Global Food Security Workshop: Insects as Animal Feed



Executive summary

In August 2015, the Global Food Security programme (GFS) held a workshop to identify knowledge gaps and scope the priorities for research around the use of insects as an alternative animal feed. Its purpose was to explore and highlight possible issues associated with rearing insects on an industrial scale, for example the safety of insect protein in feed (allergens, zoonoses etc), consumer acceptability and economic viability. It was also a way to increase the GFS understanding of the role this protein source can play in the context of the wider food security challenge.

3/4 of the predicted 2.3% average annual increase in meat demand up to 2050 will be from pig and poultry. (OECD, 2015)

Meat production is already responsible for 18% of the 36 billion tons of 'CO₂-equivalent' greenhouse gases the world produces every year,¹ and it takes 33% of all the arable land to produce enough feed for them.² At the same time, the rapidly expanding aquaculture industry is competing for feed inputs with other livestock - particularly the demand for fish meal which, if we carry on as we are, is likely to outstrip supply very soon. Therefore, there is a need for partial replacements for traditional animal feeds such as soya bean, fish meal and other processed animal protein (PAP). There is a wide spectrum of research looking into sustainable protein, including calls through the Sustainable Agriculture and Food Innovation Platform, Innovate UK and Horizon 2020.

Between 2010 and 2015, the animal feed market in the UK grew 3.5% annually and is currently worth £5 billion. (IBIS World)

The animal feed market is large and growing; global demand for livestock feed is estimated to be worth $\pounds 236$ billion (US \$370bn)³. There is thus a significant opportunity for the UK here in terms of competitiveness, reducing reliance on imports and potentially growing exports of protein for animal feed. It is clear that a range of different approaches and sustainable protein sources will be needed to meet growing demands for protein in the diet, one of which comes from insects. Globally, over 2 billion people have been eating insects as part of their daily diets for centuries,⁴ and the increasing interest in, and sale of, insect protein in the EU has sparked a review of novel food regulations, demonstrating a need to address certain questions around food and feed safety, feed efficiency and processing methods.

Summary of key priorities

Session 1. Identifying the key knowledge gaps

After a brief summary of the current state of knowledge, regulation and industry in the area of research into insects as animal feed, it was clear that insect meal is a source of high quality protein (equivalent to that of fish meal for example) with the potential to supplement the protein requirement for monogastric livestock (pigs, poultry). With this in mind, participants identified what questions across the system still needed answering, in order to get a holistic view of research questions, barriers and priorities. These included:

- Insect nutritional profiles and lifecycle assessments
- Insect feed substrates, rearing and breeding conditions
- Economic viability, scale and processing methods
- Environmental, social and economic sustainability
- Livestock compatibility to insects as a feed source
- Efficiency of insects as feed
- Biosecurity and food safety
- Possible effects on palatability of livestock products (colour, size, taste etc.)

Session 2. Key priorities

After hearing the positive results from an industrial feed trial, participants identified the priority they thought was most important. Over the whole group, the top 5 were:

- Availability and suitability of substrates: optimal insect species and substrate pairs and methods of substrate transport and storage.
- Safety: assess risks to public and animal health (e.g. allergens, zoonoses, contaminants and bioaccumulation).
- Legislation: basic entomological research and insect lifecycle analyses to inform policies around standard operating procedures, risk assessments and product labelling.
- Economics of production: technology for automation, comparison with current feed commodity costs; identification of avenues to market.
- Consumer acceptance: engage consumers early on and inform them about current animal feeds and the need for more sustainable protein sources.

These topics were broken down further by each group during the session into sub-questions and the barriers and enablers for UK research.

Session 1: Knowledge gaps

Need for change

If we carry on as we are, feeding our growing population by 2050 will require 70% more food⁵ and 55% more water.⁶ Agriculture already uses 70% of the Earth's fresh water, and reserves are dwindling resulting in a predicted 40% shortfall by 2030.⁷ On top of this, there is no new land for agriculture, natural resources are becoming increasingly scarce and global GHG emissions must be reduced to keep below the 2 degrees of warming threshold. It is widely acknowledged that the demand for meat is rising with the increasing proportion of middle income populations.⁸ Livestock farming is very resource intensive and the 1 billion tonnes of feed crops poured annually into livestock troughs could feed some 3.5 billion humans.⁹ It is clear, therefore, there is a need for partial replacements for traditional animal feeds such as soya bean, fish meal and other processed animal protein (PAP).

Public perception

In order to get an idea of the existing public knowledge level and perception around insect protein, GFS carried out an indicative public panel survey which collected 47 responses over 2 weeks. Although this survey only used a very small sample size, it brought to light some very interesting insights. It could be seen that the nutritional information on product packaging was a key driver influencing consumer purchase choices, followed by 'natural / organic' labelling and environmental impact. Another key finding was that the participants lacked awareness about current animal feeds, let alone insect meal, which affected the groups' thinking in terms of consumer and retailer engagement strategies.

Current state of knowledge

The research into public perception that PROteINSECT, the Which?/GO Science Food System Challenges public dialogue¹⁰ and other projects have carried out have confirmed that the public are, overall, supportive towards the use of insect meal as an alternative animal feed, but that they would like more information. The key outputs from the FERA workshop on insects as animal feed held in April 2015, which aimed to establish the current state of knowledge of the sector were:

- Regulation needs to follow technology automation is essential for economic viability
- Adopt an added value approach for additional products (i.e. not just protein) (Figure 1)
- Substrates and insect species are key research areas
- Additional research energy requirements & sustainability
- Engagement with retailers is key but at what stage?



Figure 1. The insect value chain, PROteINSECT

PROteINSECT Project

Dr Elaine Fitches, from Durham University, whose research lies in applied entomology, introduced participants to the EU funded PROteINSECT project. The tests and trials for PROteINSECT have used housefly larvae and manure as the insect – substrate pair for potential use as an alternative to high quality fish meal. Fly larvae are rich in protein with an amino acid composition comparable to that of fish meal. Insects thus have the potential to be an alternative to highquality fish meal rather than soy which is of lower economic and nutritional value. It is highly unlikely that insects will be grown on a scale comparable with soy, however, should this become possible, Elaine demonstrated that farming insects as opposed to soy for animal feed could result in a 200 foldreduction in land-use for the equivalent yield of protein. The following values are based upon current non-optimised larval production systems for recreational fishing used in the UK.

Protein	Average yield (t/ha per year)	Protein content	Protein per year (t	
Crop (e.g. soy)	2.5	90% dry wt & 40% crude protein	0.9	
Fly larvae potential (non-optimised)25 t/ha every 8-10 days = 1000		25% dry wt & 60% protein	150	

If a decision was taken not to pursue this technology, then one would need to consider:

- What we would do with our waste
- How we would ensure imports of insect products are safe
 and
- How a further reliance on protein imports would impact the livestock industry and economy



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The workshop participants were split into 5 multidisciplinary groups to discuss what barriers to research still existed and needed to be taken forward in light of the morning's presentations and key outputs from the FERA workshop. They were asked to consider (but also expand on):

- Insect nutritional profiles and lifecycle assessments
- Insect feed substrates, rearing and breeding conditions
- Economic viability, scale and processing methods
- Environmental, social and economic sustainability
- Livestock compatibility to insects as a feed source
- Efficiency of insects as feed
- Biosecurity and food safety
- Possible effects on palatability of livestock products (colour, size, taste etc.)

Discussion within each group resulted in 5 separate sets of identified knowledge gaps which built on previous work. These were then consolidated and arranged into a matrix of priority level of research questions vs. time taken for research to deliver in order to highlight what the highest priorities were in the short term.

The results of this exercise are displayed in Figure 2.



Time		0-5 years		5-10 years	10-15 years
High Priority	 Availability of substrates Zoonotic diseases Allergens for humans Traceability Contaminants Environmental impacts Anti-microbial resistance Ethics: insect and livestock welfare Lifecycle assessments 	 Waste management Suitability of substrate Effects of diet change on animal gut microbiome Optimal insect species Feed conversion efficiencies Basic entomological research Economies of production Technology and automation 	 Efficiencies of scale Regional scalability – big industrial centres vs. subsistence/on farm production Legislation Public education – current feeds Consumer acceptance – insect meal Retailer engagement 	 The global system and vulnerabilities Added value chains Product labelling Pet food market 	 Production economics compared to soy Optimising production for multiple outputs
Medium Priority	 Impacts of converting low value waste into substrate (fertiliser use, cheaper to grow substrate?) Logistics – rear insects near waste stream site or farm site? 	 Investment required by farmers to change feed Information sharing about production technologies Impact on existing businesses 	 Taste of products Evidence of sustainability/reduced environmental impact compared to fish meal 	 Energy generation using waste heat from larvae rearing Potential for residual material as soil conditioner or even fertiliser 	

Figure 2: matrix of UK research priorities

Session 2: Key priorities

Participants heard from Heidi Hall, technical project manager at AB Agri, who led an industrial research project with FERA, co-funded by Innovate UK looking at the nutritional content of farmed insects for poultry feed. The results presented showed that common housefly larvae (Musca domestica) have a nutritional content comparable to high-quality fish meal in both AMEn (apparent metabolisable energy, nitrogen corrected) and amino acid digestibility. During the digestibility trial in broiler chickens, the birds showed no signs of any detrimental health effects fed on a diet containing up to 60% insect meal.

After a short discussion session, each of the 5 multidisciplinary groups was assigned a key priority area for research to work-up in further detail. Discussion was focused around 1) any sub-questions that would need to be addressed and the mix of disciplines needed to address them, 2) the different funders and industry contributions that would need to be involved and 3) the barriers and enablers for UK research. Further detail around these priorities can be found at Annex A.



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The key outputs were:

- Availability and suitability of substrates Mapping of optimum insect species and substrate pairs against the availability of each substrate to ensure sustainability; identify optimal methods of substrate transport and storage; explore the impacts of redirecting potential substrates (e.g. manure) away from current uses (e.g. fertiliser).
- **Safety** Perform a full insect lifecycle analysis to provide a complete nutritional profile (including anti-nutrients); develop processing methods and tests to eliminate risks to public health (e.g. allergens, zoonoses, contaminants and bioaccumulation); run feed trials to ensure animal health and welfare is protected (both livestock and insects).
- Legislation Assess the need for a separate set of safety and farming/ feeding regulations for invertebrates (and assess their potential impact on existing pet and human food industries); carry out basic entomological research and insect lifecycle analyses to inform policies around standard operating procedures (e.g. for processing and slaughtering), risk assessments and product labelling; establish how far back along the supply chain information would need to be supplied to ensure complete authenticity and traceability (e.g. origin of substrate/waste source).
- Economics of production Development of technology for automation to ensure economic viability and sustainability; economic models of insect production should be compared with current feed commodity costs; identification of avenues to market and demand pull factors (reduced environmental impact, positive messaging, market gaps etc).
- **Consumer acceptance** Evaluation of lessons learned from past issues where positive public perception has been essential; begin with public education around current animal feeds and the need for more sustainable protein sources; concerted, timely and evidence-based dissemination of safety issues to avoid conjecture and speculation; involve farmers and retailers early on to assess their willingness to take up this new technology.

Conclusion

This workshop has identified the key priorities, sub-questions and next steps should the UK embark on research into insects as animal feed. The Global Food Security programme will consider these research priorities alongside other activity in the area of sustainable protein sources.



Global Food Security Workshop: Insects as Animal Feed

Roadmaps for UK research

Tuesday 4th August 2015, London

Prepared by Emma Rivers on behalf of the Global Food Security programme

Chair: Dr Sarah Beynon

Sarah is an invertebrate ecologist and agricultural conservation biologist, with a particular interest in beneficial insects in agricultural systems and the ecosystem services they can deliver. Her research interests are also moving towards the farming of insects in the UK for animal feed and human consumption.

Speaker Profiles:

Dr Elaine Fitches is a Research Fellow in the Department of Biological and Biomedical Sciences at Durham University, UK working in close collaboration with the Food & Environment Research Agency (Fera, York). Her dedicated research focus lies in the field of applied entomology. She has increasing involvement in the field of "insect biotechnology", investigating the potential for the use of insects as sustainable product alternatives for use in animal feed and as industrial feed stocks; she is currently co-ordinator of the EU funded "PROteINSECT".

Heidi Hall is a technical project manager in a brand new division of AB Agri looking at next generation proteins; she manages a range of projects and supports research looking at new proteins to ease the deficit we are starting to see in the livestock industry. She recently managed their project with Innovate UK looking at insects as a novel protein source.

Annex A – Breakdown of key priorities http://www.foodsecurity.ac.uk/assets/pdfs/insects-as-animal-feed-annex-a.pdf Annex B – List of workshop attendees http://www.foodsecurity.ac.uk/assets/pdfs/insects-as-animal-feed-annex-b.pdf

References

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Global Food Security (GFS) is a multi-agency programme bringing together the main UK funders of research and training relating to food. GFS publications provide balanced analysis of food security issues on the basis of current evidence, for use by policy-makers and practitioners.

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