Conference report: Insects to Feed the World

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THE CONFERENCE, 'INSECTS TO FEED THE WORLD', convened from 14 to 17 May 2014 in Ede (Wageningen), the Netherlands. The conference was jointly organized by Wageningen University and Research Centre (WUR) and the United Nations Food and Agriculture Organization (FAO), and received support from the Government of the Netherlands, civil society groups, and from private companies active in this emerging sector. The conference brought together the largest assembly to date of stakeholders from all over the world to consider key aspects of collection, production, processing, nutrition, marketing, and consumption related to insects in a global multi-stakeholder dialogue. The conference marked an important step towards mobilizing the potential of insects as human food and animal feed to contribute to global food security and in particular to exchange information on the feasibility of mass rearing of insects to increase the availability of animal proteins in a more sustainable way.

This conference was an outcome of the joint collaboration between FAO and WUR and is a direct follow-up to the recommendations from the FAO Expert Meeting on Edible Insects held at FAO in 2012 and to the FAO-WUR joint publication *Edible Insects: Future Prospects for Food and Feed Security* (van Huis et al., 2013).

About 450 people from 45 countries around the world attended the conference. Participation at the conference was based on a paid registration fee. The large number of participants coming from all continents and the wide media attention received before, during, and after the conference reflects the global interest in edible insects. The participants represented research institutions and universities, private companies, international organizations, civil society, and governmental agencies in the agriculture, food, feed, and health sectors. The use of insects as food and feed proved to be very relevant, mainly due to the rising costs of major protein sources for animal feed (such as fish and soybean meal), food and feed insecurity, environmental pressure, population growth, and the increasing demand for animal protein (meat, fish, dairy products, eggs, etc.) among the world's rapidly growing middle classes.

The overall objective of the conference was to lay the foundations for continued dialogue, further research, evidence-based policymaking, and investments to promote the use of insects as human food and as animal feed in the context of food and feed security. More specifically, the objectives of the conference were to:

- create global awareness for this alternative food and feed source;
- map the state of the art and identify knowledge gaps on key topics;

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- identify constraints in the development of the insect food/feed sectors;
- promote interaction among stakeholders in the insect value chains;
- establish inter-disciplinary networks among relevant partners;
- contribute to standardizing methodologies for analysing nutritional composition of insects;
- promote the elaboration of (inter)national statistical data on production and trade in insect products for food and feed;
- formulate recommendations to increase the impact of using insects as a food and feed source.

The conference programme included thematic sessions on: harvesting from nature; production of insects as food and feed; food safety, legislation, and policy; insects as feed: specific production systems; nutrition, processing, consumer attitudes, and gastronomy; environmental issues; and outreach and communication. Participants from multiple disciplines presented and discussed their work through eight plenary and 18 parallel sessions, which were supported by three poster sessions, with a total of 112 presentations and 54 posters. The conference further offered 15 booths exhibiting work by private companies, international agencies, and civil society groups. Two field excursions were available to the participants: one at the entomology and food and feed testing facilities of Wageningen University to show the present status of insect-related research; and one to the insects rearing and processing hub in the province of North Brabant.

In summary, the conference concluded the following:

- The conference clearly highlighted the rapidly growing and dynamic nature of using insects for food and feed worldwide, and revealed far more of the potential and current activities around using insects and their products, including for health care as well as for providing raw materials for the non-food sectors.
- The potential of insects for human food and animal feed is highly relevant in view of: their good nutritional quality; human population growth, and commensurate higher demands for animal proteins in the form of meat and fish; the fast rising costs and quantities needed of major protein sources (for example, fish and soybean) to feed the growing number of farmed animals; and the high environmental impact of our current high meat consumption food habits (and animal farming practices that use human grade feed grains that could be directly consumed by humans).
- A wide range of socio-economic opportunities based on using insects are accessible at any scale of production both in developed and developing countries. These include creation of jobs, enterprise development, food and animal feed production, organic waste processing, and increased global trade.
- Major challenges include: further awareness-raising with the general public to promote insects as healthy food and feed for animals; influencing policymakers to approve insect-inclusive food and feed legislations; further research efforts to provide and expand with validated data the available scientific evidence and benefits of using insects in the food and feed chains.

- There remains a wide gap between activities being conducted largely for food in developing countries, and the high-tech, large-scale industrial initiatives focusing on feed for livestock and aquaculture, primarily in developed countries.

The FAO and WUR were readily recognized and appreciated for providing global leadership and support in this fast unfolding sector.

Summary notes from the sessions

Key messages from each session were captured by session hosts and organizers and relayed into the closing plenary presentation on Conclusions and Recommendations of the Conference. This section is a compilation of thematic sessions in chronological order as prepared by the conference organizers. As such it provides an overview of the messages throughout the conference, but does not constitute a joint conclusion by the participants.

Harvesting from nature

Harvesting insects from natural resources was given special attention through keynote presentations during the first sessions on day one. Three plenary sessions highlighted the significance of harvesting wild insects for livelihoods, especially in rural areas. Cases from countries in Africa, Latin America, and Asia were presented and they indicated how people utilize insects for food and medicine and foster livelihood opportunities through marketing opportunities.

Insects are often considered a pest to agricultural crops, but through agro-ecological knowledge, innovative solutions were presented to utilize these insects as food and feed. Furthermore, ideas on how to fight large-scale pest outbreaks were presented, which depend largely on the development of efficient technologies to capture outbreaks.

The speakers highlighted the heterogeneity in the collection and consumption of insects, concerning species in developing countries, and the role of sharing cultural and ecological knowledge among generations to preserve these traditional practices. In particular, the transfer of knowledge between generations and the cultural traditions attached to them are changing or diminishing under the influence of new dietary patterns.

The participants emphasized some major issues regarding the future of harvesting from nature for humans and ecosystems, such as overharvesting of species and habitat degradation, which have to be taken into greater consideration, when utilizing insects. The world's population is expected to grow by more than 2 billion people within the next 30 years. This population growth will mainly be in those countries where entomophagy is already part of the natural diets and which will further increase demand for insects to supply local diets.

Developing sustainable harvesting practices is one of the most urgent issues to be addressed, especially in areas where a decline of naturally available insects has already been reported. In some countries, however, the growth of urban demand puts

pressure on natural resources. In order to develop and implement such measures, further research and support by government authorities is essential.

Semi-cultivation and farming are considered the most viable options to protect natural populations of insects, especially as farming techniques and expertise have improved in recent years. Knowledge sharing and improvement of the techniques that are currently used, including the safe handling of production, have an important impact on natural harvesting. Participants concluded that wider dissemination of materials on how to conduct sustainable harvesting, semi-domestication and farming, processing, storage, and local marketing are needed.

Production of insects as food and feed

Improvement of the methods of producing insects as human food and animal feed in a controlled environment is widely accepted to be a key issue. Different aspects were addressed: small- and large-scale production, as well as similarities and differences between the production of insects in temperate and tropical regions.

The participants called for the establishment of a knowledge network to consist of producers of edible insects and that would cut across regions. It was recommended that this network include the existing expertise found in the pet food industry, biological control industry, and zoos. The network should furthermore form a liaison with academics and policymakers in order to discuss legal aspects such as patenting of production methods and production of non-endemic insect species.

This session highlighted that environmental concerns and health risks need to be addressed from an early stage onwards. The use of food waste and side streams in insect production was deemed particularly promising. However, the quality of the used waste and the produced insects need further empirical studies and monitoring. The transmission of diseases has proven to be problematic on a global scale in the conventional livestock sector. Prevention, detection, identification, and mitigation of microbial contaminants are crucial for successful and safe insect production.

Concerns have been expressed over the profitability of producing insects on a large scale because, for example, it is labour intensive and feed costs are high. One major challenge that was discussed is the development of automation processes at affordable costs to assure a constant supply of insects. The participants also highlighted the development of business plans.

The viewpoint and activities of research projects such as GREEiNSECT, PROteINSECT, FLYING Food, and WINFOOD were presented. These are working internationally across disciplines and institutions to foster empirical evidence around the utilization of insects for food and feed.

Silkworms were featured in one of the sessions because these insects are already being produced on a large scale. Knowledge of silkworm biology is extensive, silkworms are widely accepted as human food, and silkworms are firmly embedded in our cultural history.

Food safety, legislation, and policy

The growing interest in the utilization of insects for food and feed has led to a strong interest from companies, researchers, and organizations to review the legal framework that governs production, processing, sales, and consumption of insects. Worldwide standards for the production and trade of insects and insect products in food and feed do not currently exist.

The presentations and discussions during the conference strengthened the fact that legislation has to be developed in two areas, considering both animal feed and human consumption of insects.

Microbiological safety, toxicity, pathogens, and insect diseases have to be considered in this new sector and a stronger link between natural science and policy-making has to be established in order to ensure safe production and processing methods. For farmed insects, these standards will focus primarily on species which have shown to be promising for domestication. Participants agreed that moving insects out of a legal grey area is most important for future developments in this vital area of food security.

Adaptation of feed laws towards upcoming insect-based products for fish and animal feed was encouraged by the industry in order to secure investments. Governments and international organizations have acknowledged this request for action, but standards, risk assessments, procedures, and quality control measures have to be developed in dialogue with and supported by all stakeholders involved in the production and marketing chain.

Consumer safety was highlighted by officials as a cornerstone to be further examined in order to warn consumers of potential allergic risks. Evidence of allergenic components in insects is available and seems to be comparable to allergies to consuming crustaceans. Research on the allergenic potential of insect proteins and chitin digestion is an area that should be broadened and investigated in more insect species. Actors such as the European Union are currently investigating how to frame legislation, but have urged that further evidence is needed in order to advance. In particular, the work undertaken by multi-disciplinary research groups has been highlighted to secure progress in this field.

Insects as feed: specific production systems

This session focused on insect species currently used as feed for particular fish species, poultry, pigs, and pets (e.g. gecko): the black soldier fly (*Hermetia illucens*), the housefly (*Musca domestica*), crickets and grasshoppers (e.g. the house cricket *Acheta domesticus*), and mealworms (e.g. *Tenebrio molitor*). Representatives of companies already producing insect meal in industrial quantities, including AgriProtein and EnviroFlight, provided insights into their activities and viewpoints.

Ongoing research is focused on the issues of diet formulation, nutritional values of the insects produced, type of feed substrate to raise the insects, and the performance of animals that are fed with the insects. The stakeholders involved have a strong interest in exploring the use of other insect species as feed. The environmental

benefits of producing and using insects as animal feed were also highlighted during the session.

Aquaculture in particular is considered a sector with important future potential for using insects as feed and this sector fostered discussion around the most suitable insect species in feed formulas of the past and the future. The discussion was enriched by test cases of fish species, e.g. Atlantic salmon (*Salmo salar*) and rainbow trout (*Oncorhynchus mykiss*).

Nutrition, processing, consumer attitudes, outreach, and gastronomy

The utilization of insects in modern and traditional diets has opened the door for an interesting discourse on how consumers in different parts of the world perceive insects and how people are starting to utilize insects in business cases. Furthermore, the nutritional properties of certain insect species were discussed.

Presentations on consumer attitudes towards insect consumption in Western countries provided insight into the human psychology of consumption of food and how insects can be utilized through chefs and food entrepreneurs. While overall attention for entomophagy is greatly echoed throughout the media, the approaches chosen for working with insects as a food ingredient are varied and still in an experimental stage. The concept of 'deliciousness' of insects was explored and the participants agreed that gastronomy will play an important part in shaping our ideas about insects as food.

Moving insects from 'bizarre and sensational' to a respected food ingredient was an important issue for participants. Hence, different ways of how normalization could be achieved were discussed. Educational material and studies on consumer perception were presented and there was a discussion on how different members of society would perceive the presentation of this food item that was new to them. An overall improvement of the perception of insects was called for. Evidence was shown that this can be achieved by addressing 'what insects are' and 'what insects do', such as the role of insects in pollination, biological control, and other ecosystem services.

The nutritional composition of insects differs substantially between species; this is also due to the variety of scientific analyses currently used. Participants presented further evidence of the beneficial nutritional composition of insects, which will need to be further streamlined in order to solidify the existing data. Discussion centred on the extraction and composition of insect proteins and lipids and the way human metabolism converts these macronutrients.

Business cases of small entrepreneurs, from insect farmers to food processors who develop products, were introduced to the audience. Businesses are emerging in developing, transitional, and developed countries and are at the forefront of experiencing consumer perception and developing innovative products. A market in Western countries is currently developing, but edible insects are still a niche product.

Environmental issues

The environmental benefits of rearing insects for food and feed were confirmed as a strong case to promote the use of insects as human food and animal feed. Advantages of the use of insects over conventional livestock include: diminished greenhouse gas and ammonia emission, a higher conversion efficiency of feed into high-value animal protein, low water use, and the prospect of efficiently incorporating waste and side streams into the production systems.

These subjects imply that when rearing insects, less land is used and land is used in a more efficient way. Nevertheless, additional life cycle assessments are required to further confirm the sustainability of rearing edible insects and/or to compare with the traditional systems for the production of food (meat, fish in case of proteins), or for rearing insects as animal feed protein supplements (comparing with coarse grains, fish or soybean meals for example).

Conclusion

Insects have been an important element in the human diet throughout the world and throughout human history. This first international conference on insects as food and feed showed how insects can continue to benefit humankind. Insects have an excellent potential as a high-value source of animal protein for the rapidly growing world population. A strong point is the relatively small ecological footprint of farming insects compared with farming conventional livestock in terms of: 1) land use; 2) the efficiency in converting feed into high-value animal protein; and 3) greenhouse gas and ammonia emissions.

To realize the potential of insects, assuring a sustainable supply of the edible insect resource is required. This can be achieved by further developing insect farming technologies. Further knowledge on insect processing in relation to (technical) properties relevant for the food and feed industry must be developed, including sensory properties and consumer acceptance.

Since edible insects are currently not covered by legislation, the development of regulation is urgently needed to provide the industry with clear guidelines. In order to allow consumers to make informed decisions, certification schemes can play a role, together with labelling in order to ensure consumer protection.

Chefs and food entrepreneurs are encouraged to further develop insect gastronomy in order to upgrade entomophagy on a global scale. A variety of strategies can be used to promote the use of insects as food and feed. The strategies used depend on the target group. Strategies could go top down, for example celebrities consuming insect products, and/or bottom up, with consumers in search of more environmentally friendly animal protein.

Recommendations

Through the conference, participants, who included CEOs and business executives, civil society and governmental agency representatives, gastronomy chefs, scientists,

representatives of international organizations, and more, shared their lessons and experiences, made comments, and joined the call for providing recommendations on how best to move forward the use of insects in the food and feed chains. A review of the good progress made so far on the implementation of recommendations emanating from the FAO Expert Meeting on Edible Insects in January 2012 (FAO, 2012) by the public and private sectors, by the media, and by the FAO was noted with acknowledgement by the participants.

Major areas now requiring urgent attention are: further improving and focusing awareness, legislation and regulations to govern food and feed safety, trade and marketing procedures, labelling, and control measures of insects and their food/feed products; protocols on farming (more) insect species; protection of wild gathered insect species with their corresponding traditional knowledge and diets involved; improving communication, outreach strategies, and messaging to the public at large (i.e. the ultimate 'consumers' of insect-based products in the food/feed chain) on the potential, opportunities, and acceptability of insects to contribute to a more sustainable and socially more equitable global food security.

A collection of key messages identified by the participants during the sessions were compiled by the conference organizers into the following non-binding recommendations from the conference for the various actors involved:

For academia (and research agencies) to:

- Address knowledge gaps, including:
  - sustainability of harvesting from nature;
  - indigenous knowledge of edible insects;
  - identification of edible insects species;
  - standard methods for the determination of nutritional values;
  - mass-rearing techniques;
  - trade and value chains of existing markets;
  - ethical issues (e.g. animal welfare).
- Establish international research consortiums which can apply for or support/provide funding.
- Conduct interdisciplinary and international research programmes on using insects as food and feed.
- Reposition the field of entomology to focus more on the use of insects for food, feed, health and as a provider of raw materials to other sectors.

For the private sector to:

- Continue to create national, regional, and international associations of food and feed companies based on insects:
  - to improve the communication and the sharing of knowledge between companies, academia, and with policymakers;
  - to develop product quality standards and quality control mechanisms (e.g. proactive self-regulation, certification schemes).
- Improve technologies, efficiencies, and automation in insect production, processing, and marketing steps to reduce costs of insect-based products in the market.

For governments and international donors to:

- Recognize the potential of and include insects into national food and feed security strategies.
- Create enabling environments for developing the edible insects sector, including through incentive policies, legislation, and clear regulations governing the sector.
- Take an active and constructive role in policy debates and legal issues through relevant ministerial bodies at national level and at regional/ international levels where relevant in the global food and feed authority discussions.
- Increase funding opportunities for education, communication, and for fundamental and applied research in insects as food and feed.
- Include edible insects into habitat conservation strategies, practices, and legislation to protect insect populations from overharvesting.

For international organizations and civil society to:

- Provide technical support to stakeholders and countries in using insects as food and feed.
- Provide platforms for exchange of knowledge and best practices among countries.
- Include the topic of 'Edible Insects' formally into their work programmes, communication and outreach efforts, funding options, and strategies for achieving global food security.

References

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