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Insect Food Value Chains: Mapping and Governance Mechanisms

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Title: Insect Food Value Chains: Mapping and Governance Mechanisms

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Abstract

Governance in insect food value chains is needed as suppliers lack technical competence or market knowledge. The positioning of an insect-based product in the chain, which involves quality, consistency, variety, processing, packing, reliability, and price, requires governance. Mapping the insect food value chains across Western Europe and Thailand not only depicts the way insect-based food products are conceived and finalized in this geographic research scope but also how the industry is governed through the networks and connections among its actors. It is the depiction of the narrative description of the chain based on the relevant data collected from qualitative interviews with key actors at the different stages of the value chain.

Keywords: insect food, value chain governance, value chain mapping, Thailand, Europe

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Introduction

Insects have been for a long time a major source of food for some and a common one for others. Actually, around 2 billion people in different parts of the world like Africa, Asia, and Latin America consume insects regularly (Van Huis *et al.*, 2013). Although insect consumption, or entomophagy, is an old phenomenon spread over time and geography, the degree of its use per insect species and by humans varies a lot depending on locals' preference, sociocultural implication, and geography. Entomophagy is defined as the practice of eating insects by both humans and insects, but for the scope of this study, the definition is limited to the practice of eating insects solely by humans. The increase of the human population has been creating an external as well as an internal pressure on the food production system.

An external pressure to the current food system exists and is now briefly discussed. The world's population is increasing and is expected to reach 9 billion people by 2050. This increase will be accompanied by an environmental deterioration caused by food production practices unless humans adapt radical and sustainable changes in their food production and consumption habit. As a matter of fact, it will be necessary to render the food production systems more efficient and sustainable as well as to inform and educate people on the issue so they would accept, or at least not resist, the required gradual change in our consumption habits.

Feeding the growing earth population presents a future challenge in food sustainability and security. The current global food systems play a role in the deteriorating environment. Urbanization as well as the increase in income levels and purchasing power in, but not restricted to, developing countries is putting a pressure on food producers to produce rapidly more with little active concern for the environment. Therefore, the aggregate demand for globally consumed products will further increase. It is expected that demand for milk and meat are going to increase by 70% and 58%, respectively, if the estimated population number hits the 9 billion in three decades from now (FAO, 2011). The fuel-feed-food competition will not make it easier for food production to increase in a sustainable way. However, the mass production of different insect species with their low environmental footprint, high reproduction rates, and high conversion rate of feed, which can also be waste biomass or waste by-products, can stand the environmental challenge (Paoletti *et al.*, 2005; Veldkamp *et al.*, 2012).

Besides, an internal pressure in the current food system also exists. Many people whether in western or eastern societies rely on animals for their protein intake; animal protein is found there in many dishes and processed food (Hartmann *et al.*, 2015). Besides, the current meat production process from livestock is ethically questionable mainly by concerned animal rights organizations and the like and is not very efficient

as the process consumes a lot of resources like water, energy, and land.

Moreover, advantages of insect consumption do exist and are now discussed. As opposed to conventional animals consumed by most of people who eat meat, insects are shown to be an interesting and important source of protein and other nutrients in addressing arising food sustainability and security problems. Its importance stems from certain facts such as that insects have a high reproductive ability, a nutritional value that is considered rather high as compared with meat, saves in the utilization of water and land, which are scarce and disputed resources, and a high conversion efficiency of feed which can be raw materials such as plants or even waste and by-products from production (Costa-Neto, Dunkel, 2016).

In the last few years western academics and practitioners have given their attention to insects as a potential and sustainable protein source in food and feed (Pascucci and de-Magistris, 2013). This attention was challenged by many concerns raised by studies regarding regulations, and consumer acceptance barriers which stem from culture and psychology (Caparros Megido *et al.*, 2014; Hartmann *et al.*, 2015). Such concerns play an important role in the fate of the creation and development of an 'entomology-based food and feed industry' (Derkzen *et al.*, 2010). However, such concerns have not prevented entrepreneurs from stepping in the insect-based food industry and launching their start-ups. The challenges that those start-ups face is particular yet sharing the same wide concept with challenges usually faced by new entrants in any industry. Those start-ups are particularly facing challenges from a regulatory and marketing perspective (Pascucci *et al.* 2015).

The objective of this study is to analyse several insect-based food value chains while investigating its governance mechanisms that are applicable to facilitate integration and connectivity when primary activities in the chain are separated. The specific objectives are mapping insect-based food value chains, and investigating governance mechanisms within the value chains.

Methodology

Research approach

For this research study, the researcher has chosen to conduct a qualitative research. The main reason dictating this choice is the fact that prior research in insect-based food insect industry as well as value chains in western Europe and in Thailand is so far limited which justifies the choice of a qualitative research. Another reason for conducting qualitative research is its capability of grasping socially constructed meaning and cultural aspects within the research topic which has a certain geographical scope (Western Europe and Thailand) and limitations. Quantitative research, in contrast, was disregarded because of its strong reliance on a vast amount of numerical data and its focus on analysing statistics or testing hypotheses (Saunders, Lewis, and Thornhill, 2009).

Furthermore, this research approach adopts two of the three principal ways of carrying an exploratory research. The first is searching for any existing literature covering partially or thoroughly a topic related to the insect food value chain. The second is opting for interviewing experts and business actors in the insect value chain. The third way of carrying an exploratory research is by conducting focus groups interviews, this approach is discarded by the researcher as the first and second approaches were enough for working towards the research objectives. This type of research in particular can be associated with the activities of the traveller or explorer (Adams and Schvaneveldt, 1991) (Saunders, Lewis, and Thornhill, 2009). Actually, the researcher in this study has travelled to Thailand and in Western Europe for the purpose of exploring the dynamics of insect food value chains and meeting its respective key actors and entrepreneurs.

Sampling procedure

As opposed to probability sampling (or representative sampling) which is usually allied with the conduction of surveys targeting a randomly selected sample and used for population of more than 50 cases, non-probability sampling (or non-random sampling) is the most practical type of sampling suiting this exploratory research (Henry, 1990). With this chosen technique, little importance is given to the interviewed sample size. However, the twelve carefully selected interview participants were experts, farmers, processors, and retailers located in France, Germany, the Netherlands, the UK, and in Thailand. The below table depicts the study sample with their associate codes and further details regarding the interviews such as the mode, time, and duration.

Table 1: Interviews process details						
Interviews	Profile (and code)	Date	Location	Mode	Duration (min)	First contacted
Interviewee 1	Expert E1	29.11.2016	England	Skype	33	By email
Interviewee 2	Expert E2	02.12.2016	The Netherlands	Skype	22	By email
Interviewee 3	Retailer E1	21.12.2016	The Netherlands	Skype	45	By email
Interviewee 4	Retailer E2	28.12.2016	Germany	Skype	33	In person
Interviewee 5	Expert T3	09.01.2017	Thailand	Direct	42	By email
Interviewee 6	Farmer T1	10.01.2017	Thailand	Direct	95	By email
Interviewee 7	Processor T1	11.01.2017	Thailand	Direct	100	By email
Interviewee 8	Processor T2	13.01.2017	Thailand	Direct	50	By email
Interviewee 9	Farmer T2	30.01.2017	Thailand	Direct	64	Facebook
Interviewee 10	Farmer E3	03.02.2017	The Netherlands	Skype	38	By email
Interviewee 11	Processor E3	07.20.2017	France	Direct	54	By email
Interviewee 12	Retailer E3	09.03.2017	Thailand	Email	-	By Phone

Data collection

The qualitative data was collected mainly through the recording and transcription of the field research interviews. The interviewees are well aware of this method and gave their consent on it prior to the interviews and did not express any disagreement with it during and after the interviews.

The semi-structured interviews conducted meant that the interviewees had the freedom to talk about what they wanted while the interviewer was guiding the conversation in a certain direction. The questions were open-ended and showed little to no biases in their formulation. However, the researcher seldom gave a random answer as an example to an interview question whenever an interviewee, and due to the English language barrier, expressed a comprehension issue. One of the interviews in Thailand was assisted by a translator who had been informed on the research topic and had a prior view of the interview questions.

The interviews were face-to-face and at the work location of the participants, however, and due to time and

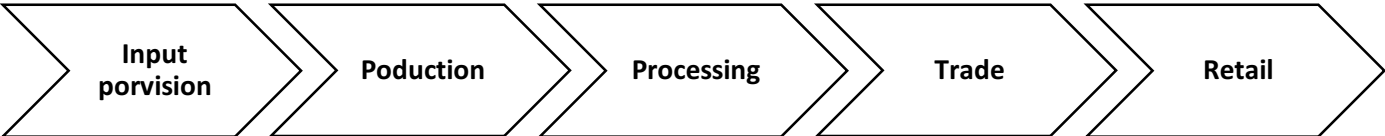
budget constraints, the researcher was not every time at the same location as the interviewee. When that was the case, the interview was carried over Skype and in English. The researcher met with some of the interviewees in France, Germany, and Thailand for a direct interview. The other interviewees who are located in England, The Netherlands, and once in Thailand were interviewed over Skype in the same manner as the direct interviews. Moreover, all twelve interviews were conducted in the period between the 29th of November 2016 and 30th of January 2017. None of the interviews was conducted in the last week of December 2016 and the first week of January 2017 due to Christmas and New Year's holidays, the little time interviewees had in that time of the year, and the researcher's planned travel dates.

Mapping Key Actors and Activities

From the information collected through the semi-structured research interviews that the researcher conducted with certain key stakeholders in the insect-based food industry, it was possible to map, as shown in table 2, not only the interviewed actors (with exception of the experts) but also those who are upward and downward in the chain, like their respective suppliers and buyers. In the case of the interviewed experts, relevant information on stakeholders was also gathered and used in the mapping process.

The table below shows the relevant findings organized in an aggregate form in order to generate in a first step a linear value chain, like the ones figuring in literature, before moving afterwards to a more complex and realistic mapping that takes into consideration the non-singularity of insect-based food products as well as the geographical scope of this research that is divided between Western Europe and Thailand.

Table 2: Mapping of found actors and activities involved in the insect food value chains

					
Key actors	Insect feed suppliers	Insect farmers	Processors of insects into: flour, insect-based food, functional food	Traders, shippers, food distributors	Supermarkets, retail shops, online retailers, restaurants, street food retailers
Key Activities	Provide feed for insect production	Insects breeding, controlling quality and shape	Processing insects into: flour and food like snacks or pasta, controlling quality and shape of supplied insects	Shipping and distribution	Flavouring insects, storing, marketing, packaging products, offering insect-based meals
Supporting actors and activities	Online forums for sharing tips on rearing and consumption. Insect farmers' association and other cooperation lobbying for regulatory changes. R&D companies for scaling up insect production and controlling quality. Food manufacturers supplying outsourced food ingredients like pasta for insect-based food production. Marketing agencies. Research universities.				

The insect food value chain, like many other value chains, involve more than one final product being produced and sold in more than one country. Each of those different products undergoes its own set of activities to final consumption. Since this is the case, the process map should look more complex than the linear mapping. The figures below are based primary on the business models of the interviewed actors and shows the potential complexity of insect food value chain in each of Western Europe and Thailand. It is worth noting here that the below map is mere representation of the field research findings of this research rather than the whole actual map of the insect food value chain which cannot be depicted due to the dynamic nature of value chains.

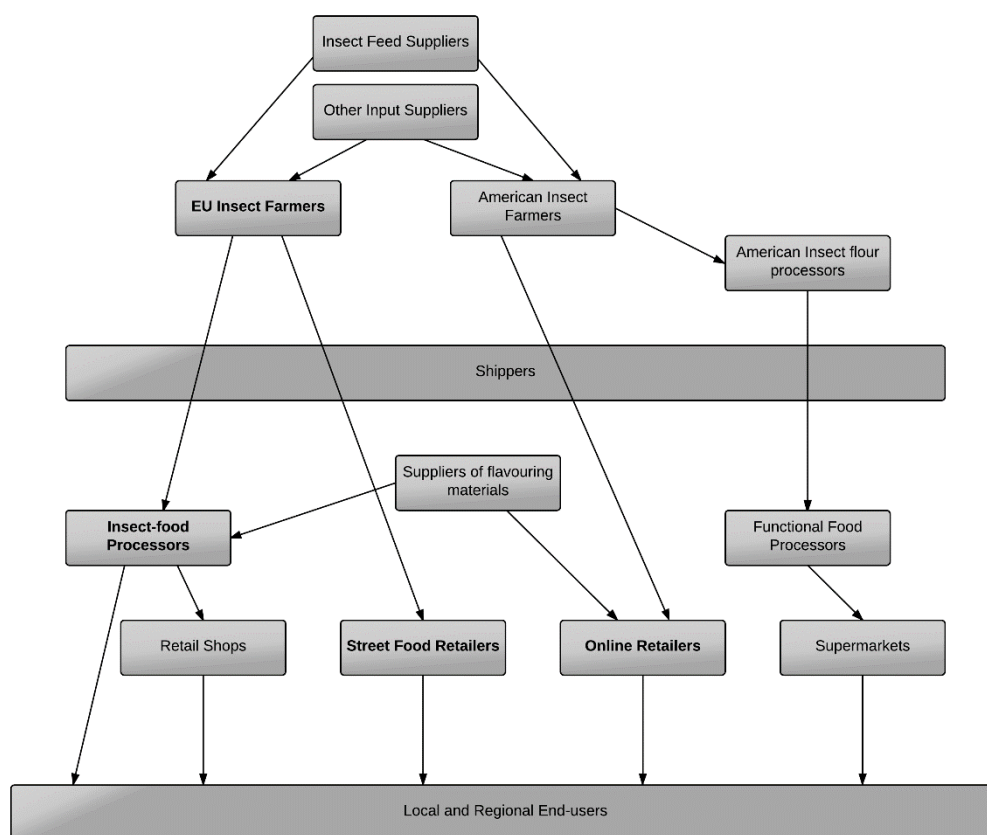


Figure1: Mapping key actors and activities in the insect food value chain in Western Europe

The stakeholders, whether farmers, processors, or retailers, who have participated in this research and who are mapped in the above and below figures, are mapped in bold characters for clarity. Besides, the referral to any participant in this research continues to be done according to the coding scheme in the first section of this chapter. According to Expert E2, who was asked about how people can buy insect-based food in The Netherlands, the people who the expert has spoken to 'have bought insect-based convenience food in the supermarket' and the expert's interviews with others has informed that 'about half of it is sold in small shops,

and the other part is sold online.’ By shops the expert means delis in which convenience food is sold.

Expert E1’s knowledge was limited to the UK, however, the following information was conveyed: some companies import cricket or mealworm powder from America and make cereal or protein bars with it. Expert E2 knows about insect breeders who are selling their insects to start-ups who transform them into powder like cricket powder or to food companies ‘who produce things like insect burgers’, or to ‘to protein bar manufacturer who incorporates them straight into the products.’ Expert E1 has been studying the insect burgers and knows that ‘they are made by a company that manufactures functional food who in turn sub-contracts production to a company that makes vegetarian convenience food’ before they are sold to supermarkets.

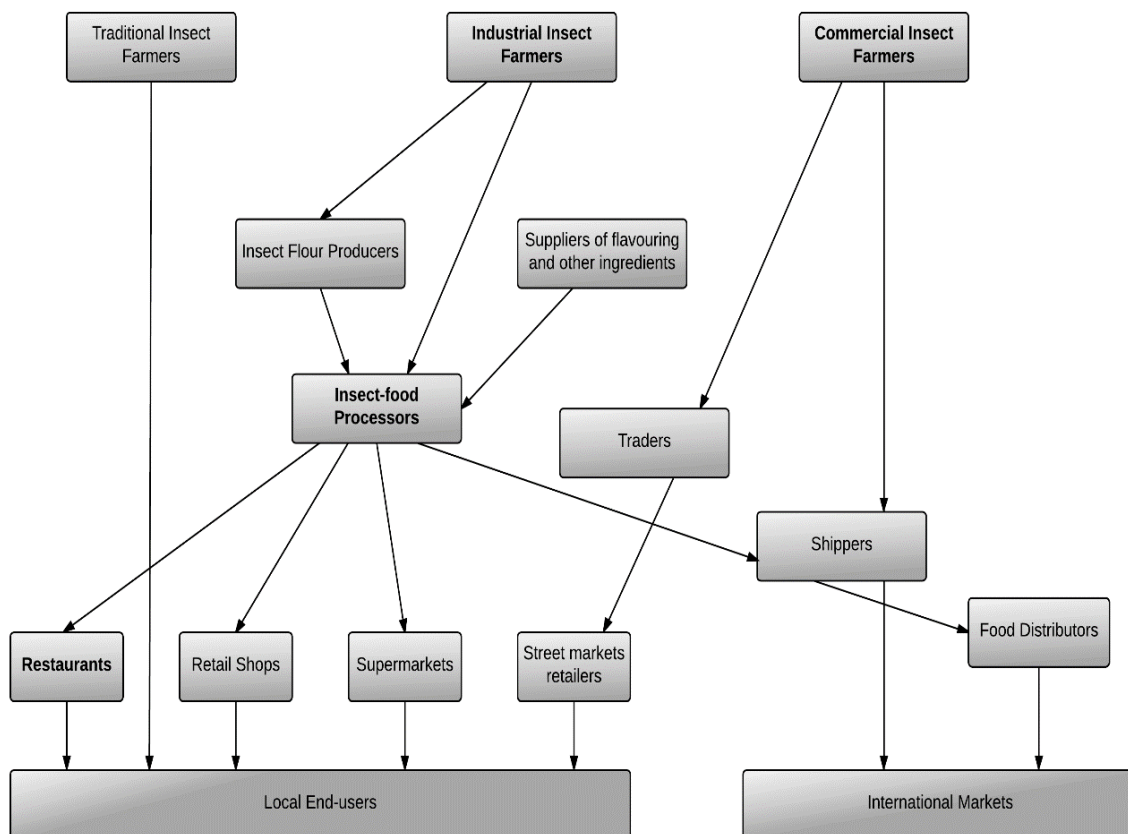


Figure 2: Mapping key actors and activities in the insect food value chain in Thailand

Expert T3 focused on differentiating between those 20,000 cricket farmers and 5,000 palm weevil farmers who figure in official statistics like the one of the FAO. According to the expert, there are village farmers whose insect harvest is dependent on the seasons and commercial farmers who focus on cricket farming

‘because it is easy to grow and it is cheap, and it is grown for a food industry so not as an insect meal.’ Then there are ‘traders who sell these insects to food companies that use these insects as ingredients to make insect meal or sell to retail shops maybe in tourist areas or downtown Bangkok.’ The expert adds by saying that he has heard also about special insect gourmet restaurants that offer insect foods.

Expert T3 spoke of the tourist areas and retail shops as locations where one can buy insect food like microwavable ready to eat meals and snacks. The researcher has been to these locations and have seen packaged roasted insect snacks sold in small convenience shops and fresh fried insect snacks sold in touristic areas by food street sellers and in open air markets. The researcher also started looking for restaurants in Bangkok offering insects on their menu after that Expert T3 told him that he has heard of them. The search ended up in finding one fancy restaurant in Bangkok and the interview answers collected from the owner of that restaurant. Thus, the information that has been collected from the different stakeholders are figuring in the mapping presentations of this section.

Mapping the Geographical Flow of Products

Since the insect-based food industry is made of value chains spread over and separated by continents, the researcher decided to categorize the key actors not only according to their main activities, which is a straightforward way for distinction, but also according to their geographical location. Based on the mapping done through the first two step and on the identification of the geographical location of core processes from the collected field research data on both the interviewed stakeholders, and, from the interviews with them, on other stakeholders (farmers, processors, etc.), a geographical map is developed in this section in a straightforward manner. The purpose of mapping the geographical flow of insect-based products is to make it possible to show regional differences which would help stressing on certain the separation of activities and the vanishing of the mechanism of collocation and agglomeration.

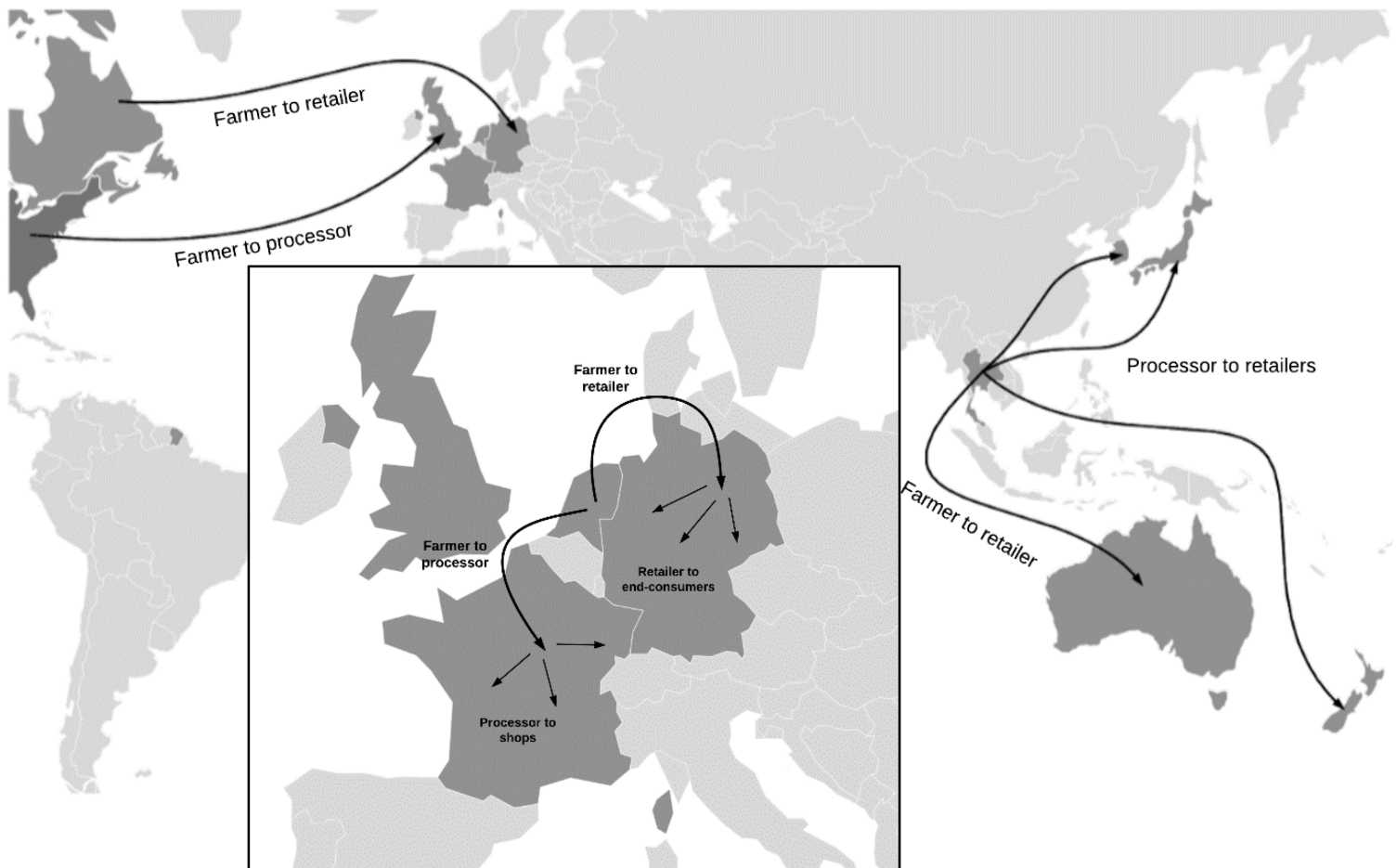


Figure 3: Geographical mapping of insect-food products value chain

After having mapped in the previous sections stakeholders in insect food value chains, and in order now to meet the second research objective, the discussion goes on to cover issues related to governance mechanisms and cooperation that are based on the primary data collected and backed by literature.

Coordination Structures

According to Gereffi (2001), there are two overall types of governed chains: producer-driven chains and buyer-driven chains. Normally, producer-driven chains are perceived with products for which the expenses of R&D or the wants of capital for production are great; and in buyer-driven chains, the lead firms are ‘manufacturers without factories’ involved in product design, marketing and advertising.

According to the data collected, there is no one type of chain when it comes to the insect food value chain. However, the nature of the final products renders the value chain closer to some classic examples of buyer-driven value chains such as fresh fruits and vegetables, clothing, and footwear for which the entry barriers for production are rather low. In a buyer-driven chain, lead or ‘coordinating’ firms distribute requirements to a devolved and internally contesting system of independent producers and manufacturers. The data collected from the European participants does not show the presence of any lead firm. However, two of the firms in Thailand who participated in this research show similar behavior to the one of a lead firm. Processor T1 and Processor T2 both distribute certain business activities, such as farming insects or processing them into flour, to independent farmers and/or processors. Besides coordinating this process, the two processors focus on packaging design and marketing as they do not possess any production facilities but rather their suppliers do.

The form of governance can change as an industry evolves and matures, and governance patterns within an industry can vary from one stage or level of the chain to another. In addition, recent research has shown that many GVCs are characterized by multiple and interacting governance structures. The analysis of the collected primary data clearly shows that the general form of governance in the insect food industry is of market governance type. It involves transactions that are relatively simple. Information on product specifications is easily transmitted, and suppliers can make products with minimal input from buyers. These arms-length exchanges require little or no formal cooperation between actors and the cost of switching to new partners is low for both producers and buyers. The central governance mechanism is price rather than a lead firm. The prices of whole and flour insects which are relatively high in Europe and currently at affordable rate in Thailand affect the demand for and supply of insects like with any other commodity.

In the insect food value chain, there is a certain system of coordination that is in place to meet the quality, quantity, and consistency of supply, and also to ensure compliance with standards. This coordination is mostly based on formalized arrangements such as binding contracts. As observed in the primary data collected, contracts exist mainly between processors (buyer) and insect farmers (producer), and between processors and traders. When a firm such as an insect processor decides to buy fresh insects instead of producing in-house, the transaction is governed by a set of decisions related to the transaction itself: price, quantity or volume, number of suppliers and their qualifications. For an optimum output, certain decisions

have to be made relevant to what ‘specifications should goods be made, what technologies should be used to do so, what defect rate will be tolerated, how often and to where are the goods to be delivered’ and so on (Gibbon, Bair, and Ponte, 2008).

While binding contracts govern the business between processor, farmers, and traders, none of the interviewed retailers worked with their suppliers under contracts. The transactions between them is done via online orders of certain quantities at fixed prices while taking into account the delivery time. Processors are more concerned with formalized coordination and mainly exclusivity agreements. Processor T1 has signed exclusivity agreements with two of his different suppliers in order to insure a constant supply and at a constant price. Although the quality was not referred to in the context of formalized agreements, Processor T1 states that he focused on selecting the best insect flour from the eight flour processors in Thailand. Processor T2 has included the quality issue in his contract with his supplying farmers, demands from them to follow his standards, and even sends an audit team to farms and audit the raw materials and size of insects. Processor E3 has not mentioned any exclusivity agreements, however, he mentions that he has a long-term deal with the supplier and that he is the number one buyer from him, maybe implying a low number of clients buying from his supplier.

So the coordinated governance under which farmers participate in a value chain can be further understood after understanding the contracts under which those actors operate. Besides the contracts, coordination is also subject to ‘contracted input provision, marketing, certification, contract farming or outgrowing, or final product sales to buyers’ (DFID, 2008, p.68). It also may include formalization of collective activities (associations, groups) driven by producers (mainly farmers) to reduce costs, increase revenues or reduce individual risks. This type of coordination is contiguous to the issue of cooperation.

Expert E1 and Expert E2 provided different information on how cooperation is taking place in the industry. While they are some networks in the UK that charge a fee in return of their help, there are also online forums belonging to companies involved in the insect food industry ‘where people can share rearing tips and things like that.’ Expert E2 spoke more about the cooperation that is happening between insect companies that are lobbying to have more insect species allowed to be reared and used for food. The lobbying is also happening through insect farmers’ associations. All three processors are part of such associations. Processor T1 and T2 are part of the same association called the ASEAN Food and Feed Insects Association and Processor E3 is part of the same association mentioned by Expert E2 and which is called International Platform of Insects for Food and Feed (IPIFF).

Farmer T1, located in Thailand, listens to his foreign buyers and gives them what they want as they know exactly what the demand of their market is and what the customers like. However, the flow of knowledge goes in both directions as farmer T1 advises his (Western) buyers on marketing the insects because they do

not have much experience on how to consume crickets or inform their own customers. Processor T1 has a totally different experience in this regard. His buyers who could be big food distributors ask about how many tons he can provide per week, what his lead time is if instead of ordering one container they order five containers, and how much time he needs to deliver these containers.

Rules, Regulations, and Standards

Farmers and other actors involved in the insect food value chain must comply with both official and commercial rules and standards in order to participate in the chain. These rules and standards have, indeed, an origin and ways through which they are enforced. Although the word 'governance' is similar the word 'government', it does not mean that the rules and standards for governance are only set and enforced by the government. In fact, 'the instruments of governance range from contracts between value chain participants to government regulatory frameworks to unwritten 'norms' that determine who can participate in a market' (DFID, 2008, p. 62). Hence, rules and regulations can be set by actors within and outside the value chain, and depending on who sets them they can be either formal (with official legislative backing) or informal (determined by commercial norms).

Most of the interviewees have at some point during the interviews mentioned or spoke about issues relevant to rules, regulations, or standards. A company or institution can govern by setting and controlling standards by simply setting a certain barrier like a financial fee to pay. Expert E1 informed the researcher about the novel food act that will make people pay to have their insects products licensed and also about the fee that supermarkets ask before putting the product on a particular shelf. Expert E2 informed the researcher that company that have the idea of producing an insect-based food work with a production partner who is willing to help them after a certain compromise is reached. However, it is up to the category manager of the supermarket to influence how the shape of the product will be. When it comes to insect farmers, Expert E2 spoke to one of them who has all the rearing, processing process, and product development done in-house. That is different to the insect burgers whose 'development was a compromise between manufacturer, producing company, and retailer'.

In terms of standards, governments do not set standards, however, some of them like the Dutch and the Belgian governments have ruled the permission of the use of insects in human food. However, this use is governed by certain regulations. Manufacturing standards can be set by organizations like IPIFF which works as a kind of agglomeration of producers. They are sort of developing productions standards which are drawn on existing food production standards. So the industry is sort of making its own standards to fortify its position and to persuade concerned stakeholders of the safety of insect-based products.

The issue of regulation and quality was again brought up when Expert T3, in Thailand, spoke of the pesticides residues and the absence of testing procedures which pushes the EU to reject Asian food from Thailand and Asia, and also the need to protect the harvested insects in the wild from pesticide contaminations which is making some other farmers breed insects in a controlled environment instead of wild harvesting them. Even Farmer T1, also in Thailand, expressed hesitation to import from neighbouring countries certain insect species, which he is not able to farm due to the lack of know-how, because they could be contaminated with

pesticides.

The insect food industry in Western Europe is regulated in each country differently, however, and according to the interviewees, the western regulations on insect consumption are being drafted slowly and in favour of the industry and that is mainly due to the work of lobbying associations such as IPIFF in Brussels. Processor T2 has a similar point of view as he says that even though western countries have started farming insects after Thailand they have already achieved changes in their regulations on insect consumption. This can be explained by the fact that insect rearing and consumption is seen as traditional in Thailand, and hence the low pressure of formalizing it, whereas it is perceived as a sustainable and economic issue in western countries, hence the need to regulate it so the industry can be controlled and can grow. According to Retailer E1, the reason why insects' prices in Thailand are so low is because it is not that regulated in terms of hygiene so almost anybody over there can produce insects and that is why the prices in Europe are so high because of all the standards that the western farmers have to deal with. He adds by saying that the way insects are produced in Thailand does not meet the European legal requirements before sale.

Besides the formal rules and regulations that are officially backed by legislation and that were discussed so far, the data collected covers as well informal regulations and standards that are determined by commercial norms. Processor T1 and while talking about his customers, informed the researcher that big foreign food distributors ask not only about his ability to serve them on time and with the required amounts, but also about certifications. Same thing goes with Farmer T1 who says that many of his foreign buyers, think of the Asian products as low quality that is why he is requested to show them certificate of analysis (COA) as evidence of safe quality. Even 'upper class Thai buyers' ask for the certificate. Processor T2 deals also with commercial standards both with the actors supplying and buying from him: supermarkets impose on him their own standards on the quality, price, and packaging; in his turn he imposes on the contracted farmers his own standards and audits them regularly on the raw materials, size of insects, and pricing.

Farmer T1 and while speaking of standards, mentioned first the feed he is supplied with and explained his concerns with checking its content and standardization because it affects the quality of his farmed crickets and therefore his relationships with his foreign (Western) buyers. This indicates so far that both farmer T1 and processor T2 themselves organize, provide and pay for quality control. On the other hand, farmer T2, who is selling to local Thai buyers, finds it difficult to control the quality of insects and hygiene of farm, however, his value proposition is breeding clean insects with a good shape.

Limitations and Further Research

Conducting an analysis of the insect food value chain which is an industry value chain has its own limitations. Due to the fact that an industry- or sector-wide value chain is pretty broad, it obscures the detection of important upgrading opportunities for actors in the chain. Upgrading a firm can also mean gaining a certain comparative advantage over its competitors. However, the value chain in which competitors are operating may differ from the one in which the interviewed actors are. The broad industry may be the same but the value chain not the same. For instance, low cost and full-services airlines are two competitors who, even though both operating and competing in the same airline industry, are located in two different value chains having different boarding gate operations, crew policies, and aircraft operations. Therefore, analysing together the roles of low cost and full-services airlines will not yield clear findings in terms of how any of the two actors may upgrade in the industry.

Looking at the insect food value chains, it is seen that end products are varied and different so are the targeted end-consumers. This implies the limitations of this research in analysing upgrading opportunities for a processor turning insects into snacks and a processor turning insects into flour. Same goes for a farmer targeting complex markets and another one targeting the domestic market. A further research on the insect food value chain could bring it forward and focus on a certain and specific chain, for instance, the value chain of insect flour-based food, or the processed whole insect food value chain.

Just as the term industry is broad so is the term insect (species). This implies again a limitation in analysing governance and upgrading opportunities in the chain due to the fact that every insect species can be reared and used in a different way and by different middle- and end-markets. For a further research to be contributing in its own way, a specific insect species should be focused on. For instance, crickets, which the researcher observed as the most cited insect species during the conducted interviews, can be focused on rather than putting all edible insect species in one bag. This differentiation between different insect species should also be done because every insect species has different nutritional contents, needs a different rearing and processing method, tastes and is perceived differently. An air insect like a bee is not similar to a ground insect like a cricket or a soil insect like a mealworm.

Moreover, a firm's source of competitive advantage cannot be determined in a value chain analysis by looking at the firm as a whole or as performing one activity. A firm should rather be separated into all of its actual performed activities so (potential) competitive advantages can be determined in one or more of the activities. This is relevant to the activities performed by a firm that Porter (1998) divides between the primary and secondary ones. A research with case studies could focus on fewer firms involved in the edible insect industry and allocate the remaining efforts to dissecting a company's operations for better results in finding out the actual or potential competitive advantages.

Finally but not least, the limitations arising from this value chain analysis research have the qualitative semi-structured interviews as the focal point. It is difficult to capture all of governance issues in one interview per respondent. Although the data was collected through semi-structured interviews rather than fixed-format questionnaire, its qualitative nature makes it unquantifiable and, therefore, harder to interpret. A further research with a quantitative approach could seek to evaluate governance modes or bargaining powers of firms by scaling the findings and, hence, make it quantifiable and less subject to different interpretations.

Conclusion

The lack of rules and legislation on how to farm insects is challenging the new entrants to the edible insect industry. There is an absence of regulation about the welfare of the insect which makes it an issue worth addressing and regulating before it turns later on into a hindrance to entrepreneurs like what is happening in the meat industry between meat producers and ethical consumers. Another barrier is the difficulty in getting an insurance that the farmed insects are safe, and the absence of rules to rely on for farming. Then comes the financial challenges of having to pay to get licensed and to get the product placed on specific shelves in supermarkets. Insect breeding in controlled environments should be regulated especially since that wild harvesting will be negatively affected by: the uncertainties that are increasingly coming with the climate challenging and that affect rural farmers who get their insects during certain seasons; and the pesticide contaminations affecting insects harvested in the wild.

Processed insect-based food is and for different reasons not easily accepted in Europe as well as in Thailand. The main reason in Europe has to do with food safety and the one in Thailand has to do with westernization of nutrition habits and also the processing of insects which are considered as a traditional food. Farmer E3, whose produce is transformed by processors into insect flour, sees a challenge in getting consumers to accept insect flour not only in Europe but also in Thailand where insects are being consumed in rather their whole form. Hence, the need to invest in effective marketing strategies.

With regard to the standards in the insect food industry, certain standards and grades exist in the industry both as formal and informal. By having the resources to learn about market participation requirements the *poor* or disadvantaged value chain actors can find opportunities for any type of upgrading (DFID, 2008). Therefore, the analysis of upgrading opportunities for disadvantaged producers is concerned with the access of the latter to crucial information about informal and formal regulations, standards, and markets requirements.

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