINCHAIN Project. (2022). *Deliverable D6.1—Microbial and chemical safety data of insect substrates and mixtures*. https://susinchain.eu/wp-content/uploads/2023/07/D6.1_Microbial-and-chemical-safety-data-of-insect-substrates-and-mixtures.pdf

Traynor, A., Burns, D.T., Wu, D. et al. (2024). *An analysis of emerging food safety and fraud risks of novel insect proteins within complex supply chains*. https://www.nature.com/articles/s41538-023-00241-y

Tyson Foods. (2023, October 17). *Tyson Foods Announces Partnership with Protix for More Sustainable Protein Production*. https://www.tysonfoods.com/news/news-releases/2023/10/tyson-foods-announces-partnership-protix-more-sustainable-protein

UNEP. (2021, April 3). *UNEP Food Waste Index Report 2021 | UNEP - UN Environment Programme*. https://www.unep.org/resources/report/unep-food-waste-index-report-2021

van Huis, A. (2013). *Edible insects: Future prospects for food and feed security*. FAO.

Watson, C., Preißing, T., & Wichern, F. (2021). Plant Nitrogen Uptake From Insect Frass Is Affected by the Nitrification Rate as Revealed by Urease and Nitrification Inhibitors. *Frontiers in Sustainable Food Systems*, *5*. https://doi.org/10.3389/fsufs.2021.721840

Ynsect. (2022, March 29). *Ynsect opens first mealworm farm in the US and enters local premium chicken feed market after Jord joins its production platform*. Ynsect. https://www.ynsect.com/2022/03/29/ynsect-opens-first-mealworm-farm-in-the-us-and-enters-local-premium-chicken-feed-market-after-jord-joins-its-production-platform/

Ynsect. (2023, June 6). *WORLD-FIRST: ŸNSECT REVEALS THE FIRST HIGH-DENSITY GENOTYPING CHIP FOR INSECT BREEDING*. Ynsect. https://www.ynsect.com/2023/06/06/world-first-ynsect-reveals-the-first-high-density-genotyping-chip-for-insect-breeding/

Zhan, S., Fang, G., Cai, M., Kou, Z., Xu, J., Cao, Y., Bai, L., Zhang, Y., Jiang, Y., Luo, X., Xu, J., Xu, X., Zheng, L., Yu, Z., Yang, H., Zhang, Z., Wang, S., Tomberlin, J. K., Zhang, J., & Huang, Y. (2020). Genomic landscape and genetic manipulation of the black soldier fly Hermetia illucens, a natural waste recycler. *Cell Research*, *30*(1), 50–60. https://doi.org/10.1038/s41422-019-0252-6

Zurek, L. & Gorham, J. R. (2008). Insects As Vectors Of Foodborne Pathogens. In *Wiley Handbook of Science and Technology for Homeland Security*. https://onlinelibrary.wiley.com/doi/10.1002/9780470087923.hhs365

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