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EDITORIAL

# Can we re-think a model of values in which humans and insects can share mutual advantages?

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**Abstract**

Starting from the case study of sericulture, the author describes how consumers may currently have reservations about the environmental and ethical sustainability of insect farming, considering it a form of intensive agriculture. Drawing on the cultural reworking of silkworm rearing in countries such as Japan and the United States, and on recent projects developed in Europe at the intersection of agriculture and culture, the author proposes adopting farming models that can lead to social acceptance, integrate with local traditions and benefit both humans and insects.

**Keywords**

animal welfare – insect domestication – multispecies ethnography – organic silkworm – rearing – sericulture

## 1 Introduction

Thirteen years have elapsed since the FAO International Expert Consultation on 'Assessing the Potential of Insects as Food and Feed in Assuring Food Security' was held at the FAO headquarters in Rome, in 2012 (van Huis *et al.*, 2013). Notwithstanding the considerable increase in expectations for growth in the insect industry, insects as a food source for humans have yet to be firmly established (Biteau *et al.*, 2025). In addressing Westerners' reluctance to consume insects, the emphasis was placed on environmental benefits, underscoring that insect incorporation into the diet would contribute to a reduction in greenhouse gas emissions, land use and energy consumption (Biteau *et al.*, 2025). Additionally, it was highlighted that this practice would facilitate the recovery of by-products within the framework of a circular economy (Smetana *et al.*, 2016). Nevertheless, consumers might not necessarily view insect farming as being as sustainable as it is often portrayed. Silkworm-rearing can be considered a case study through which to understand this phenomenon.

Apart from the cocoons being processed for silk extraction, the pupae are often separated from the boiled, steamed or dried cocoons and can be used for various purposes, such as animal feed (for livestock, poultry, and fish), human consumption (fried, roasted, or used in soups and other dishes), or in traditional medicines and in cosmetics (due to their high protein and lipid content).

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## 2 How the perspective on silk production has changed over the years

Until a few decades ago, silkworm-rearing was considered an environmentally friendly practice with significant positive social implications, such as increasing the income of small farmers and rural families and advancing the role of women, who have always been particularly involved in caring for the larvae and processing the fibre. As well as being a symbol of refinement and luxury, silk material was valued for being natural and non-polluting, as it is fully biodegradable (Altmann and Farrell, 2022).

In recent years, many studies have challenged the assumption that silkworm production has a more favourable environmental impact than other natural fibres and polyester. When it comes to fabric production, silk has by far the highest environmental impact, with 80.9 kg of $CO_2$ equivalent, followed by polyester with 14.9 kg of $CO_2$ equivalent (Sustainability Lab, 2024).

These results have been highlighted by the international press and some fashion industries. However, significant changes to the results are to be expected when considering the use of the item (durability, washing) and its end-of-life status (recyclability). Therefore, it is crucial to define the scope of the analysis, i.e. the stage of the product life cycle that the study focuses on (*ibid*).

Concerning insects for food use, Biteau *et al.* (2025) state: 'It is important to keep in mind that the lower environmental impact of insects compared to meat is not extraordinary—most foods, including protein-rich ones, are less resource-intensive than meat.' In the same paper, the authors say: 'Plant-based alternatives have a higher consumer acceptance and a lower environmental impact than insects, making them a viable option.' The World Health Organization judges that appropriately planned plant-based or predominantly plant-based diets are healthier and more environmentally friendly than conventional diets (*ibid*).

In general, it can be said that Life Cycle Assessment is a useful tool for evaluating critical environmental issues, but it is very often applied only to segments of the production cycle and, in any case, it cannot be the only parameter on which to evaluate the opportunity to conduct a production activity, because it does not take into account many other social factors that have an impact on the environment (e.g. supplementing farmers' income in some areas through insect farming or maintaining farmers in rural settings rather than favouring urbanisation).

However, the sustainability of insect farming is not only a matter of its environmental impact but has also recently become a more complex issue with cultural implications.

## 3 'Multispecies ethnography' and its relationship with insect farming

Since the early 2000s, 'multispecies ethnography' has emerged as a different approach to viewing the world and an alternative to dichotomous schemes, according to which nature (animals) and society (humans) are originally heterogeneous (Kirksey and Helmreich, 2010). It calls into question long-established 'anthropocentric' paradigms by acknowledging non-human entities as dynamic agents in collectively inhabited environments, exerting influence on social, cultural, and ecological practices (*ibid*). This standpoint finds concurrence with the overarching notion of multispecies justice, a philosophical concept that seeks to ensure fair treatment of all living beings and acknowledges their symbiotic roles in ecological systems (Celermajer *et al.*, 2021). The emergence of this new worldview has attracted the interest of many different researchers with diverse backgrounds (such as Environmental, Science and Technology, Animal Studies, among others) to investigate animals used in labs and food production from their unique disciplinary perspectives (Kirskey and Helmreich, 2010). The fundamental premise is that the anthropocentric concept, which asserts the negligible importance of insect welfare and health when human needs are prioritised, has become invalid.

## 4 Pain perception in invertebrates

The welfare of farmed animals is regulated by Directive 98/58/EC, which excludes invertebrates. Consequently, there are presently no EU requirements for the welfare of insects apart from national legislation, which may include insects, e.g. in the Netherlands (Meyer *et al.*, 2025). Here, the law recognises the intrinsic value of production animals, including insects, ensuring freedom from hunger and thirst, discomfort, pain, injury or disease, fear and distress, and the freedom to express normal behaviour. Research is ongoing on how these five freedoms apply to insects. According to Erens *et al.* (2012), in insects '... pain sensation, or suffering, is very unlikely to occur. The perception of injury is related to the perception of pain. If, based on existing scientific

research, insects are not likely to experience chronic pain and go about with their normal behaviour even after, for instance, a body part has been removed, then "injury" is probably not of fundamental importance to insect welfare.' However, the consensus is that a precautionary approach to insect welfare is required (Barrett and Adcock, 2023; Barrett and Fischer, 2023; Delvendahl *et al*., 2022; Klobucar and Fisher, 2023). Rearing conditions that optimise performance in terms of survival and yield for commercial purposes are likely to be aligned with welfare considerations but are species specific. IPIFF has published a factsheet on insect welfare to standardise industrial practice, but the document is non-binding (IPIFF, 2019).

## 5 Main problems in silkworm rearing

The emergence of these new currents of anthropological thought and the public debate on these sensitive issues has changed the general perception of certain processes (Rowe, 2020a). The primary challenge associated with silkworm rearing pertains to the final stage of the juvenile phase, in which the larva transforms into a chrysalis by spinning a cocoon around itself. In order to prevent the adult from damaging the continuous thread that constitutes the cocoon when it emerges, thus rendering the industrial reeling process impractical, it is necessary to kill the insect. Due to technological constraints related to the preservation of the fibre properties, the process must be completed as expediently as possible to facilitate the loss of water. Consequently, the process of drying, which elevates the cocoon's temperature to above 100 °C, swiftly results in the chrysalis devitalisation (Lee, 1999). Although rapid, this practice (which is also applied to other insects used as food for humans or animal feed) is regarded by a growing segment of the population as cruel (Rowe, 2020b). Indeed, the concept of 'ahimsa' or 'peace silk' has been introduced, involving no killing of the insect and respect for its complete life cycle. 'Peace silk' is characterised by its higher cost and reduced quality in comparison to traditional silk. This is because the cocoons used in silk production are damaged during the moth's emergence and can only contribute a small fraction to the whole silk industry. The transparency of the practices employed by suppliers of 'peace silk' is challenging to ascertain. Michael Cook, a silk moth farmer, published an article in which he critiques 'peace silk' methods and draws attention to the potential deaths that may be incurred by the subsequent silkworm generation (Rowe, 2020b).

A further point raised on websites dealing with the issue of cruelty to silkworms is the number of larvae that die on farms due to disease (Rowe, 2020b). This problem can also be generalised to all insect farms, particularly intensive ones, where repeated cycles frequently result in the multiplication of pathogens, unless heavy disinfection, administration of antibiotics and prophylactic measures are carried out. It has been asserted that this issue can cause the most profound suffering and be far more serious than silkworm slaughtering (Rowe, 2020b). However, in the context of sericulture, this problem is particularly pronounced in tropical countries, where cycles can occur at a rate of 8–9 per year. This is due to the rapid growth of pathogens, as well as the continuous use of pesticides for other crops, which must support an elevated production rate. It can be posited that all forms of intensive farming, irrespective of the domestic animal in question, give rise to analogous criticalities. The crux of the issue does not lie in the practice of silkworm/insect farming itself, but rather in the decision to adopt a specific production model. In relation to the incidental poisoning of insects by pesticides on mulberry leaves, it is important to note that this problem is not limited to farmed insects. Indeed, it is a more widespread issue that also affects wild insects. Once more, the focus does not lie on the practice of farming itself, but rather in the pervasive use of pesticides within the agricultural sector (FAO, 2025).

## 6 Cultural elaboration of the pain inflicted on silkworms: the *kuyō* ritual in Japan

In Japan all creatures — humans, mammals, insects and fish — are considered 'living beings'. In connection with the Buddhist idea of transmigration, killing a living being is equivalent to killing a possible human reincarnation. With regard to sericulture, which involves the death of silkworms, various regions of Japan have adopted the spirit of "kuyō" (ritual of commemoration) towards silkworms in the form of memorial stones or towers (Kozawa, 2024). Kozawa interviewed present-day silkworm farmers to investigate how they have reinterpreted this customary practice. Some farmers view silkworm rearing as part of a larger cycle, in which the life of the silkworms is transformed and regenerated. Furthermore, they believe that the death of silkworms is linked to a new existence within human society. They also reflect on the mutual relationship between humans and silkworms. Silkworms are thus not only seen as individuals, but also as a species shaped by humans

and transformed into fully domesticated animals — living entities whose destiny was inextricably intertwined with that of humans. In fact, silkworm farmers want to pass on sericulture to future generations to ensure the continued survival of the silkworm (Kozawa, 2024).

Kozawa concludes by saying: 'This spirit of "kuyō" can be interpreted as a kind of "absolution", which justifies the killing of other species from a purely human perspective and is therefore a form of anthropocentric thinking. However, the fact remains that humans cannot live without killing other living beings and that human life itself has been passed down uninterrupted through interdependent relationships with all other forms of life' (Kozawa, 2024).

## 7 Modern cultural elaboration of silkworm rearing: Silk Pavillon II

The idea that the fates of silkworms and humans are intimately connected is also evident in the work of Neri Oxman, an American architect based at MIT in Boston. In her 2020 exhibition 'Silk Pavilion II' at the Museum of Modern Art in New York, she investigated the possibility of spinning silk into sheets rather than cocoons by providing silkworm larvae with a special support structure (Mariem and Amine, 2024). This project demonstrates that this unique insect can act as both a construction worker and a designer, collaborating with a man-made structure that guides its movement and deposition of silk to create an enhanced form (Mariem and Amine, 2024). Consequently, the chrysalis forms outside the cocoon, eliminating the need to kill the animal to harvest its silk.

## 8 Silkworm and domestication

Climate change and the awareness that it is caused by human activity, increasing pollution and the destruction of certain natural habitats, create especially in the Western world a sense of guilt and unease about our consumption habits and a need to rethink our relationship with the environment around us (Mallet *et al.*, 2021). As mentioned above, this raises the issue of reconsidering humans as beings in relation to other creatures, while productive and economic activities have to be integrated into a more general 'ecosystem'. Domestication and animal husbandry, practised by humans since Neolithic times (Yang *et al.*, 2014), must therefore be reworked and adapted to the present day, but this cannot be done without taking certain general considerations into account. If it is anthropocentric to ignore the presumed and unproven suffering of insects due to farming, it is also anthropocentric to attribute human feelings and emotions to invertebrates. Returning to the case of the silkworm, humans have domesticated the silkworm and deliberately kill a very high number of individuals per year but have ensured the species' survival to the present day in a surprising biodiversity. The spread of *Bombyx mori* has been much greater than its original range, considering that *Bombyx mandarina*, which is regarded as the domesticated silkworm ancestor (Banno *et al.*, 2004), lives in Far East Asia only. Let us compare the two insect species: certainly, some millions of domestic silkworm pupae are sacrificed yearly, but how many wild silkworm eggs hatch after being exposed to winter diapause on trees and bad weather? How many small larvae are preyed upon by birds, ants, wasps or simply fall ill due to the sudden change in temperature? And how many fall to the ground from the mulberry trees? On the other hand, if this did not happen, there would not be enough mulberry trees in the environment to feed the population, which would grow exponentially with each generation. For the human species, which reproduces in a limited manner, everyone is precious and irreplaceable, but for a moth that lays between 400 and 600 eggs, the loss of three quarters of its offspring, and more, is an innate strategy for the survival of the species. Insects are animals and therefore capable of sustaining and undergoing significant injuries, and this is a natural occurrence. The moth that emerges from the cocoon does not feed because its mouth and digestive system are no longer functional for this purpose. Its adult life is dedicated to mating and laying eggs, which occurs approximately between 24 and 48 hours after the adult emerges. For the rest, the moth's life is a slow and inexorable agony, in which it dies of exhaustion of its bodily resources, i.e. starvation, and this situation can last between a week and ten days. This phenomenon was not created by domestication. Nature has decided that after reproduction, the insect has fulfilled its function. Humans kill the insect in the chrysalis stage to preserve the silk cocoon. As much as this interferes with the natural cycle of the animal, it is no more cruel than what would naturally occur. Therefore, while it is true that, when unnecessary, humans should not inflict suffering on any living being, it is also true that everything must be viewed within a natural perspective and a framework of reasonableness.

## 9 Welfare and type of farming: focusing on the relationship between farmers and insects

I have tried to explain the opposition to insect farming from the perspective of possible consumer concerns (Delvendahl *et al*., 2022) about inflicting suffering on animals. However, I have also described how culture can be active in alleviating this concern. For instance, in Japan, there is the practice of "kudo", and more recently in the USA, works of art have been created that celebrate the collaboration between humans and silkworms without involving the killing of the chrysalids. Therefore, it is important that any technological innovation, such as insect farming, is accompanied by cultural interpretation and appropriate ethics. In the case of silkworms, a significant advance has recently been made in Italy. In 2015, the 'Seta Etica' (Fair Silk) project, supported by the Veneto Region, involved reviving silkworm farming in the Veneto region to produce silk and gold jewellery. From the outset, it was agreed that any new activity had to provide small-scale farmers with a fair income. Economic conditions were negotiated between the farmers and the industry that would process the product, resulting in a three-year purchase contract that justified the initial investment. Farmers were then trained through specific vocational courses organised by the Laboratory of Sericulture of Padova (CREA), and a rearing standard was established to ensure the activity was carried out in an environmentally sustainable way and to create fair conditions for silkworm rearing. The opportunity to have their product purchased was only open to farmers who adhered to this standard (Seta Etica, 2017). The rearing techniques were ideal for the insect, resulting in a superior quality product. CREA's sericulture laboratory gave technical assistance to the farmers and the purchasing company, with frequent field visits to check that the standard was being respected.

Subsequently, a standard of practice for organic silkworm rearing was introduced to make sericulture even more environmentally sustainable (ICEA, 2015). This created a small economy, which began to attract other industries interested in using the by-products. Attempts were also made to introduce innovations with the support of other regional projects, and a regional law was issued aimed at restoring the area's landscape heritage, consisting of ancient mulberry trees (Consiglio Regionale del Veneto, 2024). This revitalisation effort culminated in the submission of a project to the European Community for the preservation of genetic resources and cultural heritage linked to silkworm farming: ARACNE (Horizon Europe 2023–2026) (Aracne, 2023). Italy, France, Spain, Slovenia, Greece, Bulgaria and Georgia are participating in this project with the long-term aim of promoting a cultural itinerary to attract tourists and create environmental, social and historical educational prospects, as well as job opportunities for farmers' communities, thereby encouraging them to remain in their territories. This enormous effort to combine creative and cultural production, agriculture and innovation is yielding good results and has been well received in the participating countries.

## 10 Conclusion

Although silkworm farming is a well-established practice in Europe and cannot be compared to the introduction of new insect rearing, it nevertheless provides an interesting case study through which to understand how the acceptance of insect farming can vary depending on its practices and the accompanying cultural narrative. For example, developing mini-livestock rearing among small farmers who can explain to the public how they carry out the process with passion, by using sustainable methods and nourishing the insects with healthy, organic plants (or plant by-products), might be a way of protecting the land and the environment and organising a successful supply chain. Therefore, sustainability is promoted by balancing economic growth with social equity and ecological health (Dizitha and Sanjatmiko, 2024).

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