Sustainable Proteins? Values Related to Insects in Food Systems

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Abstract Developing large scale production systems for farmed insects to supplement or replace feed and food ingredients from vertebrate livestock is often heralded as a more sustainable way to produce animal protein than currently used livestock production methods and is receiving increased interest from a diverse set of stakeholders ranging from political decision makers, environmental interest groups, farmers, industry and scientists. This is hardly a surprise, as sustainability has been widely embraced as a broad and inclusive political (ideological) as well as managerial (practical) framework. Ideally sustainability is a balance between a one-sided focus on productivity and profit on the one hand, and uncompromising demands for nature preservation and calls for radical changes in the agricultural production on the other. But there are different views on how to strike that balance – to some extent reflecting different values – which in turn gives rise to different challenges on how insects can contribute to food systems around the world.

1 Introduction: Why Insects for Food and Feed?

Sustainability – in its broadest sense encompassing environmental, economic and social dimensions – is widely embraced as a broad and inclusive ethical as well as managerial framework allowing for a common platform for discussing productivity and nature related concerns in many, if not all sectors of society, including food and feed production (Gamborg and Sandøe 2005). In this chapter we present an account of the values related to insects in food systems, discussing mainly concerns related to the environmental dimensions of sustainability that producing insects for food

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and animal feed may give rise to. In doing this we draw the attention to a wider set of values and ethical issues related to insect production, including issues related to animal welfare and wider animal ethical issues. It should be noted that both insect production and other kinds of protein production, whether based on plants or animals, differ a lot both with regard to intensiveness/extensiveness, size, environmental impact etc. In this chapter we discuss the general issues related to claims about sustainability, but fully acknowledge that it is necessary to be much more specific than we are able to be here to make an actual comparison of the different systems.

For many years global food security – understood as the task of providing an adequate and nourishing diet for all humans – has been high on the global agenda (FAO 2015a). Despite intensive efforts there are still almost 800 million people, mostly in the developing world, who do not have enough food to live a healthy active life (FAO 2015b). It is estimated that more than three million children under the age of 5 die every year because of poor nutrition (The Lancet 2013). The second of the 17 *Sustainable Development Goals* of the United Nations that officially came into force in 2016 states that the global community should work to eradicate hunger by the year 2030 (United Nations 2015).

This food security challenge hence has two interacting dimensions. One is the actual population growth, the other is a potential shift to animal based protein in regions so far eating a plant based diet. As showed by FAO, in e.g. India and South Asia demand for poultry meat will increase also independently of population growth with about 725–850% the coming 30 years (FAO 2011). The severity of the situation is visible by a number of further facts: (i) A growing world population estimated to reach 8.5 billion in 2030, 9.7 billion in 2050 and 11.2 billion in 2100 (United Nations 2015); (ii): The subsequent need to increase food production, both to allow for a growing population and a shift towards a diet containing more animal protein in many parts of the world, resulting in a need to increase global food production by 60% by 2050 (Alexandratos and Bruinsma 2012); and (iii): Climate change is expected to create difficulties for global food production through both direct and indirect effects, which increases the need to develop a "climate-smart food system" to ensure food security for a growing world population (Wheeler and von Braun 2013), including ensuring that produced food is actually consumed by reducing food waste (Sala et al. 2017).

On top of these challenges comes the growing acknowledgement that current food production systems, especially animal production systems, are at odds with the idea of a sustainable food production (Röös et al. 2016). Conventional livestock production such as cattle affects its surroundings substantially (Gamborg and Gjerris 2012; Ilea 2009). About 2/3 of all arable land is already used for animal production which has been shown to contribute to deforestation, changes in savannas, drainage of wetlands, and desertification (Norris et al. 2010). In general, current livestock production is a cause of environmental degradation in many cases (Steinfeld et al. 2013). Furthermore, the livestock sector is a significant contributor to GHG emissions that creates climate change that subsequently will create further challenges to food production as mentioned above. The contribution of the livestock sector to anthropogenic GHG emissions is estimated as ranging from 14.5%

(Gerber et al. 2013) to 18% (Steinfeld et al. 2006) to more than 50% (Goodland and Anhang 2009). A consequence of this is that just securing the necessary feed resources to a growing population demanding animal protein on a daily basis while at the same time attempting to lessen the environmental and climate impact will be one of the most challenging issues for ordinary livestock production (Makkar et al. 2014) and for aquaculture (Henry et al. 2015) in the future.

The search for solutions to the combined challenges described above has led some researchers to suggest that utilizing insects as a source for food and feed through the development of efficient large-scale production systems could be a significant factor in both ensuring food security (van Huis et al. 2013) and developing a more sustainable food production (Oonincx et al. 2010). In the following sections we will look more closely at why insects for food and feed in the rapidly growing literature are considered more sustainable than current production systems – recognising the multitude of different systems and possible insect production systems – beginning with a discussion of what sustainability may entail.

2 Sustainability: A Complicated Concept with Ethical Implications

The notion of sustainability, although notoriously unclear, has escalated as a contemporary concern (Nel and Ward 2015). It is seen as a fundamental principle which influences or even transforms governance (Bosselmann 2016). Originally, the concept was tied to long-term and wise management of natural resources such as forestry and fishery – then often referred to as 'sustained yield' serving the purpose of procuring certain goods (Gamborg and Larsen 2005) – but during the last 250 years, the interpretation of sustainability has evolved and today it is used as a comprehensive concept integrating ecological, economic and social aspects of the use of the natural environment and development of society. As such, sustainability is widely embraced as common platform for discussing productivity and nature related concerns in many, if not all sectors of society, including food and feed production (Gamborg and Sandøe 2005).

From an economical perspective sustainability is often seen as a question of determining the short and long term gains from different activities and include discussions of to what extent certain resources are renewable or considered replaceable, and at what cost. From a social perspective sustainability is often seen as an ethical demand to create a fairer international and intergenerational resource distribution, often coupled with notions such as worker's rights, public involvement and inclusion of animals in the ethical sphere. From an environmental perspective the focus is on the effects of human activities on ecosystems and biodiversity, often coupled to questions about the regenerative capacity of natural systems. However, the precise relevance and content of the different aspects of the concept are understood very differently in the vast literature as different interpretations in relation to the various aspects of sustainability spanning from business as usual, over modernization, to radical change (Söderbaum 2014).

The concept's ethical thrust is toward social justice and future generations. But, as mentioned above, it can also be used as a concept espousing the moral relationship between human beings, animals and the natural environment. As such the concept of sustainability also includes ethical considerations on which kinds of beings have moral standing; That is, what beings should be considered morally significant and seen as part of a moral community encompassing moral agents (some humans) and moral patients (all humans and perhaps animals and other organisms)? Very roughly, three types of theory can be distinguished on the question whether we have responsibilities to or regarding animals and the natural environment?

The first view, an anthropocentric or human-centred ethics, holds that responsibilities, if any, towards animals or other parts of nature derives entirely from human interests. Any responsibility regarding animals and the natural environment are thus indirect. This view can be extended so that *future* human generations are also objects of moral responsibility. Much of the concern about future generations that is visible in most commonly held views on sustainable development can be explained in anthropocentric terms. Thus, concerns about insects used for food and feed are not directly related to insects themselves or the environment of which they are part, should according to this human-centred perspective solely be evaluated in relation to the effects such a use of insects would have in terms of positive or negative consequences for humans, e.g. in terms of food security, nutritional value, and economic and environmental impact.

According to the second ethical view called sentientism that belongs to the group of non-anthropocentric views on moral standing, all beings – humans or not – who are capable of having subjective experiences of pain and pleasure in such a way that their welfare matters to them, are directly ethically relevant. This view can be found in both utilitarian and rights-based versions, and states that all sentient animals are to be included into the moral community and their interests taken into consideration when evaluating the ethical acceptability of a given action. With regard to insects used as food and feed, consequences for sentient animals ought therefore to be included in the ethical consideration in line with considerations for humans, both living and future. From this perspective it becomes very important whether insects are considered to be sentient or not. Today the mainstream scientific view is that insects are not capable of experiencing individual welfare or sentient enough to be granted legal protection as e.g. mammals.

The question of "insect welfare" is however attracting increasing interest these years as the interest to utilize insects in large scale production systems to produce protein for food and feed is growing. With more than one million species of insects, of which approximately 2000 at the moment are used for food purposes (Jongema 2015), and with huge differences between them this question cannot be answered in general. Although comparisons and analogies can be made between different species, the potential for welfare experiences needs to be answered for the species in question. Further, if they do have the capacity for welfare, an understanding of how to design production systems to avoid impairment of their welfare needs to be developed, given they are considered worthy of ethical consideration. So far the empirical evidence for insect welfare is weak. According to a review by Eisemann

et al. (1984: 166): "*the neural organization of insects and observations of their behaviour does not appear to support the occurrence in insects of a pain state, such as occurs in humans*". The same conclusion was reached in another, more recent study that found that little neurobiological evidence seemingly exists for the existence of pain-like states in insects (Sneddon et al. 2014). A further problem is that it can be very hard to determine whether insects can experience welfare as they are so different to us compared to e.g. mammals. As Smith (1991: 30) notes: *"The question of pain in invertebrates will be very difficult to resolve - if, indeed, it is resolvable*".

Some researchers are, however, more open to the idea of at least some insects having the capacity for welfare. According to Broom (2001) there is evidence for some aspects of pain in invertebrates, but as he himself points out in a later work: "[*t]he more different from humans an animal appears to be, the less likely it is to be evaluated as sentient*" (Broom 2014: 66). There are, however, other more recent studies that show that nociception and the capacity to integrate information into complex decisions are present in at least some invertebrates (e.g. honey bees and spiders) (Elwood 2011) which opens the possibility of insect welfare being a meaningful concept, at least within some species. Sherwin (2001) cites several studies pointing to both physiological and behavioural evidence that pain perception does exist in insects. On this basis, she argues that if we accept the "argument-by-analogy" when assigning e.g. a chimpanzee the ability to feel pain when receiving an electric shock – because we recognize the similarity with our own reaction – we should be willing to do the same with insects, when we discover that they have mental abilities that are analogous to those of beings who we accept as experiencing pain. From a sentientistic viewpoint this question is crucial for the development of large scale production systems. If the relevant insect species have the ability to experience welfare, the ethical acceptability of using insects for food and feed, hinges on that production systems are designed to take their welfare, whatever that may be, into account. As long as it is not known, it seems only fair to use the precautionary principle and at least seek knowledge about the welfare potential before initiating production.

According to the third group of views or theories on moral standing of different organisms, that is also firmly placed within the non-anthropocentric views – the so-called biocentric, or life-centred, view – we have direct responsibilities to living entities within the natural environment. That is: all varieties of animals and plants deserve direct moral consideration. Hence, according to this view we have direct duties to insects, independently of their psychological capacities. Another way of putting this is to say that insects have rights, most importantly the right not to be exploited by humans; at least not for non-essential needs or trivial interests. Thus, according to this line of thinking, broader animal ethical issues arise which go well beyond the welfare issues, such as insect integrity, death and naturalness (Gjerris et al. 2016). However, differences of opinion exist about how to express this responsibility. It should be noted that to some this third way of looking at human-nature relations should be entailed in a very strong version of the sustainability concept.

Regardless of how inclusive a view one argues for – in terms of how far-reaching responsibilities one assumes and whether these responsibilities include animals and even insects – it is one thing to determine what entities should have moral standing and quite another to decide how to balance the different concerns such as benefits to (some) humans, respect of moral rights, or risks to other humans, ecosystems or animal welfare. Thus, different ethical concerns may come into conflict in the quest for a more sustainable feed and food production.

3 Are Insects for Food and Feed More Sustainable Than Other Forms of Protein?

Deciding which parameters are relevant when seeking (a higher degree of) sustainability of a product or production method (let alone trying to provide measures for this) not only entails the risk of arbitrariness, but also means choosing among different aspects of sustainability that might not always go hand in hand. Sustainability thus entails value-based choices and the notion of sustainability is essentially shaped according to the interests at stake (Maxey 2007). Moreover, it depends on how alternatives are assessed, and which alternatives that are considered. For example, making an environmental life cycle assessment (LCA), comparing alternatives is far from straightforward for several reasons: Firstly, an (attributional) LCA is bound to be relative to the system in which it is being compared. Moreover, the functional unit needs to be the same in the systems which are compared, which might be difficult to achieve. In addition, a proper factual foundation is paramount, and when it comes to insect production systems, published environmental data is still limited (Halloran et al. 2016). Further, comparing alternative production systems is also difficult, as there is likely to be disagreement or at least different views on which data are relevant. Finally, it should be noted again that the sustainability of insect production obviously will differ depending on the specifics of the individual production systems. All this points towards that discussions are likely persist in terms of how to delineate such assessments, e.g. whether feed used for the insects should be mixed grain or vegetables or organic waste (Abbasi and Abbasi 2016). Another factor which plays a role is that currently (2017) only few real-life studies exist, such as Halloran et al. (2017).

Another issue is whether sustainability can be understood as something absolute (this *is* sustainable) or as something that should be evaluated in comparison with other products/productions methods (this is or more/less sustainable than another system). If the latter is the case, insects for feed and food production should be seen not only relative to the products/production methods that they aim to replace but also with other (realistic) alternatives of providing protein rich food and feed.

Production of insects for food and feed challenges a number of aspects in current farm animal production systems. Moreover, it contributes to a holistic perspective on food production chain, pinpointing that what is considered waste in one system

can be used as insect feed in another. Insect rearing might contribute to enhancement of sustainable food systems thanks to lower emissions of climate gases than farm animals (Oonincx et al. 2010) and insects having significantly lower feed conversion rates because of physiological and biological differences (Miech et al. 2016). After adjustment of edible weight crickets need less than half the amount of feed to convert into edible substance (meat) compared to chicken and pig, and six times less than beef cattle (van Huis 2013). However, when crickets are fed the same feed as chickens, some of the same environmental issues arise, including that some ingredients used for feed are directly suitable for human consumption.

Hence, to be a more sustainable alternative, other feed sources are needed. Miech et al. (2016) studied feed conversion rates in crickets reared in Cambodia as related to chicken feed and different weeds. They found no difference between chicken feed, cassava tops and *Cleome rutidosperma*. Further they suggested that by-products from the food industry could also be promising alternatives. Another important aspect is that insects' need of water is far less than that of any mammal (van Huis et al. 2013), and in combination with a high feed conversion efficiency this contributes to limiting both direct and indirect (growing feed) use of resources. In this perspective, insects could promote increased sustainability in protein production for human consumption.

Further, land use for feed production is one of the largest impact factors in climate change, and as insect farms require less space per animal than current animal farming this is an important aspect. A Dutch study showed that mealworm farming has a total lower global warming impact than conventional farming, but relatively high levels of energy use due to thermal comfort temperature for e.g. mealworms and crickets (Makkar et al. 2014). Moreover, efficient transport thanks to dense packing and far less use of energy and less water at slaughter (freezing and deep-frying) also contribute to a lower environmental impact. Another possible indirect sustainability factor is related to the nutritional content of insects. It has been found that amino-acids and omega 3 in mealworms are comparable to that of fish (FAO 2013), opening for possibilities to decrease current overfishing of wild fish populations and water pollution from fish farms by exchanging the source for these nutrients to insects.

Insects reared for human consumption might also improve the situation for wild insects (Halloran et al. 2015). While loss of biodiversity is a global challenge, crops and weeds produced as feed for livestock insects can be a source of feed also for wild pollinators contributing to enhancing or at least sustaining local biodiversity (pers.com. Anna Jansson). This said, it should be noted that a total shift away from animal based protein sources to vegetables and crops might have an even greater potential, as the detour over feed conversion is omitted and vegetables and crops are used directly in human consumption. There are, however, other elements in sustainability such as biodiversity and land use where neither crops nor human activities can replace that of animal grazing.

To sum up, compared to traditional livestock production, insect production often comes out as having a smaller environmental impact. But if it is regarded realistic to move a substantial part of current consumption of livestock protein to insect protein,

it could also be seen as realistic to move consumption in other directions to ensure an even more sustainable food production. Here it seems necessary also to compare plant-based alternatives to animal proteins, whether from traditional livestock or insects. Traditional vegetarian protein sources such as chickpeas, lentils, beans etc. is one option. Products like seitan, quorn and tofu are other sources of protein that would need to be compared with proteins from insects. In line with this, several companies are in the beginning of developing (economically) feasible versions of what could be labelled "high-tech" plant based "meat" e.g. the company *Impossible Foods Inc*. Finally, the attempts to develop vat-grown meat from muscle cells (also known as *artificial meat* or *clean meat*) could also be interesting when considering what constitutes a more sustainable food system than the present ones. Such studies are beginning to appear and will provide a better basis for understanding claims about the sustainability of insect production (Smetana et al. 2015; Röös et al. 2016).

The different options do not necessarily exclude each other, but any claims about the sustainability of large scale insect production for feed and food should be compared not only with traditional livestock production, but also with other realistic alternatives. Here it is worth noticing that what is considered "realistic" alternatives might also be up for discussion as the social context matters in terms of acceptability.

4 Ethical Aspects of Changing Eating Habits

Besides choice of definition of sustainability, scrutiny of scientific investigations of insect welfare and the actual climate impact of large scale insect rearing for food and feed, compared to traditional animal sources of protein and other sources of protein, a set of issues related to public acceptance remain to be discussed. That is, even if some ways of producing insects can be shown to be a relatively more environmentally sustainable, climate and animal welfare friendly form of animal protein, this is of little use unless people accept insects as food and feed.

From a historical point of view, entomophagy is nothing new (Gahukar 2011), and is also daily practiced in many parts of the world covering more than 2000 edible insects (Jongema 2015), yet it is classified as a 'novel food' (EC 258/97) within the EU. Further, it has been argued in a recent study of consumer acceptance of insect consumption, that it is important to distinguish between initial motivation to eat insects or insect based food on the one hand, and repeated consumption on the other, which, in parallel with other food items, is influenced by other factors such as price, taste, availability and whether it is adoptable to previous eating habits (House 2016). Insects are documented to evoke disgust and fear among some potential target consumers (Verbeke 2015). i.e. among citizens whose consumption pattern in general have a large climate footprint as well as a low interest in livestock welfare. Hence, the scepticism is the largest where the need of changing eating habits is largest, which calls for effective strategies to change behaviours (Hartmann et al. 2015).

As with any shift of social practices towards a more sustainable life style, there is a need for the public's acceptance of a redefinition of what is normal, by including e.g. insect eating into mainstream practices (Kanerva 2016). In order to reform the actual eating and purchasing habits, attitudes and values need to be changed, a process that may run both ways supporting each other (Kanerva 2016). A range of factors influence our eating habits, such as tradition, taste and moral values, and over many years the arguments related to improved personal health has been said to be most influential on changing behaviour. It has been recently argued that aspects related to moral dimensions of food such as cultural, societal and environmental concerns could contribute even more to change eating habits by nuancing the picture of the food chain (Hekler et al. 2010).

Assuming this view is correct, a variety of values that influence food choices can be highlighted such as different definitions of sustainability, comparing climate impact of different protein sources, animal welfare standards in conventional livestock and insect rearing etc. to influence the public's choice in a direction towards insect consumption. If, on the other hand, ethical arguments in favour of animal rights, combined with a biocentric perspective is promoted, insect eating is not an option.

This means that as the aim strived for is related to values, and the values are related to the aim, the entire setting of values and aims need to be changed and promoted to achieve more sustainable eating practices. There is no guarantee that the values included in a shift from traditional livestock production/consumption to insect production/consumption are shared by a significant number of consumers in the Western world, even though the opposite could be true on a global scale as insects is an integrated part of the diet in other areas of the world (cf. FAO 2011). Should this, however, be the case, it is still a difficult task as many decisions are not entirely rational or preceded by a conscious decision-making process. Further, people seem more prone to accept divergences between what they ought to do, and what they actually do, i.e. accepting cognitive dissonance (Ong et al. 2017), than to transform their actions to be in line with their values. Within ethical theory these issues have been dealt with in terms of decision-making.

Within traditional ethical theories such as utilitarianism and deontology, it has been argued that once a criterion or principle for an ethical correct action is founded (e.g. maximising happiness for all moral objects or acting according to a good intention), this should be implemented in terms of applying the theory (or, rather the principle) on the situation. Contrary to such a 'top-down' approach, a 'bottom-up' approach has been suggested to better meet the range of different aspects involved in a decision, such as moral intuition and the actual context. Between these models an interaction model is suggested, that may facilitate creating a balance between ethical principles and context related aspects (Lindström 2012). Within this model public ethical values related to sustainability (e.g. biodiversity, climate mitigation or working conditions) may be related to personal values (e.g. taste, economic situation, habits) and facilitate both coherent decisions and practical decisions that are possible to live by in everyday life to avoid cognitive dissonance.

Further, thanks to the context sensitivity, change of societal values or personal preferences can be included in a continuous decision-making process which may contribute both to redefining normality with regard to eating habits and to take the step to actually adopting eating habits to include insect based food as called for by Kanerva (2016) and House (2016).

5 Conclusion

Is insect production, as an example of mini-livestock (Hardouin 1995), a more sustainable protein source than ordinary (vertebrate) livestock such as chickens, pig or cows or compared to systems providing non-animal based proteins for food and feed? This is difficult question to answer unanimously for several reasons.

First, it depends on how sustainability is defined, and which dimensions and concerns (e.g. human health, environmental impact, socio-economic implications or animal welfare) that are included. Secondly, it depends on how these concerns entailed by sustainability are translated into more concrete criteria and indicators for specific production systems. Thirdly, it depends on how well we are able to measure different aspects; different criteria and indicators, and whether they are equally easy to measure in different production systems to prevent skewedness or bias. Fourthly, it depends on what alternatives (e.g. cows, pigs, lentils – and what production systems) we are comparing with, and how these are described and delineated as there is a wide range of farming systems under which these alternatives are cultivated/reared, and a divergence in insect farming systems from small-scale insect farming and industrial farming systems is very likely. Fifthly, it depends on how these different concerns are balanced against each other.

Finally, one could argue that assessing insect production for food and feed according to a sustainability framework is in itself an ethical decision: who or what counts – do insects have moral standing, and if they do what are their moral significance *vis-à-vis* humans? Evidently, making these kinds of assessment is inherently and immensely complex. This does not necessarily imply that one should refrain from making such assessments, as long as they are done in a transparent way. The point is, however, that the way such assessments are done and what conclusions are drawn are not merely a scientific matter but also involves different value judgements. Thus, disagreement with an assessment can not only be based on scientific arguments but also on differences in underlying ethical values. Consequently, discussions of the future of using insects for food and feed should contain a discussion of the ethical issues.

These ethical issues include a discussion of whether it is found acceptable to use insects merely as means to an end: using insects to provide humans with nutritious food and using insects as feed for other animals. Such a view implies that insects have no moral standing in their own right or, at least, that their moral significance is less than that of humans and the animals they constitute feed for.

Such a stance would be challenged from several non-anthropocentric positions. Some positions claim that it is wrong not ascribing rights to insects such as not to be killed to serve a non-essential human interest. This in turn raises further discussions of what ascribing insects an ethically relevant kind of integrity would be based on and imply. Another way of discussing the ethical acceptability of using insects for food and feed is in terms of comparing welfare interests of humans and other affected sentient beings, thus comparing the welfare gains of humans with possible welfare loss of the insects. The latter include a discussion of two things: (i) a philosophical discussion of whether welfare is the key aspect for determining the acceptability of the use of animals such as insects for food and feed. This discussion can be compared with current discussions of animal welfare within modern livestock production: (ii) a more empirically grounded discussion of whether insects can experience welfare. Do they feel pain, pleasure, suffering and moreover: how to measure this?

Using insects for food and feed and justifying this by pointing to an increased sustainability, is in itself a value based argument relying on a certain view on the ethical importance of insects in the greater perspective compared to for example future generations. Part of the future challenges for using insects for food and feed is thus to enter discussions of the underlying values related to our food and feed systems, and more broadly, to the way we relate to the natural environment.

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