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## Mapping of the Black Soldier Fly value chain in East Africa

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We hope that this study contributes to a better insight in the Black Soldier Fly value chain in Kenya and Uganda, especially in the economic aspects of it.

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## Abbreviations

5-DOL	5 Days Old Larvae
ACALISE	African Centre of Excellence in Agro-ecology and Livelihood Systems
BSF	Black Soldier Fly
BSFL	Black Soldier Fly Larvae
CIRD	Centre for Insect Research and Development
DCA	Dan Church Aid
F&S	Fair & Sustainable Consulting
FAO	Food and Agriculture Organization
ICIPE	International Centre of Insect Physiology and Ecology
JOOUST	Jaramogi Oginga Odinga University of Science and Technology
KCCA	Kampala Capital City Authority
KEBS	Kenyan Bureau of Standards
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MoH	Ministry of Health
MoU	Memorandum of Understanding
MTIC	Ministry of Trade, Industries and Cooperatives
MSD	Market Systems Development
NARO	National Agricultural Research Organization
NEMA	National Environment Management Authority
NPK	Nitrogen, Phosphorus and Potassium
RoI	Return on Investment
UIRI	Ugandan Industrial Research Institute
UMU	Uganda Martyrs University
UN	United Nations
UNBS	Ugandan National Bureau of Standards
URA	Ugandan Revenue Authority
USAID	United States Agency for International Development
VC	Value Chain

## **Executive Summary**

### **Objectives of the study**

Production and processing of Black Soldier Fly Larvae (BSFL) is emerging as a new agricultural sub-sector in East Africa to provide a high-quality and affordable alternative source of protein for animal feed and organic frass.

This study mapped the BSF value chain in Kenya and Uganda to provide insight into BSFL farming opportunities and potential for BSF products in Kenya and Uganda. In addition, a deep dive in Kenya was performed focusing on climatic conditions, local waste economies, current uses, and production methods of BSF products and market research and recommendations on feasibility of various BSF products.

### **Methodology**

The study was conducted using a qualitative research methodology. In Kenya 35 interviews were held and in Uganda 25 interviews, they were conducted with a selection of different types of actors in and around the BSF value chain (e.g., BSF producers, waste providers, off-takers, end-users, support organizations and governmental institutions). The fieldwork in Kenya was done in Central Kenya (Nairobi, Kiambu, Kajiado, Machakos, Nakuru), Western Kenya (Uasin Gishu, Kakamega, Kisumu, Homa Bay, Siaya) and Mombasa. In Uganda in Kampala and the surrounding districts and in Kayunga and Jinja.

### **The BSF value chain in Kenya**

There are an estimated 1,200 active BSF producers in Kenya. Two main production systems shape the BSF value chain in Kenya. The first is BSF production at household level, done by small-scale farmers who often have a mixed farm with both crop production and animal rearing. Some do full-cycle BSF production; others do partial BSF life-cycle farming - from egg or 5-day-old larvae (5-DOL) to full-grown larvae. This production system is mainly used to reduce costs of feed and fertilizer while improving quality and health of animals and crops. The second is BSF production at a commercial scale. This means that eggs, 5-DOL, wet larvae, whole dried larvae, dried larvae meal and frass are produced at higher volumes with the aim to sell to various clients, ranging from small-scale farmers to feed millers. This production model happens at small-, mid-, and large-scale in Kenya. Note that production systems are fluid and overlapping and producers can move from one production system to another overtime.

The sector is characterized by a few large and well-known players with headquarters in- or around Nairobi and a large body of small- and mid-scale businesses scattered around (peri)-urban regions across the country. A higher concentration of businesses was observed in Central Kenya and in Western Kenya. These regions are also identified as holding the highest

potential for growth of the sector due to a relatively higher public awareness, waste availability and demand for protein. The coastal region was found to have favourable climatic conditions for breeding.

Prices of most BSF products vary greatly between producers as price agreements and standardization have not yet been established in the sector. Both the demand and supply of BSF products is highest in Western and Central Kenya and was found to be lower in Eastern Kenya. Based on current estimated production and sales volumes, it is estimated that the annual total sales of BSF products in Kenya account for roughly 434,750,000 KES (2,960,504 USD) (Note: this is a very rough estimate and shall not be used for any other research or calculation purposes outside of this report). The top two producers in Kenya account for the absolute majority of these production and sales volumes.

A significant number of research institutes is active in the BSF sector in Kenya. This includes (but is not limited to) Kenyan and international universities and research institutes. BSF farming is also gaining popularity amongst donors and NGOs and several organizations have funded and/or implemented BSF-related projects and businesses in Kenya. Not all funding is directly allocated because of BSF, but mainly because BSF fits into overarching themes like promoting circular economies, sustainable agriculture, and youth and/or women entrepreneurship.

Roles and functions within the value chain in Kenya are overlapping and hybrid. For instance, all the Kenyan research institutes that were interviewed are also producing BSF commercially (to some extent) and/or engaged training activities and donor-funded projects. The lack of specialization and a clear division of roles creates a situation in which everyone is competing for the same place in the sector, which not only impedes collaboration and sharing of information but is also inefficient in creating market linkages with off-takers and end-users. Relationships between value chain actors are mostly informal. There is a sectoral organization called the Association of Insect Farming & Its Products. It is growing, but currently in early stage of development and thus large-scale value chain coordination is still largely lacking.

The BSF sector in Kenya has largely been unregulated due to it bordering between the Ministry of Agriculture, Livestock and Fisheries and the Kenya Wildlife Service (KWS). This overlap of regulatory bodies resulted in a grey area in which most producers have operated informally and without guiding policies and regulations. In recent years, more attention has been drawn to the growing sector and the need for creating an enabling policy environment. The Ministry of Agriculture, Livestock and Fisheries is currently mainly concerned with feed regulation in terms of sanitation and biosafety. BSF is identified as a potential new source of protein within the ministry, but no official policies have been developed to specifically target the BSF sector. There are three relevant documents generated by the Kenya Bureau of Standards: Code of Practice for Insects in food and feed, Standard for Dried insects for compounding animal feed

and a Standard for Organic Fertilizer. Additionally, the National Environment Management Authority (NEMA) conducts environmental impact assessments to assess potential environmental impacts due to BSF production (specifically waste handling) and ensure that BSF businesses comply with environmental regulations. Except for the NEMA license, most interviewed producers were largely or completely unaware of policies and standards related to BSF.

Several services are available for BSF producers in Kenya. Firstly, training on BSF through research institutes, social enterprises, other BSF producers and donor-funded projects. Although training on BSF is widely available, more extensive high-quality training programs are needed that focus on the advanced practical and technical aspects of BSF. Secondly, business development services are offered to BSF farmers through donor projects, often delivered through social enterprises and NGOs. Thirdly, quality testing of produce is available through private businesses as a paid-for service. In the same light, KEBS standards are a paid-for service.

There are a few services missing from the value chain altogether. Firstly, access to financial services is largely lacking. Formal financial service providers like banks and investors are unfamiliar with the BSF sector and regard it as a high-risk business due to the lack of proof of concept. Additional capital is mainly needed to upscale production and professionalize the sector. Secondly, there are currently no government extension services for BSF. This impedes on wide-spread adoption of BSF and knowledge dissemination. Thirdly, processing services are missing from the value chain. Many interviewed small- and mid-scale BSF producers expressed that they would be interested in communal drying facilities and/or developing other more affordable ways of processing.

The largest challenges of BSF in Kenya are related to the protein (BSFL). In theory, the demand for BSF products is high as most off-takers and end-users are desperate for better alternatives to soybean meal and fish meal. However, in practice we see that the amounts of BSF products sold are much lower than amounts produced. This results in the lack of profitability of BSF businesses and BSF not yet living up to its promised potential.

Multiple underlying challenges were identified. Firstly, there is a challenge with the consistency of BSF production. Secondly, production volumes of BSF have not yet reached the critical mark. The landscape of BSF producers in Kenya is largely made up of small-scale producers with no drying capacity and currently there are no aggregation services or centralized drying facilities. Off-takers require a consistent supply of large volumes of dried and sometimes de-fattened BSFL and this demand cannot be met yet by the sector. Thirdly, prices of BSFL products are a challenge. Feed millers have expressed that even if the desired quantities and qualities can be supplied, the current prices of dried BSFL products are not competitive enough.



Several opportunities in and for the BSF sector were identified. Firstly, the opportunity of BSF to address the organic waste management issue in Kenya. Opportunities mainly arise regarding the formation of mutual beneficial partnerships between BSF producers and waste providers and producers, county governments and waste collection groups. Secondly, arguably the biggest opportunity is still the large demand for protein from feed-millers. Keeping in mind the challenges above, it becomes clear that there is a big opportunity for initiatives that create better market linkages. Thirdly, there is an opportunity for innovative entrepreneurs to create and find niche markets and/or specialization within the value chain (e.g., breeding or high-quality frass production). Fourthly, additional product development and research on BSF oil and its application is an opportunity. Finally, growth of the BSF sector is a big opportunity for job creation, especially for youth and women.

To utilize the potential of BSF in job creation and entrepreneurship for youth and women, specific challenges need to be considered. The main challenges for both groups are access to capital, land and (to a lesser extent) knowledge. In recent years there has been more attention to women and youth entrepreneurship and projects are designed to specifically target (entry) barriers for these groups. This creates an opportunity for women and youth in BSF to participate in such projects and programs.

### **The BSF value chain in Uganda**

Like in Kenya, Uganda also has two main production systems: full or partial cycle BSF production at the household level done by small-scale farmers for cost-reduction or resilience reasons (450-500 producers) and BSF production with a commercial intention and at a larger scale (5 producers). Most BSF producers get their inputs (waste) from their own household (small-scale farmers), markets and breweries (commercial BSF producers). Most BSF producers are situated in the central region in Uganda, with a concentration of producers in Kampala and surrounding districts.

BSF production is low. A very rough estimate (be careful using these figures) is that 45 tons of frass, 19 tons of wet larvae, five tons of 5-DOL, 1.5 tons of dry larvae and eight kilos of eggs are produced per month. Rough estimated sales are even lower: 30 tons of frass (estimated value: 32.6 million UGX), 2.5 tons of wet larvae (estimated value: 6.7 million UGX), 1.5 tons of 5-DOL (30 million UGX) and 2.7 kg of eggs (10.8 million UGX) per month.

Small-scale farmers hardly sell the BSFL and frass that they produce. Commercial BSF farmers sell frass to large, medium, small crop farmers and eggs, 5-DOL (including BSF-training) to small-scale farmers. Processing of BSF products (e.g., dry larvae) is hardly done: there are not yet many agrovets (frass) and animal feed manufacturers/feed millers (for BSFL) who buy BSF products. There is an overrepresentation of youth in the BSF value chain as waste collectors (young men) and as workers in commercial BVF farms. Women are overrepresented as small-scale poultry farmers who produce BSF on the side.

There are various institutes that research BSF (e.g., Universities, NARO, CIRAD), though most of them are also BSF producers. BSF training services are there, often funded by donors who support commercial BSF producers and research centres to train small-scale farmers to take up BSF farming. Financial service providers are there, but most BSF producers do not meet their requirements. There are limited standards and laboratories to test the BSF products.

Looking at governmental bodies, The Ministry of Agriculture is currently developing a national livestock development policy in which 'productive insects' will be included. In addition, a new animal feed bill is almost being passed through the Parliament that includes the use of insects in animal feed. The policy is being complemented with the UNBS standards for dried insect products for compounding animal feeds and for edible insects. Awareness raising on BSF production is done via district entomologists, though most are not aware of BSF yet. NEMA conducts environmental impact assessment, which are needed by commercial BSF producers.

Relationships between the value chain actors are often informal except for some of the large-scale producers who have formalized relationships with their waste providers and off-takers. Though most commercial BSF producers know each other, there is no stage of open dialogue (yet). Value chain coordination is largely absent and value chain actors stress the need for a sectoral association.

Challenges to develop the BSF value chain in Uganda have mainly to do with the fact that it is a new value chain. Sales of BSF products are still low due to low consistency, in quality and quantity, and high prices (according to off-takers). Farmers often lack inputs to produce and/or process BSF (e.g., equipment, finance, knowledge, parent stock) and do not have enough awareness and knowledge of BSF to produce. Waste management and sorting of waste is another challenge, just like lack of services and lack of cooperation and value chain coordination.

Despite the challenges to develop the BSF value chain in Uganda, there are also opportunities. The most important are the high demand for protein and frass, the fact that BSF is an input for many innovative products (e.g., specialized animal feed, soap, bio-diesel) and its potential to solve organic waste management problems and to create additional jobs and income for farmers.

Specific challenges for youth and women are lack of finance and land, though BSF production requires less of both in comparison with other agricultural value chains. Women also face challenges because of gender norms, they are not always able to come to BSF training as they are bound to their house and household chores. However, BSF production is often done nearby the household's house, which also makes it an opportunity for them. For youth, BSF production can be an interesting opportunity because it is a new value chain and it offers, next

to production, also opportunities in marketing and it even connects to waste collection. Furthermore, often donors aim to create economic opportunities especially for women and youth. Finally, youth and women groups are good entry points for extension officers and commercial BSF farmers to reach out to them to make them aware and train them on BSF.

### **Similarities and differences between the BSF value chain in Kenya and in Uganda**

Though there are many similarities, generally speaking one can say that in most aspects the BSF value chain in Kenya is further developed than in Uganda. There are more BSF producers active in Kenya with more variation in terms of scale, level of professionalism and level of specialization. In addition, Kenya has more production and sales of BSF products for lower prices. There are more donors and investors engaged in BSF in Kenya and it has already a BSF association. However, in terms of policies Uganda is ahead of Kenya. Finally, the challenges and opportunities to develop the BSF value chain are quite similar in Kenya and in Uganda.

### **Recommendations**

- Adapt the BSF production approach to the situation or context.
- Conduct more research on the economic viability and sustainability of BSF business models.
- Create commercially attractive BSF product-market combinations that are (e.g., specialize in part of the cycle, targeting niche markets for BSFL products)
- Raise public awareness on BSF, with a focus on women and youth
- Better knowledge dissemination
- Improve the quality of training for BSF producers
- Organize of small-scale farmers
- Better value chain coordination and dialogue between stakeholders
- Set up a nationwide BSF platform or association
- Raise awareness among government workers
- Make loan products more accessible to BSF producers
- Diversify the donor-recipient portfolio to avoid donor darlings and ensure representation across the value chain

# 1. INTRODUCTION

Black Soldier Fly Larvae (BSFL) production is getting more and more attention. Because of their high levels of protein, fat, micronutrients, vitamins, and essential amino acids, BSFL are an excellent replacement for protein in pig, poultry, and fish feed. The by-product of the process is frass, which is insect manure. This is a highly nutritious organic fertilizer rich in NPK (nitrogen, phosphorus and potassium). The production of BSFL has a small ecological footprint and contributes to a circular economy through the recycling of biowaste, as BSFL eat different organic waste sources. BSFL are highly productive and can be mass-reared in a relatively small environment.

Interest in BSF production has been growing because of the increasing demand for sustainable and less costly alternative protein sources for animal feed. This demand is driven by global population growth, increasing demand for animal products, scarcity of conventional feed ingredients such as soy and, consequently, high production costs. Additionally, there is a move towards organic fertilizer especially because of shortages and associated price increases of fertilizers due to the war in Ukraine, which is directly impacting food security and cost of living in developing countries such as Kenya and Uganda.

Production and processing of BSFL is emerging as a new agricultural sub-sector in East Africa to provide a high-quality and affordable alternative source of protein for animal feed and organic frass. Hence, though the promise of BSF products is high, to what extent can it (already) live up to these high expectations in Kenya and Uganda?

## 1.1 Research objectives

The two-folded objective of this research is:

- Executing a value chain mapping of BSFL farming opportunities and potential for BSF products in Kenya and Uganda.
- Performing a deep dive in Kenya focusing on climatic conditions, local waste economies, current uses and production methods of BSF products and market research and recommendations on feasibility of various BSF products.

To meet the dual objective of the study, eight research questions have been formulated. Table 1 shows them and indicates in which part of this report they are answered. In addition to this study, a proof of concept of three BSF business models in Kenya is made by FAO, with support of F&S. These results of this exercise are written in a separate report.

**Table 1. The research question that this report answers, including in which sections**

Research question	Answer Kenya	Answer Uganda
<b>General</b>		
1: Who are the key stakeholders and actors in the BSFL value chain and what are their characteristics and interests?	4.1, 4.3 and 4.4	5.1, 5.2, 5.3
2: What are the market opportunities for BSFL products?	4.5	5.4
3: What does the current policy landscape regarding BSFL look like in Kenya and Uganda and what opportunities and challenges are there for future policy development?	4.6	5.5
4: What are the current opportunities and challenges for youth and women entrepreneurship and employment in the BSFL value chain in Kenya and Uganda?	4.7	5.6
<b>Deep dive</b>		
5: Which Kenyan regions have the most potential for BSFL farming?	4.2	N/A
6: How is BSFL currently being processed and used in Kenya?	Part of 4.3	N/A
7: What do the local markets for BSF products look like in Kenya?	4.5	N/A
8: What is the current and projected (next five years) market size (including estimated value) for BSF products in Kenya?	4.5	N/A

*Note: as chapter four on the BSF value chain in Kenya includes the answers to the research questions in the deep dive, this chapter is more elaborated than chapter five on the BSF value chain in Uganda.*

## 1.2 Relevance of this study

The BSF sector in East Africa is still in its infancy, lacking professional sectoral organization, quality standards, knowledge of processing and product development, and access to high-quality training. Nonetheless, many people are seeing the immense potential the sector holds in the region to leverage favourable climatic conditions and new BSF farms are emerging at a rapid speed across the Region.

In 2021, a paper was published attempting to create a comprehensive review of insect farming enterprises in East Africa. According to the authors, at the time of research there were nearly 1 000 BSF and cricket farms in Africa, but over 95 per cent of these farms operate as microenterprises<sup>i</sup>. However, the paper does not define what counts as a microenterprise or which criteria were used to select the enterprises. It was furthermore estimated that the top-nine BSF producers combined produced approximately ,780 metric tons of dried BSFL annually. According to the article, this would be sufficient to successfully substitute soyabean- and fish meal in animal feeds to produce 4.7 million chicken per year.

However, the article does not mention specifics of how this estimation is made (e.g., which percentage of protein in the animal feed is substituted with BSF, which type of chickens the calculation is based on).

Studies conducted in Uganda and Kenya on the willingness of farmers to adopt insect-based animal feed have shown very promising results. It was found that 90 per cent of fish farmers, 85 per cent of pig farmers and 93 per cent of poultry farmers are open to adopt and use insect-based animal feed<sup>ii</sup>. It is further estimated that the replacement of five to fifty per cent of the conventional feed sources with insect protein in Kenya would generate a potential economic benefit of USD 69 - 687 million for the poultry sector<sup>iii</sup>. However, in practice, the uptake of BSF in animal feeds remains relatively low and many (smaller) BSF businesses are dealing with a surplus of produce they fail to sell.

The abovementioned examples represent a general trend that can be observed in research to date: Many have outlined the immense potential of the BSF sector in East Africa, promising great ecological, economic, and social benefits<sup>iv</sup>. While highlighting the sector's great potential is extremely valuable, contemporary research has thus far failed to address some of the key bottlenecks that prevent the sector from reaching this potential. To better understand the challenges of the sector, particular attention needs to be drawn to the interlinkages between stakeholders and the interplay of a wide set of socioeconomic, political, climatic, and cultural factors that shape realities in the BSF value chain in eastern Africa.

Furthermore, it has to be noted that the sector has been rapidly changing and developing in recent years. Hence, results presented in publications are prone to be outdated already. For example, new BSF enterprises arise every day, microenterprises have grown into mid-sized businesses and many people who started BSF farming in previous years have decided to abandon it due to failing business or other circumstances. The landscape of the sector has changed; for instance, new sub-markets and products are emerging (like specialized breeding units focused on selling eggs to other BSF businesses or businesses solely focused on producing BSF-based pet food).

This research aims to bridge existing knowledge gaps by providing a nuanced, inclusive, and realistic review of the current state of the BSF farming sector in Kenya and Uganda. By performing a value chain analysis, interlinkages between different players and layers of the value chain will be outlined. This allows us to gain more insight into the contemporary challenges of the sector and how to possibly address them in a deliberate way.

### **1.3 Geographical scope of the study**

BSF value chains are in a nascent stage with some countries or regions further developed than others. This means that widespread standardization of the value chain is lacking. While overall there are similar stakeholders present in different countries and regions, it needs to be stressed that BSF value chains are highly context dependent. Consequently, generalization is challenging and BSF is best studied in local contexts taking geography-specific conditions into account.

That is why this study will focus on Kenya and Uganda. Although the BSF sector is still in its infancy in East Africa, it is most developed in these two countries. This provides the team with the best opportunity to research the full value chain of BSF in specific contexts.

This study includes a mapping of the BSF value chain in Kenya and Uganda at the national level. However, for the fieldwork, a narrower geographic scope has been chosen. In Kenya, fieldwork was done in Central Kenya (Nairobi, Kiambu, Kajiado, Machakos, the upper Rift Valley, Nakuru) and in Western Kenya (Uasin Guishu, Kakamega, Kisumu, Homa Bay, Siaya) and Mombasa. In Uganda the fieldwork was done in the Kampala (city and Makerere) and the surrounding districts of Mukono, Wakiso (Kira), Kwana, and Mpigi. Field work was also conducted in Kayunga, Jinja, and on the shores of Lake Victoria where significant fish farming is conducted.

These locations were chosen based on initial desk research and prior experience in the sector that has shown that most BSF farming activities are located within this geographical scope. Focusing on these specific areas allowed the team to research the localities of BSF farming in-depth, which provides a better understanding of the nuances of the value chain at large

### **1.4 Reader guide**

The rest of this report is divided into 6 more chapters. The next chapter gives an overview of the research methodology. In chapter three a brief background on BSF farming is given. In chapter four and five the results of this research are shared; in chapter four for Kenya and in chapter five for Uganda. Chapter six is a short synthesis chapter. Chapter seven gives recommendations to FAO. The annexes provide the literature list, a list of interviewed people, the topic lists, the calendars of the fieldwork and detailed calculations of the BSF production and sales in Uganda.

## 2. Research methodology

This chapter includes an overview of the approach that we used for this study, including frameworks and tools. Furthermore, the methods that used are discussed. The chapter ends with the limitations of this study.

### 2.1 Approach and frameworks

For the value chain mapping and deep dive, F&S combined two approaches: the ValueLinks methodology of GIZ and the Market Systems Development (MSD) approach.

- **The ValueLinks methodology** aims to analyse a value chain and find solutions for developing a value chain sustainably by taking commercial products and markets as its starting point.
- **In the MSD approach** a market system is analysed (this includes the value chain and its supporting functions and rules and norms) to address the underlying causes (constraints and opportunities) of poor performance in those markets that matter to people living in poverty with the aim of creating lasting changes that have a large-scale impact.

In both the ValueLinks methodology and the MSD approach, the first step is an analysis of the value chain or market system. In this study it started with the identification of the main markets for BSF products (e.g., eggs, wet larvae, dry larvae, frass) in Kenya and Uganda. This included an overview of the general demand and offer and overview of who are they buyers of BSF products.

Then, the key actors and stakeholders involved in the BSF value chains in the two countries were mapped. Value chains are complex socioeconomic systems with actors at various levels. These include actors in the core value chain, like input providers, producers, processors (ValueLinks methodology), but also emphasis is put on actors in the system around the value chain (MSD approach). This includes support functions (e.g., as financial service providers, research institutions, NGOs, etc.) as well as and actors who set rules and norms (e.g., ministries, bureaus of standards, informal networks, etc.).

Furthermore, attention was paid to the policy landscape. Besides a description of the actors that are present (the actors who set rules and norms), it was investigated what the relevant laws, policies and regulations for BSF were. Gaps in policy were also identified.



For the deep dive in Kenya, the mapping was more elaborated. This included analyses of:

- The best production regions for BSF farming (taking into account climatic conditions and local waste streams).
- Production and processing methods that were currently being used.
- Local markets and feasibility of BSF products (wet larvae, dry larvae and frass). This included market demand and supply in the different research areas, consistency and quality of the BSF, more detailed information of the buyers and rough cost-benefit analysis of the BSF products.

After the mapping, the main opportunities and constraints to value chain development were listed. With a special focus on challenges / constraints and opportunities in two areas: for youth and women entrepreneurship and employment and for policy development. In the recommendations, the study touches upon possibilities to remove these constraints and/or seize these opportunities.

## **2.2 Methods**

Several methods were used to collect data for the value chain mapping and the deep dive. Firstly, secondary data collection and analysis was done via desk research. After that, fieldwork was conducted to collect additional data. While the focus in the fieldwork was on qualitative data collection via interviews, also some quantitative data (e.g., on market demand, production volumes of BSF products, prices for BSF products, production costs) were collected. Furthermore, during the fieldwork observations were made.

### **Desk research**

During the desk research, a variety of secondary sources were used. These include BSF(L) research reports, presentations and articles by ICIPE, Dalberg Advisors' research report "*Catalysing the Insect for Feed Sector in Kenya Landscape Review*", Wageningen University produced research papers, relevant articles from the Journal of Insects as Food and Feed, relevant policy documents, etc. Annex one shows the list of literature used.

In addition, the consultant team participated in relevant online webinars and meetings. For example, on July 6, The Netherlands Food Partnership (NFP) - together with F&S and New Generation Nutrition (NGN) - organised the Insect Farming East Africa (IN-FEAST Africa) event to allow for the exchange of knowledge and experiences on insect farming in East Africa. Finally, because of the fact that F&S owns a BSF farm in Eldoret, the consultant team could use its own practical knowledge throughout this study. Based on the desk research knowledge gaps were identified as well as issues for more in-depth discussion or verification during the fieldwork.

## Interviews during fieldwork

The field data collection took place in June and August. The fieldwork in Kenya was executed between June 12-30 Central Kenya (Nairobi, Kiambu, Kajiado, Machakos, the upper Rift Valley, Nakuru) and in Western Kenya (Uashin Guishu, Kakamega, Kisumu, Homa Bay, Siaya) and between August 21-31 (Mombasa, Nairobi). The fieldwork in Uganda took place in the period June 19-30, 2023.

During the fieldwork, semi-structured individual and group interviews were conducted with stakeholders in the core value chain, the support and the rules and norms functions. Annex 4 shows the topic lists, they slightly differ for different types of actors interviewed. For the deep dive, the interviews were more extensive, and more actors were interviewed.

Table 2 gives an overview of the type of actor interviewed and the total number of interviews done. In the case where there are more actors present than the team could interview (e.g., small-scale BSF producers), a sample based on convenience sampling<sup>v</sup> was made. All the interviews were conducted by the national consultants, the international consultant joined the fieldwork two weeks, one week in Kenya (June 12-16 in Nakuru and Eldoret) and one in Uganda (June 26-30 in Kampala and surroundings and Jinja). Annex 2 provides a list of interviewees per country.

**Table 2. Number of interviews conducted, per type of actor**

Type of actor	# in Kenya	# in Uganda
<b>Core value chain</b>		
Waste providers	3	3
BSF producers (farmers and businesses at a small-, mid-, and large-scale)	17	8
BSF off-takers (feed millers, feed manufacturers)	2	4
BSF end-users (poultry, pig and fish farmers)	4	3
<b>Supporting functions</b>		
BSF association	1	0
Investors and donors	2	1
Financial institutions	0	1
Research institutes and researchers	4	3
<b>Rules and norms functions</b>		
Government institutions	2	2
<b>Total</b>	<b>35</b>	<b>25</b>

## **Observations**

Besides the interviews, observations were made while visiting waste providers, BSF producers, off-takers and end-users. The observations were 'overt', which means that the people observed were aware that they are being observed. Conducting observations is a good method to gather additional information on the state of the businesses that is not (explicitly) addressed in the interviews. Especially because the sector does not yet have a clear categorization of businesses into different levels of professionalism and/or size.

## **Data analysis tools**

Following the fieldwork, the consultant team worked on the analysis and interpretation of the data and writing the draft report. For data analysis the team used qualitative data analysis tools: Taguette and Atlas.ti to structure the information collected during the interviews.

## **Result validation**

An online stakeholder validation workshop was organized on September 20, 2023. During this meeting the main results of the study were shared and discussed with actors of the BSF sectors in Kenya and Uganda that were interviewed in the fieldwork. A separate feedback workshop with FAO staff, in which the main findings of the study were presented and the draft report was discussed, was held on October 4, 2023. Based on these inputs, the report was finalized.

## **2.3 Limitations of the study**

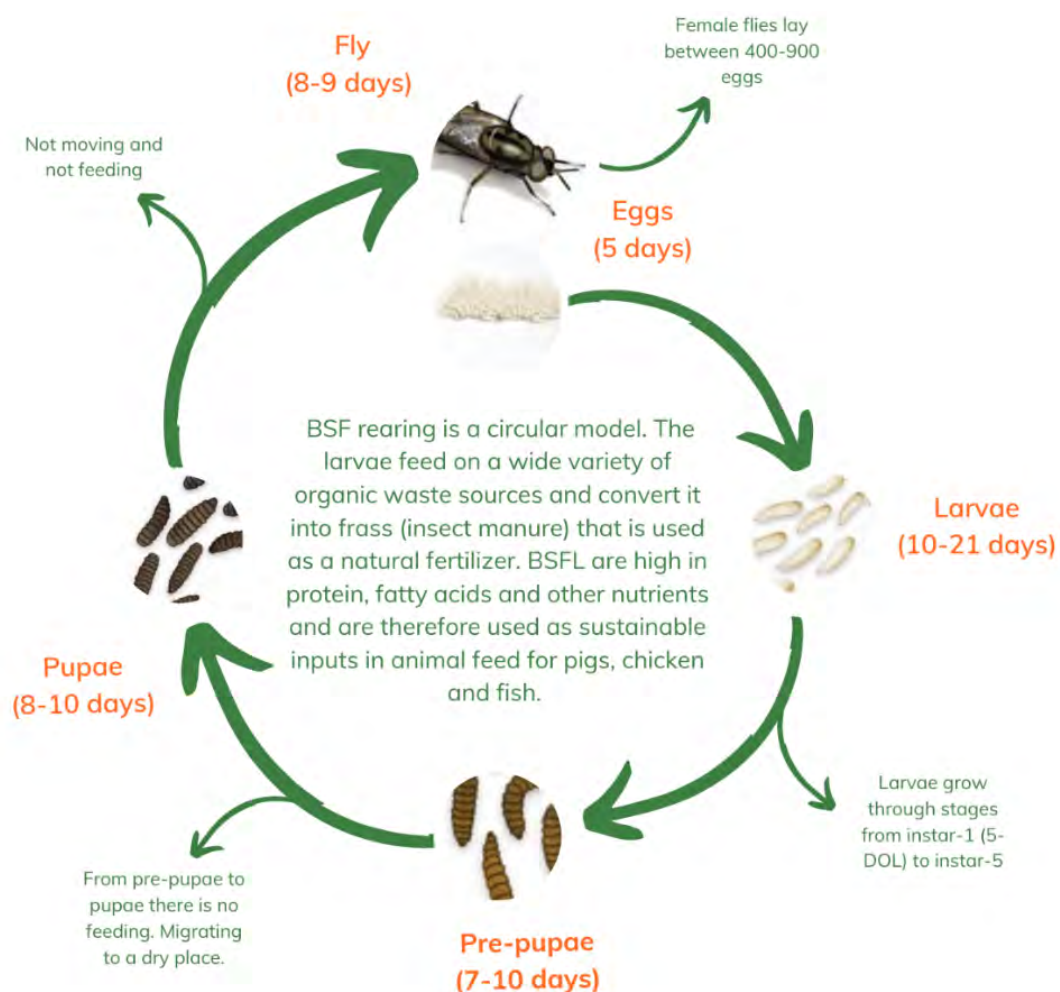
- The findings of this study are based on a sample, due to budget and time limitations not all BSF businesses and other actors in the value chain could be interviewed.
- In Uganda the consultant team has not been able to talk to any NGO with projects in BSF. The number of NGOs that are currently engaged in BSF is limited and the team did not manage to get an interview with those who do. In Kenya, no direct interviews with feed millers were done due to unavailability of the approached actors. Information on feed millers was gathered from stakeholder meetings and the consultants first-hand experience from business meetings with feed millers.
- The projections of BSF production and sales are based on many assumptions (see sections 4.5 and 5.4 and Annex 5) and should be treated with caution.
- Besides being the executor of this study, F&S is also the owner of a BSF business in Eldoret. This has the advantage that F&S understands the BSF value chain well and has practical knowledge of and experience in BSF production and processing. However, this could also lead to conflict of interest. To lower this risk, F&S has chosen a consultant team for this study that are not involved in F&S's BSF business anymore.

### 3. Background on Black Soldier Fly farming

To understand the BSF value chain in Kenya and Uganda, it is important to give some basic information about BSF and its development. The Black Soldier Fly (BSF), *Hermetia illucens*, is a common and widespread fly of the family Stratiomyidae. The BSF adult flies measure about 16 millimetres.

BSF is a highly productive and relatively easy to manage insect that can be grown in a small, contained environment. It can manage temperature differences well, though it does produce better at relatively warm temperatures. The ideal temperature is 26.8 to 28.8 degrees Celsius. The fly is well resistant against diseases and has a relatively short production cycle, from eggs to larvae, taking up to three to five weeks. Figure 1 shows the lifecycle.

Figure 1. Lifecycle of BSF



An adult female fly lays between 500 to 900 eggs at a time<sup>vi</sup>. These eggs are typically deposited on surfaces above or adjacent to decaying matter such as manure or compost and hatch in about 4 days. The larvae can feed on a wide variety of organic matter, adapting their diets to different nutrient content. The larval stage lasts from 18 to 24 days, depending on the substrates provided to the larvae, of which the post feeding (prepupal) stage lasts around seven days. The length of larval stage can be delayed by months due to low temperature or lack of food. The pupal stage lasts from one to 2two weeks. Adults can live typically 47 to 73 days when provided with water and sugar in captivity or nectar in the wild or survive for about eight to ten days on fat reserves gathered during larval stage when water is provided<sup>vii</sup>.

Black soldier flies are not attracted to human habitats or food and do not constitute a nuisance to humans<sup>viii</sup>. They are even beneficial as they prevent the laying of houseflies and blowflies in decaying matter. They prefer to sit still and do not fly around. They don't bite or transmit diseases. Most of their adult life is spent mating and laying eggs. The BSF larvae quickly reduce the volume of waste and what is left can be used as compost. The larvae are used as chicken, pig and fish feed.

## 4. The BSF value chain in Kenya

This chapter elaborates on the BSF value chain in Kenya. The chapter starts with an analysis of the value chain. This includes an overview, the best BSF production areas in Kenya, and a value chain actor mapping (in the core value chain, support functions and rules and norms functions). It then describes the functioning of the value chain, followed by a market scan for BSF products in Kenya and analysis of the Kenyan policy landscape. The chapter ends with an elaboration of the most important opportunities and challenges for BSF farming in Kenya, with a special focus on opportunities and challenges for youth and women employment and entrepreneurship.

### 4.1 Overview of the BSF value chain in Kenya

In Kenya, demand for animal feed/protein and fertilizer has been growing. According to the head of Animal Feeds and Nutrition Services at the Ministry of Agriculture, Livestock and Fisheries, Kenya requires 55 million tons of animal feed per year but produces only 40 per cent<sup>x</sup>. With protein levels between 15 per cent and 25 per cent<sup>1</sup>, the yearly estimated demand of protein in animal feed is 8.25 million to 13.75 million tons. Moreover, in 2021, Kenya imported animal food with a value of 35.4 million USD; exports of animal food had a value of USD 4.87 million<sup>x</sup>.

Furthermore, Kenyan consumption of fertilizer in 2020 was 65.2 kg per ha of arable land. Growing from 13.5 kgs per ha in 1971 with an average annual rate of almost six per cent<sup>xi</sup>. This leads to an estimated 378.16 million kg of fertilizer consumption, as arable land in Kenya is 5,800,000 ha. Considering that there will be people who would like to use fertilizer but do not have the means, the demand for fertilizer will even be higher than the current 378.16 million kgs of current consumption. In 2021, Kenyan imports of fertilizers had a value of 355.45 million USD, according to UN COMTRADE<sup>xii</sup>.

The above shows that there seems to be an opportunity for BSF products in Kenya. Looking at the main BSF products that are currently on the market in Kenya, these are: BSF eggs, five-day old larvae (5-DOL), wet larvae, dried whole larvae, BSFL meal and frass. Other products include BSF oil, however this is still in an early experimental phase and is not produced and sold in significant quantities and (pre)pupae which were observed to only be sold incidentally. Wet larvae and frass are the basic outputs for each BSF farmer. BSF eggs, 5-DOL and (pre)pupae are only produced by full-life cycle farmers.

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<sup>1</sup> The level of protein in animal feed depends on the type of animal and its level of maturity. In general, one can say that a high-quality animal feed contains between 15 per cent and 25 per cent protein.

Whole dried BSF larvae are only produced by producers with access to drying equipment. Mostly, this is limited to the large-scale producers and some mid-scale producers of the upper segment (see section 4.2 for the definitions of large- and mid-scale producers). Some smaller producers make use of solar dryers. Large-scale producers are either experimenting with BSFL meal or already selling it (albeit in relatively small quantities). BSFL meal is de-fattened crushed dried BSFL, which is the preferred version for most animal feed millers and other BSF off-takers.

There are two main production systems that shape the BSF value chain in Kenya. The first is BSF production at household level, done by small-scale farmers who often have a mixed farm with both crop production and animal rearing (mainly chicken and/or pigs). Some do full-cycle BSF production; others do partial BSF life-cycle farming - from egg or 5-day-old larvae (5-DOL) to full-grown larvae. This production system is mainly used to reduce costs of feed and fertilizer while improving quality and health of animals and crops. It can be argued that this production method therefore contributes to creating more resilient livelihoods. The household producers use their kitchen waste and crop production waste to grow BSF, feed the full-grown larvae to their animals and use the frass to fertilize their crops.

The second is BSF production at a commercial scale. This means that eggs, 5-DOL, wet larvae, whole dried larvae, dried larvae meal and frass are produced at higher volumes with the aim to sell to various clients, ranging from small-scale (animal) farmers to feed millers. This production model happens at small-, mid-, and large-scale in Kenya. Both production systems are further elaborated in section 4.3.

It should be noted that the production and consumption functions in this value chain are often hybrid and fluid. For example, there are household level farmers who use their BSF production as a cost-saving mechanism as described above and sell part of the wet larvae and frass to neighbouring farmers. Or commercial BSF farms that, besides selling their BSF larvae, also have poultry that are fed on BSFL to reduce feed costs and improve quality.

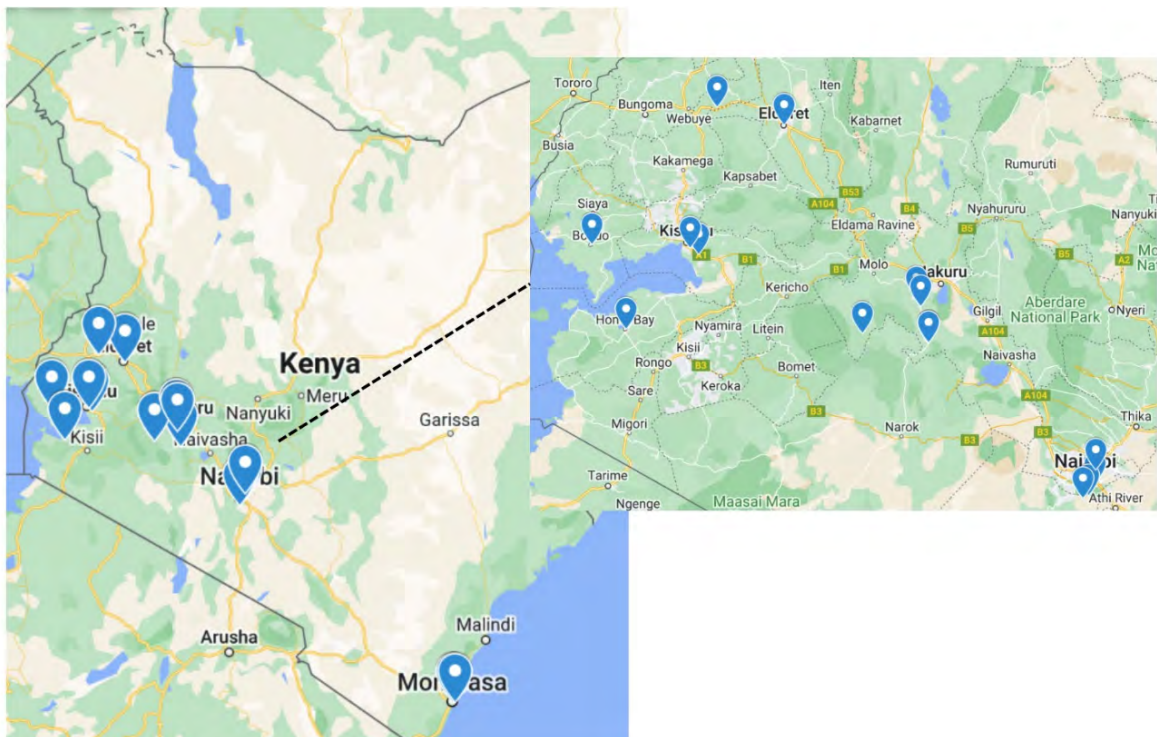
In addition, many BSF products are sold between the two production systems: commercial BSF producers sell BSF products to other BSF farmers. This applies mainly to BSF eggs, 5-DOL, (pre)pupae and so-called starter kits of wet larvae. Another important 'product' sold is technical training on BSF. Most interviewed BSF producers mentioned that they offer extended training and educational services to aspiring and new BSF producers, interested neighbours and/or others. Consumers of BSF products include BSF off takers and end-users, these mainly buy wet larvae, dried whole larvae, larvae meal and frass. Frass can be further categorized into raw frass and processed or enhanced frass. The popularity of composite frass is growing as producers and users observe the benefits of combining BSF frass with other ingredients and methods like vermiculture.



## 4.2 BSF production areas in Kenya

The BSF sector in Kenya is a relatively young sector. Most BSF businesses in Kenya were founded from 2017 onwards (one outlier is Sanergy that started BSF in 2014). The sector is characterized by a few large and well-known players with headquarters in- or around Nairobi and a large body of small- and mid-scale businesses scattered around (peri)-urban regions across the country. A higher concentration of businesses was observed in Central Kenya (Nairobi, Kiambu, Kajiado, Machakos, the upper Rift Valley, Nakuru) and in Western Kenya (Uasin Gishu, Kakamega, Kisumu, Homa Bay, Siaya). See also Figure 2.

**Figure 2.** *Locations of interviewed BSF producers in Kenya*



In general, these regions are believed to have favourable climatic conditions for BSF farming. However, there are mutual differences in terms of humidity and temperature that influence the production cycle. In warmer places like Machakos the production cycle was reported to be as short as nine days from 5-DOL until harvest, whereas in colder locations like Limuru the cycle can take up to 12 days until harvest. Similarly, Nairobi, Eldoret and Nakuru were found to be somewhat prone to inconsistent production due to seasonal influences. However, these fluctuations are manageable with the right set-up and climate control tools. Furthermore, waste was reportedly not a challenge for producers in Kisumu, Eldoret and Nakuru, provided that the location of the farm was chosen strategically and located close to a reliable waste source.



Additionally, the coastal region around Mombasa was included in this research. It was found that although some BSF farming is taking place in and around Mombasa and Kilifi, public awareness on BSF amongst the local population is lower compared to Western Kenya. One reason for this seems to be that compared to Western Kenya, there are fewer chicken farmers or households keeping chicken and thus the local market for BSFL is less present.

However, the climatic conditions are favourable, and it is therefore no surprise that Sanergy has located their breeding facility in Kilifi. Mombasa furthermore houses a large-scale producer that is primarily focused on producing dried BSF for the European export market. According to ICIPE, the coastal region has less waste compared to Western Kenya which could prove a challenge for BSF. However, the producers and NGO interviewed did not report any issues regarding waste availability so far.

There are undoubtedly more Counties in which BSF farming is taking place. However, due to the lack of official registration of BSF businesses with a sectoral organization this is difficult to determine within the scope of this research.

### **Potential regions**

Except for areas with extremely cold or extremely hot climates, BSF can be reared in any location in Kenya provided there is enough waste, and the set-up of the facilities is designed to mitigate climatic influences to some extent. For this reason, the northern region of Kenya (Marsabit, Turkana) was mentioned to have less potential for BSF farming. The climate is less favourable, and availability of waste is challenging. Additionally, some interviewees pointed out that cultural and religious beliefs regarding the use of insects as food and feed in the northern region could prevent the widespread adoption of BSF.

There remains a lot of potential within Central Kenya, especially Nairobi and Kiambu because of population growth and availability of waste, more advanced waste collection systems and the availability of a range of services in the area. In the Western region, in specific Kisumu, Homa Bay and Siaya mainly because of the large availability of waste from local markets and fish production, and because of its favourable climatic conditions. Interviewed producers in Kisumu and Homa Bay reported less production fluctuations due to climatic conditions compared to Eldoret and Nakuru. Thirdly, Mombasa could potentially grow into a popular region for BSF farming. As was discussed above, the area is reported to have less waste and fewer off-takers. However, Mombasa and the coastal region in general have a high potential for breeding facilities due to the highly suitable climate.

## 4.3 Mapping of the BSF value chain in Kenya

This section maps the different actors in the value chain: the core value chain actors, the support functions and the rules and norms functions. When discussing the BSF producers BSF production and processing methods and equipment are discussed. The section also elaborates on where youth and women are present in the value chain. It ends with a visual presentation of all actors in a donut map.

### 4.3.1 Core value chain actors

#### **BSF producers**

Official categories for BSF producers have not yet been defined. As was described in previous sections, overall, two main production systems were observed: household producers and commercial producers. For the sake of this report, the definition of BSF producers is therefore not limited to commercial or registered businesses, but rather includes everyone farming BSF on any scale and with any intention be it commercial or home use. For ease of analysis, the producers are further divided into small-, mid-, and large-scale based on the professionalism of their facilities and production volumes.

It is difficult to estimate the total number of BSF producers in Kenya due to several reasons. Firstly, although many people have been trained in BSF farming, many of them have abandoned the business and it is difficult to determine how many are still actively farming BSF. Secondly, sectoral organization is in an early stage and the infrastructure and procedures to monitor farmers entering and exiting the sector are lacking. Nevertheless, it is estimated that Kenya counts circa 1 200 active BSF producers. In Table 3, an overview is presented with characteristics of BSF producers that were interviewed.

#### Large-scale producers

Sanergy is the largest BSF producer in Kenya, producing between 20-50 tons of dried BSF per month. Apart from its production capacity, the company is characterized by large, decentralized facilities (e.g., breeding units in a different location than production and processing units), size of operations (land, number of employees), use of technology and industrial (processing) equipment and access to international networks. The differences in the level of operations of Sanergy compared to the rest of the sector are currently large. To give an idea: one of the largest mid-scale players that was interviewed uses circa 10.5 tons of waste per week, whereas Sanergy currently processes around 200 tons of waste per day. There are a few other producers that can be qualified as large-scale within Kenya based on their estimated production volumes and the professionalism of their facilities. Even though their facilities and production level are significantly smaller than Sanergy's, they are still different from the rest of the sector in terms of brand awareness, production, resources and equipment.

Investment and running costs for large-scale production facilities were not shared during the interviews, however, it was shared that running costs are the reason why some producers were not producing at the full capacity of their facilities. The biggest running costs were transport and sorting of waste, power and labour.

It is somewhat challenging to describe the materials and equipment used by large-scale producers as it was not possible to visit all the facilities. However, their facilities are equipped with industrial machinery. For example, all of the large-scale producers made use of different types of industrial dryers of varying sizes, large grinding machines with conveyer belts for waste and industrial sieves.

Large-scale producers were found to have formalized partnerships and agreements with other stakeholders in the value chain like waste producers and off-takers (animal feed manufacturers for BSFL and agrovets for frass) and work closely together with NGOs, donor organizations and research institutions. They are part of an international network and often have high brand awareness including media coverage. All of the other producers in Kenya had heard of Sanergy and Insectipro and both companies were named as some of the most powerful players in the sector.

**Table 3. Overview of interviewed BSF producers in Kenya**

Type	Size	Cycle	Location	Start	BSF Production area	Employees	Gender owner/manager	Age owner/manager
Commercial	Large	Full cycle	Nairobi – breeding unit in Kilifi	2014	3.5 acre	100 (30 women)	Male	45 (est.)
Commercial - export	Large	Full cycle	Mombasa	2021	1 acre	14 (4 women)	-	-
Commercial	Mid	Full cycle	Eldoret (Uasin Gishu)	2021	½ acre	10 (4 women)	female	33
Commercial	small	Full cycle	Sinendet (Kericho)	2021	75m2 (est.)	1 (8 seasonal)	male	32
Commercial	Mid	Full cycle	Musembe (Kakamega)	2021	½ acre	4 (3 women)	male	36
Commercial	Mid	Full cycle	Nairobi	2017	¼ acre	2	male	-
Commercial & own use	Mid	Full cycle	Homa Bay	2020	½ acre	22 (8 women)	male	40
Commercial	Small	Full cycle	Rabuor (Kisumu)	2021	1/8 acre	1	male	36
Commercial	Small	Full cycle	Nyamasaria (Kisumu)	2021	1/16 acre	3 (2 women)	male	55

Type	Size	Cycle	Location	Start	BSF Production area	Employees	Gender owner/manager	Age owner/manager
Commercial	Small	Full cycle	Bondo (Kisumu)	2023	1/8 acre	3 (apart from group members)	female	23 (est.)
Household	Small	Full cycle	Mombasa	2020	70m2	0	female	65 (est.)
Commercial & own use	Mid	Full cycle	Tuala (Kajiado)	2022	1/8 acre	2 (1 woman)	male	27
Commercial	Mid	Full cycle	Tuala (Kajiado)	2022	1/8 acre	9 (2 women)	male	-
Household	Small	Full cycle	Njoro (Nakuru)	2022	10m2 (est.)	0	male	66
Household	Small	Full cycle	Njoro (Nakuru)	2022	30m2 (est.)	0	female	45 (est.)
Household	Small	Full cycle	Mau Narok (Nakuru)	2022	<1/8 acre	0	female	60
Household	Small	Full cycle	Mau Narok (Nakuru)	2022	1/8 acre	0	male	54

For the dried BSFL products, the main off-takers of large-scale producers consist of feed-millers that have started to include BSF in their animal feeds (some still on experimental base) and research institutes. For the frass, the main buyers are crop farmers of all sizes and resellers like agrovets. Their area of sales is mainly national, but one producer is aiming to supply the European market.

#### Mid-scale producers

A growing number of mid-scale businesses are coming up in the BSF sector in Kenya. Among the businesses interviewed 6 fall into the mid-scale category. The mid-scale producers can be further categorized based on production volumes in a lower and upper segment. Of the producers interviewed, three fall into the lower segment and three in the upper segment. The lower segment of producers harvest between 350-840 kgs of wet larvae and roughly the same amount of frass per month. The upper segment of the mid-scale producers that were interviewed harvest between 1.2 - 4.2 tons of wet larvae and 1.5 - 5.6 tons of frass per month. One of the mid-scale producers in the upper segment has concrete plans of moving towards what can be qualified as large-scale production by professionalizing the facilities and streamlining processes in the very near future.

Almost all of the interviewed mid-scale producers have a commercial intention, selling the BSFL and frass on the market. However, some of them also use the BSFL for their own consumption to reduce feed costs, increase the quality of feed and improve animal health. For

example, Ololo Lodge & Farm on the border of the Nairobi National Park, who do organic poultry and crop farming and besides using their produce in the lodge's kitchen, are a supplier for Greenspoon (organic online supermarket). For Ololo Farm & Lodge, BSF fits perfectly within their approach to circular and regenerative farming and helps to reduce feed costs. Another mid-scale producer reported that on average he sells 20 per cent of his BSFL production and uses 80 per cent for his own consumption feeding chicken and pigs.

Sales of commercially oriented mid-scale producers varied greatly depending on the focus of their business. Some had specifically specialized in (liquid) fertilizer production and reported selling 100 per cent in planting season. However, most mid-scale producers struggle to sell their BSFL. Clients of commercial mid-scale producers are mainly local chicken farmers and sometimes pig farmers. Most mid-scale producers mainly sell their larvae wet. Some mid-scale producers experiment with solar drying, see Figure 3 for an example of a simple solar dryer. Even though solar drying is an affordable option compared to industrial dryers, there are a few challenges. The drying time is relatively long (two - four days) and there are concerns regarding quality and safety due to risks of contamination.

**Figure 3.**      *Solar dryer*



Investment costs for mid-scale producers ranged roughly from KES 800 000 to 5 000 000 KES depending on the size of operations and materials used. Typically, mid-scale producers have separate spaces for steps in the production cycle as they require different climatic conditions, and each has their own set of daily activities. Therefore, the more established mid-scale farms consist of a larvaerium, a pupae suite (can be in the same space as larvaerium), a hatchery, love cages (insectarium) and a waste grinding space with a disk- or hammermill. Examples of two mid-scale set ups can be seen in the images below (Figure 4).

Most mid-scale farms make use of standard-sized plastic crates which allows them to accurately track production and streamline processes by calculating ratios and yields per crate. However, crates are relatively expensive (currently at KES 600 each) and therefore some producers have sought out cheaper alternatives as can be seen in Figure 4 below.

**Figure 4.** *Set up of various types of mid-scale BSF farms*



*Mid-scale set up (upper segment – commercial focus)*





*Mid-scale set up (lower segment - production for own use)*

It must be noted that not all mid-scale businesses in Kenya were interviewed and there are more businesses that fall into this category.

### Small-scale producers

A large part of the sector is made up of small-scale producers. As was discussed previously, this category consists of both producers that farm crops and animals (mostly chicken and in some instances pigs) and use BSF as a resilient livelihood strategy and/or cost saving mechanism by reducing feed costs, as well as small-scale producers that have commercial intentions. It has to be noted that these two categories are more or less fluid and sometimes overlap or change overtime. Individual small-scale farmers primarily produce wet larvae and frass as they do not have access to a dryer. Most of the small-scale producers do not measure their production, but from observations made it is estimated that they are able to harvest around two kgs per day. However, the quantities vary greatly between small-scale home-use producers, and some estimated their own production to be far less, only around two kilos per month.

Small-scale home producers make use of simple BSF units made with locally available materials like wood and plastic basins. In Nakuru, the knowledge and set up of these kits was provided through an NGO project which resulted in compact full-cycle kits presented in Figure 5 below. The investment costs for small-scale household producers were low, between KES 10 000 and 30 000.

**Figure 5.**      *Set up of a small-scale BSF production unit*



The small-scale commercial producers that were interviewed are estimated to produce between five to 20 kilos daily. A common characteristic of all of the small-scale commercial producers that were interviewed is the desire to upscale production. Investment costs for small-scale commercial producers varied greatly between businesses. The lowest was KES 60 000 KES and highest KES 2 200 000 KES. The differences are mainly caused by the size and type of structures and the materials used. All of the interviewed small-scale producers sell or give starter kits to community members. Additionally, there are several small-scale producers that farm as out-growers for mid- and large-scale companies. This was found in Homa Bay, Bondo and Limuru and the number of farmers involved is growing. One producer in Homa Bay expressed plans to move from 200 to 1 000 out growers in the next months. In some out-grower models small-scale farmers do full-cycle production and in other cases partial life cycle, in which eggs or 5-DOL are supplied by the aggregating company. Small-scale farmers mainly sell their produce to neighbours and households in the area rearing some chicken or doing small-scale crop farming.

**Figure 6.**      *Commercial small-scale set up*





### Other producers

It furthermore must be noted that some research institutes produce BSF with (to some extent) commercial intentions instead of merely producing for research purposes. This was observed in Nairobi (ICIPE and JKUAT), Nakuru (RESSECT) and Kisumu (JOUST). Usually, these institutes work together with donor organizations and projects are set up for community outreach and training on BSF (more details in the section on research institutes in 4.3.2).

### Waste

The BSFL can feed on a wide variety of organic waste. However, the quality and composition of the waste greatly influences the productivity and growth rate of BSF. In Table 4 an overview is presented of the main waste sources used by interviewed BSF producers. Apart from the most common types of waste mentioned above, there were some additional waste sources found. Some of these waste sources were only used for research purposes, others are actively used by individual producers.

**Table 4. Most common and other types of waste used for BSF**

<b>Most common types of waste used for BSF</b>	<b>Other types of waste used for BSF</b>
Market waste (fruits and vegetable waste)	Sugar waste from candy factories
Animal manure (pigs and chicken)	Coffee waste
Fish waste (guts)	Peanut waste
Brewery waste	Human faeces
Slaughterhouse waste	Rejected imported goods (e.g., rice, maize)
Kitchen waste	

Most of the waste is sourced locally. Therefore, some specific types of waste are logically intertwined with geographical locations. For example, around Lake Victoria people use fish waste, whereas this is less used in other parts of the country. Market waste is the most used waste source and is sourced from local markets with the help of waste collectors. In small- and mid-scale businesses, the waste collectors are usually not employed by the BSF producer but are paid per waste collection. Mid- and large-scale BSF producers that were interviewed have agreements and/or official contracts with waste producers.

For instance, it was observed how in Eldoret a BSF producer has managed to come to an official agreement with the municipality. She was assigned a cubicle on the premises of the Bahati Kirumu market where she can collect and grind the organic waste directly at its source. In most cases, small scale producers collect waste in a more informal manner from local markets, neighbours or use the waste from their own farms. A common challenge that was expressed by respondents of all sizes was the cost of transporting the waste (challenges will be discussed in more detail in section 4.7).

Most of the producers interviewed are satisfied with the quality of their waste. Only three expressed challenges. One small-scale producer using slaughterhouse waste expressed that the larvae do not grow to a big size, especially when he used slaughterhouse waste from ruminants. Some large-scale producers are facing serious challenges regarding sorting of the waste. It was expressed how most waste is not sorted properly and contaminated with plastics and other non-organic materials. This makes the sorting process very time-consuming and costly.

The majority of BSF producers interviewed are satisfied with the quantity of waste that they are getting and some even mentioned that there is much more waste than they can possibly consume. However, a significant number has also expressed not getting enough waste yet in relation to their ambitions of scaling up production. This challenge mainly seemed to apply to either very small-scale producers who are yet to find larger sources of waste besides their own farm waste and large-scale producers who need extremely large amounts of waste.

The level of satisfaction amongst the BSF producers regarding consistency of waste supply varies. Some waste is seasonal and hence per definition inconsistent. In some cases, the inconsistency is due to logistics and/or dependence on third parties that do not always deliver. BSF producers that are less reliant on outside parties (e.g. their own employees collect and transport the waste, or they are in very close proximity to the waste) were found to have less issues with consistency and are overall satisfied.

According to the respondents, factors that are important to consider while choosing waste are availability, proximity to the farm, quality (no contamination with heavy metals, plastics and/or other non-organic material), competition of other waste users, and making sure it's a diverse and balanced diet for the BSFL.

Apart from market- and kitchen waste, no other waste source was used individually, and most respondents stressed the importance of mixing waste sources to benefit the quality of BSFL. It was commonly believed among respondents that market waste in combination with animal waste (pig or chicken manure, fish guts, slaughterhouse waste) forms the best diet for BSFL. Brewery waste is sometimes added to a waste mixture because it contains yeast, which is beneficial to the growth of the larvae. Waste should be grinded into a homogenous paste for the best results. Some producers did not own or have access to a grinder and observed uneven larval growth.

### Inputs

Apart from the waste, which is discussed above, the inputs used for BSF are relatively limited. The main input is feed/substrate for the hatchery. Apart from a few exceptions of producers that hatch their eggs directly on organic waste, all BSF producers use rice husk, wheat bran,

maize bran or chicken mash for hatching eggs. BSF producers encounter several issues regarding these inputs, including price fluctuations, shortages and inconsistency of supply, and quality differences per batch.

In some instances, additional inputs are required to make a specific end-product. BSF frass itself is used as an input for composite organic fertilizers and mixed with other inputs, for example vermi-compost, animal manure and charcoal. Additional inputs are furthermore needed when BSF producers mix their own feeds and hence buy inputs for feed formulation. By far the majority of BSF producers do not (yet) formulate their own feeds. It was only observed with some large-scale producers and a few mid- and small-scale producers.

### **Waste producers**

Access to a consistent supply of 'good' waste is at the basis of every BSF farming operation and it is thus key to understand the economies of waste and the position of waste providers vis a vis BSF businesses in Kenya.

As can be read in the previous section, market waste is the most used waste for BSF in Kenya. Several markets were visited during the field research. In Eldoret, Bahati Kirumu market was visited which produces about five tons of organic waste per day. Waste management in the market was observed to be simple. Stall owners were given bins to dispose of their waste and had to empty those bins in a larger container at the end of the day, see Figure 7. Employees of a BSF farmer sort out the organic waste which was then grinded on-site and transported to the BSF producer in crates. The waste is given to BSF producers for free as the market master also explained how BSF businesses help them to overcome waste management issues and it is thus a win-win situation.

In Nakuru, Wakulima market was visited which produces around three tons of waste per day. Waste was typically thrown into a large container at the back of the market. However, two individuals were interviewed who collected waste for a BSF producer specifically. They were in the process of setting up a larger group for waste collection on the market as they saw the opportunity of selling organic waste to more BSF producers in the area. Organic waste was directly collected at the stalls and hence there was limited sorting needed after collection. The volumes collected were small, three bins of 70 kgs each were collected and transported to the BSF producer every three days.

**Figure 7. Sorted and grounded waste at a market ready for transport to a BSF producer**



A youth group was interviewed in Nakuru that focuses on waste collection and sorting. On average they collect and sort one ton of waste per week of which an estimated 250 kgs of organic waste. They explained how previously, organic waste was primarily given to members of the group that owned pigs or chicken. However, recently they started working together with a BSF producer to supply him with organic waste. The BSF producer educated the members of the group on the importance of waste management and the value of organic waste for BSF. The two parties were currently in the process of formalizing their agreement with a contract that would stipulate, amongst other things, price agreements on the collected waste.

From the case studies above, it becomes clear that local markets produce significant amounts of waste. Especially considering that most (semi)-urban locations in Kenya host multiple markets, it is evident why most interviewees identified markets as the “best local waste streams” in their respective areas. In most cases, the market waste itself is free of charge but BSF producers pay for collection, sorting and transport services. Some producers mentioned that there is competition for market waste with animal farmers. However, for most this seemed to be manageable as the quantity of waste produced is enough to meet everyone's needs.

Markets are not the only waste providers for BSF producers in Kenya. BSF farmers also take waste from large-scale animal farming companies (e.g., Farmers Choice), breweries (e.g., Kenya Breweries) and rejected imported organic goods coming in via the Mombasa port. Relations between waste producers/providers and BSF producers were either described as positive or non-existent. Most interviewees (across stakeholder categories) stressed the need for better waste management and see BSF as an opportunity to (partly) solve the organic waste problem in Kenya. To reach its full potential, many interviewees expressed that current waste management policies need to be revised, sharpened and improved to create an enabling environment for waste segregation and allow for easier and more efficient access to organic

waste (see section 4.6 for more details on policy development). It seems that there is increasing awareness on the value of organic waste and consequently more businesses and groups are arising around waste sorting and collection. From the interviews that were held, it becomes clear that a lot of waste provision to BSF producers so far was done based on informal agreements, but more organization is happening and formalization between waste providers and BSF producers is increasing, even on a small-scale level.

### **BSF off-takers**

BSF off-takers consist of businesses that purchase BSF for further processing. In Kenya, these off-takers entail animal feed manufacturers (BSFL) and agrovets (frass). The number of potential off takers from feed manufacturers in Kenya is quite high: there are 305 registered feed companies. This number has almost doubled over the last five years. However, production of animal feed only rose by 30 per cent, which indicates that there are inefficient practices within the sector<sup>xiii</sup>. All interviewed BSFL off-takers exclusively purchase dry BSF larvae as this is required for them to be able to effectively process the BSFL and mix with other ingredients. Consequently, the off-takers purchase from BSF businesses with access to drying equipment.

In general, the awareness of (the benefits of) BSF is growing, and animal feed manufacturers are increasingly expressing their interest in adopting BSF into their feed formulations. However, large scale uptake of BSF in animal feeds is not yet reached. Off takers expressed several concerns and challenges regarding BSF. In general, off takers are looking for a reliable supply in terms of consistency and continuity, which was mentioned by most small- and mid-scale BSF producers as a challenge as their production fluctuates (due to either unavailability of waste and/or climatic influences). Furthermore, there are bottlenecks around the prices of BSF products. Most animal feed manufacturers are price-driven and prices of BSF must compete with traditional protein sources like Omena (fish meal) and soybean meal.

One feed miller explained that BSF is only interesting/feasible for them if the price for BSFL meal does not exceed USD 850 per ton. However, these prices are currently not reachable for most BSF producers due to production costs (prices are now around USD 1 400 per ton). An exception to this issue is the niche market for pet food. One insect-based pet food company was interviewed, and it was discussed how they do not encounter any issues with the current prices of dried BSF products because of the premium price of pet food in the market. Furthermore, most animal feed millers require large volumes of BSF which can only be produced by a few large-scale BSF producers.

Other challenges that impede large-scale adoption include lack of awareness on BSF and lack of knowledge on application and integration of BSF products. As some interviewees expressed, this is a serious concern in the sector, as wrong application (e.g., over- or underfeeding, wrong feed formulations and ratios) can do serious damage to public opinions on BSF.

## **BSF end-users**

BSF end-users entail animal farmers that (partly) feed their livestock on BSF, whether wet, dry or ready-made BSF based feed, dog owners feeding their dogs with BSF based dog food and crop farmers purchasing frass. In essence, most small-scale BSF producers with piggery, poultry and fisheries who feed the BSFL to their livestock and use the frass as manure can be considered end-users as well. In other words, for them BSFL production is vertically integrated within their livestock and crop production systems.

Most interviewed end-users only started using BSF products recently but based on the preliminary results planned on using more BSF products in the future. The end-users interviewed were mostly price and result oriented and started using BSF to cut on feed or fertilizer costs and increase the quality of their animal feed. Two small-scale chicken farmers reported that they were able to cut down their feed costs with 50 per cent and 66 per cent after introducing BSF in their business. The interviewed animal farmers all bought wet larvae from a local BSF producer and fed them in addition to traditional feed. In addition, Box 1 gives an example of a crop farmer that has used fertilizer based on frass. So far, the interviewed end-users were satisfied with the quality and the consistency of the BSF products they bought. They all mentioned that they were unsatisfied with the quantity and would like to buy more. This was however not a constraint on the BSF producers' side, but because end-users only bought experimental quantities thus far and/or were not able to buy more at the time due to their own finances.

### **Box 1: Results of frass-based fertilizer on potato production**

Mercy (fictive name) is a crop farmer who lives outside of Njoro. She grows potatoes, pumpkins, maize, cabbage, tomatoes, etc. In Early 2023, all 15 members of the women group she participates in received a 10 kg sample of organic fertilizer based on BSF frass from a BSF producer in Nakuru. She used the sample on her crops and was enthusiastic about it: the crops looked good and remained green, while she had observed that when applying chemical fertilizer, they often turned brown. She decided to buy a bag of 50 kg. The price of the bag of BSF fertilizer was 1 500 KES, which is much lower than the chemical fertilizer that she normally buys: with government subsidy the price for the chemical fertilizer was KES 3 500 per 50 kg.

Mercy used the frass on the potatoes that she planted. The results were very good. In the previous harvest season, she produced less than 90 kgs of potatoes on a plot of 50 by 100 feet. After using the frass fertilizer, she produced more than 180 kgs of potatoes. That is a production increase of over 100 per cent. Moreover, the potatoes grown with the frass fertilizer were bigger in size and had fewer 'eyes'. This meant that she not only had a bigger surplus to sell on the local market but also that she could sell the potatoes as food items and not as seed potatoes (potatoes with a lot of 'eyes' are usually sold as seed potatoes). The potatoes were easily sold, because their quality was good. Mercy is planning to buy a new bag of frass fertilizer in August when the new planting season starts. She then wants to use it on maize, cabbage and tomatoes. Until the interview, Mercy did not know that the fertilizer was based on BSF frass, amongst other ingredients. She thought it included chicken poo and feathers.

### **4.3.2 Supporting functions**

#### **Association of Insect Farming & Its Products**

The Association of Insect Farming & Its Products was officially founded in February 2020 and is currently in the final stages of legal formalization. The association was founded upon the personal initiative of BSF producers that felt the need for more collaboration within the sector. At the time of this research, the association has 41 paying members, of which 60 per cent women and a mix of all age-groups. The association aims to provide several services to its members and the sector at large. According to the founder and current treasurer the association provides a platform for members to engage with each other on BSF-specific questions, get peer-to-peer support with technical and practical issues and ease access to resources (e.g., crates and rearing protocols). In this light, the association plans to engage stakeholders across the value chain (producers, researchers, off-takers, end-users) and in doing so create a network that conveys people, aligns interests and creates a sustainable market system around BSF.

The potential for other services like common drying facilities, aggregation of products and a seed (starter kit) distribution system are currently being investigated. Members pay a fee to access the services of the association. Currently, there is only a registration fee in place of KES 5 000. However, the association is in the process of developing a more detailed and tailored membership structure and official guiding processes and policies.

The outreach and impact of the association is growing but still relatively limited, which can be ascribed to it being in its early development stages and the voluntary basis of the board who are devoting personal time to set up the association. Many interviewed producers are aware of its existence but pointed out that the service provision is not yet sufficiently developed to fulfil the needs of the sector. Most interviewees stressed the need for strengthening the sectoral organization and expressed the importance of a strong association that would be able to represent their interest on a national level, lobby for better policies and create public awareness creation on BSF. As the association is developing, it is expected to grow into this role over the course of the next few years and play a vital role in propelling the industry forward.

#### **Producer groups**

During the research, examples of producer groups were found in Nakuru where a farmer group was formed through a project of DCA that identified and trained 10 'champion' household BSF farmers. The group of champions started off informally but reported to be in the process of formally registering the group. One of the champion farmers has additionally founded a group of 20 women and three men who have registered an official farmers group around household level BSF farming. In Bondo a youth group was found with a central BSF production facility trained by JOOUST as part of a FAO funded project. The farmer groups found in this research

were linked to or part of a project initiated by an NGO and/or research institute. Members of the groups that were interviewed all underlined the benefits of working together, sharing knowledge and, in some instances, sharing responsibilities and risks. It is known that more BSF producer groups are active in Kenya either in out-grower models, youth and women groups or independent producer groups.

### **Research institutes and researchers**

Research institutes play a vital role in the BSF sector in Kenya. Apart from the well-known international Centre of Insect Physiology and Ecology (ICIPE) and other (inter)national research institutes, Kenyan and international universities have taken up the subject of BSF farming. During the fieldwork, interviews were held with ICIPE, Egerton University (RESSECT), University of Eldoret and Jaramogi Oginga Odinga University of Science and Technology (JOOUST). Additionally, it is known to the consultant that Aga Khan University in Mombasa and Jomo Kenyatta University in Nairobi are engaged in (pilot) projects on BSF farming and The Kenya Agriculture and Livestock Research Organization (KALRO) has published some articles on BSF. Most research institutes and researchers are, besides their research projects, also involved in commercial BSF production and training on BSF, which again highlights the fluidity and overlap of roles within this sector.

#### International Centre of Insect Physiology and Ecology (ICIPE)

An extensive body of knowledge on BSF in Kenya is created by ICIPE. The institute has published numerous academic papers, project documents and presentations on BSF. ICIPE's studies cover a wide range of topics related to BSF. So far, the institute has done research on the following:

Waste-mapping: suitable waste streams for growing BSF; nutrient quality of various substrates; impact on the performance of BSF in terms of nutrient quality of the larvae; formulating recipes for substrates; improving effectiveness of BSF larvae to efficiently break down waste.

- Larvae as protein source: formulation of more than 50 types of BSF-based animal feed for livestock and fish; impact of BSF-based feed on overall animal health (specifically gut-health).
- Frass fertilizer: impact of frass fertilizer on crops in terms of yield, growth and profitability vis-à-vis commercial fertilizer in both greenhouse and open field; nutrient quality of the crop on amended soil using frass; optimal composting time.
- Economics of BSF: willingness to adopt BSF in animal feeds; BSF business model research; socio-economic impact assessment if BSF is adopted (5-50 per cent) as a source of protein in poultry feed in Kenya, Ethiopia and Uganda; willingness of consumers to eat meat derived from BSF-based feed; areas of marketing of the products.
- Product safety: conditions for improving shelf life of BSF products; disease and pest control in BSF production to prevent colony decline.



- Climate change impact: modelling to establish impact of BSF production on climate change globally; greenhouse gas emission reduction if BSF is adopted in animal-based feed; greenhouse gas production of BSF in the production facilities.
- Value-addition: product development in terms of dried BSF, BSF oil extraction, frass fertilizer, de-fattened BSF meal; Micro bacterial properties of BSF to control specific pathogens; Chitosan extraction from pupae and impact on quality of frass when included.
- Sectoral research: mapping of different farms and producers in east Africa and Africa in general.
- Policy: development of KEBS standards for dried larvae; creating an enabling environment for the producers; aspect of policy in BSF around inclusion of youth and women.

Apart from research, ICIPE offers training on BSF to aspiring farmers. According to the institute, ICIPE has trained around 60.000 people in Kenya on BSF farming from 2015 onwards. However, a large part consists of “farmer field days” in which groups of 200-300 farmers are sensitized on BSF farming. It was acknowledged that this is not effective in terms of technical training, but that it is used as a necessary tool to create public awareness on BSF farming.

The majority of BSF producers that were interviewed attended training at ICIPE. Overall, the perception of this training among the interviewed producers was that it is a good introduction to rearing BSF, and they were happy with the opportunity to receive training. However, most producers pointed out that the training is insufficient to be successful as a BSF farmer in Kenya. The feedback from producers was that the training does not adequately cover the business aspects of running a BSF farm and fails to take into account the practicalities and realities on the ground.

#### Egerton University

Egerton University started BSF production and research via RESSECT, a pilot project that was implemented in the period 2019 to 2021. Partners were Wageningen University (The Netherlands), CoELIB (an innovation hub) and Nakuru Living Lab. RESSECT aimed to determine to what extent BSF can help meet the demand for animal feed and in Kenya by producing BSFL and frass. In the pilot, it was researched to what extent BSF production is possible in Nakuru and research was done on the nutrient composition of the produced BSFL and frass.

The BSF production facility is still up and running. It has transitioned into a commercial enterprise; it is the largest BSF producer in Nakuru county at the moment. Although they sell dried whole larvae, formulated feed and frass in small quantities, the main income streams are a grant from phase 2 of the RESSECT project and income from selling BSF production training courses and starter kits to potential BSF farmers. Via RESSECT over 700 small-scale farmers are trained in BSF production.

### University of Eldoret

The University of Eldoret has plans to start projects on BSF. Up till now, no research or projects have officially been done yet, however, some (former) students are engaged in BSF farming and share knowledge and experiences with the University. The interviewed associate professor of entomology is passionate about setting up a training centre for BSF rearing in which academic knowledge is translated into practical learnings and training. She specifically pointed out the potential that BSF farming has for creating jobs and sustainable youth entrepreneurship. The University has an incubator for youth, and this is where she sees opportunities to also integrate initiatives on BSF.

### Jaramogi Oginga Odinga University of Science and Technology (JOOUST)

In 2015 the university won a grant to establish a centre of excellence for food and feed with insects. Crickets were identified as high potential insects within the project. However, there was room in the concept for examining other possibilities of insects that were of value and this is how the research mutated to BSF. BSF was found to be locally available and able to effectively harness local resources. The objectives of the project were twofold. Firstly, to improve waste management and reduce the waste in cities and getting rid of the challenges that come with waste disposal. Secondly, to come up with a sustainable feed formulation for poultry and fish using insects. JOOUST said to have developed a formulation that reduces feed costs with ca. 30 KES per kg. Another objective of JOOUST is to create sustainable employment for marginalized groups. The projects are specifically focused on engaging and empowering youth and women and their slogan is "don't leave anyone behind".

The university operates a full cycle BSF farm on their campus in Bondo. The farm functions as both a Research & Development facility as well as a commercial entity. Through their projects, JOOUST works with 60 out-grower groups (including youth groups) whom they supply with a package of training and a starter kit (love cage, eggs and substrate). The interviewees explained that they plan to aggregate from these groups but that this had not yet started.

### International research institutes and universities

Apart from ICIPE and Kenyan universities, there are some international research institutes and universities involved in the Kenyan BSF sector. The Swiss Federal Institute of Aquatic Science and Technology (EAWAG) has done extensive research on BSF globally and has produced valuable publications for the global BSF sector. Moreover, as they observed the gap between scientific research and practice, EAWAG has aimed to address this gap by translating their scientific findings into practical advice to BSF producers. Amongst these practical publications are a step-by-step guide to farming BSF which is available free of charge for anyone interested in learning about BSF farming, factsheets on BSFL processing and practical YouTube tutorials. Furthermore, there are several Dutch research institutes involved in (research) projects on BSF like Wageningen University & Research, HAS University of Applied Sciences and Aeres

University of Applied Sciences. Especially, Wageningen University & Research has published extensive (PhD) research on BSF and collaborates with different stakeholders in Kenya on advancing the insect sector. There are several more international research institutes involved in the Kenyan BSF sector.

### **Research gaps and challenges**

Even though the body of research on BSF is substantial and growing rapidly, there are still research gaps to be filled. Although this list is not extensive, the following research gaps were identified:

- Product safety: research on post-harvest pest control and contamination; quality and risks of contamination of solar dried larvae; research on shelf life to minimize spoilage; research on micro-toxins in storage of dried BSF larvae and the risk of transferring to animals that are fed BSF; research on the risk of waste contamination and the impact on BSF end-products.
- Product development: research related to the usage and product applications of BSF oil; more extensive research on de-fattened BSF products and the impact on shelf life and impact on growth performance of animals fed on BSF based feed; standardized feed recipes for a wide variety of animals with optimal inclusion levels of BSF; other possible products derived from BSF.
- Processing: research on standardizing and optimizing the drying process for BSFL to guarantee quality; potential of quality grading system for dried BSF; alternative processing options that are less capital intensive. Climate change: more extensive and longitudinal research on greenhouse gas emissions; distribution of BSF production locations vis-à-vis climate change.
- Frass fertilizer: research to beneficial organisms in the soil; what level inclusion of the fertilizer in the soil to improve the quality; benefits of combining frass with other inputs and which inputs to use for different crops.
- Waste: other substrates to be used, especially improving the quality of those waste to make them better for rearing (e.g., fermentation). Highly packed nutrients waste.
- Breeding programs: optimizing and selective breeding for either fast growing, bigger size, more female, more aggressive males, efficient mating and egg fertility; chemical ecology aspects of BSF, e.g., what is attractant that can be used to encourage females to lay eggs.
- Policy development: more research in terms of enabling and inclusive policy development to help the sector grow; policy on continental level; waste management policies.
- BSF business development: research on effective scaling of BSF businesses; market linkages and linkages to financial services; barriers and opportunities to enable BSF farmers to get investment to scale; packaging and labelling of BSF products to appeal

to consumers; use of artificial intelligence in rearing conditions and production systems, monitoring conditions, integration of data and tech.

The main challenge, however, is that knowledge dissemination is lacking due to several reasons. Firstly, knowledge is not shared openly, especially when studies or trials are being conducted in collaboration with or by commercial BSF producer. Furthermore, academic studies are published in ways that are inaccessible for most Kenyan producers due to the use of jargon and scientific language. Additionally, practical implications and recommendations are often not included in scientific papers and studies and findings remain on an abstract level. The interviewees of Egerton University, University of Eldoret and international researchers admit this is a current issue in the sector. Because of the aforementioned reasons, the body of knowledge on BSF is much more extensive than the information that is currently considered common knowledge and circulating in the Kenyan sector.

### **Social enterprises**

Even though social enterprises were not identified as stakeholders preliminary to the research, it was found that they play a vital role in the Kenyan BSF sector in terms of service provision (training), research, attracting of capital, funding through their (inter)national networks and raising public awareness on BSF. The landscape of social enterprises involved in the BSF sector in Kenya is diverse, but a few businesses are included below as an example.

#### New Generation Nutrition (NGN)

This Dutch social enterprise focuses on bringing research findings on insect rearing from Netherlands into practice globally and facilitating collaboration through sectoral platforms. In Kenya, NGN was a part of the Flying Food project aiming to upscale cricket production.

#### The Bug Picture

This is a Kenyan social enterprise and consultancy company focusing on creating social and environmental change with the use of insects, including BSF. The Bug Picture has mainly focused on providing training and support on BSF to small holder farmers on household level. The household kits that were seen in Nakuru were designed and supplied by The Bug Picture.

#### Fair & Sustainable Consulting (F&S)

F&S, the author of this report, is a social enterprise with offices in the Netherlands, Kenya and Ethiopia. In relation to BSF farming, F&S has funded a pilot BSF farm in Eldoret (F&S Insect Farms Nekesa Ltd.) and works closely together with the producer to upscale the business. Additionally, F&S is engaged in projects and research assignments on BSF, including research on the potential of a BSF association in Kenya.

### **Formal financial service providers**

Financial services are among the largest gaps in the BSF sector in Kenya. Interviewees across stakeholder categories pointed out the lack of access to financial services for BSF producers.

*"FINANCIAL SERVICES ARE STRONGLY MISSING, LINKAGES TO BANKS OR INVESTORS, SOFT LOANS. WE ARE REALLY STRUGGLING TO CONVINCING BANKS THAT IT IS A GOOD BUSINESS. WE HAD A LOT OF MEETINGS WITH BANKS, THEY ARE EXCITED ABOUT THE MULTIPLE VALUE CHAINS YOU GET FROM BSF, BUT THEY NEED TO SEE THE MARKET FIRST. COMMERCIALIZING THE PRODUCT AND MARKET ACCESS IS KEY." - RESEARCH INSTITUTE*

#### Banks

In Kenya several banks are active, such as Kenya Commercial Bank, Equity Bank, Cooperative Bank, Diamond Trust Bank of Kenya, Standard Chartered Bank, etc. They offer various services to their clients. As the above describes, BSF producers are struggling to get loans or credit for their BSF business. Of the interviewed BSF producers, none shared that they had a bank loan to finance their BSF business.

#### Investors: Truvalu Group

Several investors have shown interest in individual producers but seem to lack proof of concept to actually engage. However, there are a few investors active in BSF. During the research, Truvalu Group was interviewed. Truvalu is a private equity investor investing in early stage agri-SMEs. They operate as a co-entrepreneur, meaning that on top of financial support Truvalu provides additional business support in terms of market access, business development, coaching, access to technology and knowledge. Truvalu aims to be a long-term strategic partner to the businesses they invest in.

*"AS AN INVESTOR WE ARE ALWAYS LOOKING FOR OPPORTUNITIES THAT HAVE A GOOD SOCIAL AND ENVIRONMENTAL IMPACT AN ECONOMIC RETURN."- TRUVALU*

Truvalu identified BSF farming as a high-potential new business and invested in EcoDudu. In contrary to typical equity investors, Truvalu operates as a co-entrepreneur and is very involved in the business. Therefore, it has a good understanding of the BSF sector. According to Truvalu, the business model is very important for BSF companies especially since the sector is still very premature.

### **Informal financial service providers**

A significant portion of the Kenyan population relies on informal financial service providers, such as savings groups, and other community-based financial arrangements, particularly in rural and underserved areas. In 2021, almost 29 per cent of the Kenyans used informal groups to save, access credit and manage their finances<sup>xiv</sup>.

Of the interviews with small-scale BSF producers, two of them lent money via a SACCO with an interest rate of 5 per cent per month, to start up the BSF business. The rest used their own savings, got funding from an NGO, donor or social enterprise or lend money from friends and family.

### **NGOs and donor organizations**

In Kenya, there are numerous NGOs and donor organizations that fund, implement and engage in projects related to BSF. In this study the World Wildlife Fund (WWF) was interviewed as an example, see Box 2. However, others include the Food and Agricultural Organization of the United Nations (FAO), World Bank, DanChurchAid (DCA), Bill & Melinda Gates Foundation, Rockefeller Foundation, Ikea Foundation, USAID, Biovision, The Australian Centre for International Agricultural Research, The European Union and individual EU member states' development agencies (e.g., DANIDA, SIDA).

#### **Box 2: World Wildlife Fund and BSF**

The global [mission](#)<sup>xv</sup> of WWF is to build a future in which people live in harmony with nature. To deliver this mission, WWF works to conserve and restore biodiversity; to reduce humanity's environmental footprint; and to ensure the sustainable use of natural resources.

WWF Kenya has developed a circular economy program with the aim to promote effective transition to circular economy in Kenya. Having implemented plastic related projects for the past 3 years. It recognized that organic waste makes up more than 60 per cent of the total waste in Kenya. BSF was identified as an opportunity to address the issue around organic waste management while creating value in organic waste as a resource and creating synergies with WWF's plastic projects.

*"WE WILL NOT ONLY BE CREATING DECENT JOBS, SUSTAINABLY UTILIZING RESOURCES AND PROMOTING REGENERATIVE AGRICULTURE BUT BSF FARMING ALSO CONTRIBUTES TO OUR "NO PLASTIC INITIATIVES" BECAUSE IT EASES SEGREGATION OF WASTE." (WWF KENYA, 2023)*

Currently, WWF Kenya is mainly in the phase of scoping and piloting BSF related projects of which an important factor is to promote community involvement in BSF from the start. The pilot project is funded by the European Investment Bank (EIB) who are, according to WWF Kenya, very keen on investing in waste management solutions. WWF Kenya aims to build an economically viable model for BSF farming in Kenya and if the pilot project reaches proof of concept the organization will start reaching out to bigger investors.

The versatility of BSF can meet the objectives of a wide variety of NGOs and donor organizations. The main interest of NGOs and donor organizations is not always BSF farming itself, but rather the various contemporary challenges that BSF farming is able to address. For

example, a BSF producer in Kakamega shared that he received funding from several different donor organizations and according to him, the main reason his business was chosen for funding was not because of BSF, but because the organizations' programs were focused on climate smart agriculture and youth entrepreneurship. This shows that for most NGOs and donor organizations BSF is a means to an end to achieve their respective project objectives, whether those are related to better waste management, alternative protein sources, climate smart agriculture, improving livelihoods or youth- and women entrepreneurship.

The focus of donor funding so far has included funding research on BSF. In this space, ICIPE has received the most funding, and its list of partners is extensive. As was mentioned in previous paragraphs, ICIPE conducted many studies on a wide variety of topics related to BSF and is creating an ever-growing body of (academic) knowledge on insect rearing. Other donor funded projects have mainly focused on small-scale farmer training, set-up and support of SMEs in BSF, sustainable business development, piloting new technologies and methods and support to individual BSF producers for upscaling and community outreach.

These projects are mainly designed and implemented in collaboration with social enterprises, research institutes and (large-scale) commercial BSF producers. A critical remark is that, overall, small-scale farmers are presented as beneficiaries of projects but their voices are rarely included in project design.

### **4.3.3 Rules and norms functions**

During this research, interviews were conducted with the Ministry of Agriculture, Livestock and Fisheries and the Kenya Bureau of Standards. Additionally, NEMA was named by all interviewees as an important government agency.

#### **Ministry of Agriculture, Livestock and Fisheries**

The strategic objectives of the Ministry of Agriculture, Livestock and Fisheries are to create and enabling environment for agricultural development; to increase productivity and outputs; to enhance national food security; to improve market access and trade and to strengthen institutional capacity<sup>xvi</sup>.

#### **Kenya Bureau of Standards (KEBS)**

The Kenya Bureau of Standards is the government agency for the provision of standards, metrology, and conformity assessment. The KEBS mandate is extensive, but mainly consists of the responsibility for developing standards and quality control to guarantee safety of commodities and compliance with (inter)national standards to promote trade. Furthermore, KEBS develops and promotes codes of practice and standardization of value chains. To acquire a KEBS certificate, producers must buy the relevant standard and apply for certification.



The certification process includes testing samples of the produce and a system audit of the business. Once the certificate is issued, producers are responsible for maintaining the quality and adhere to the standard. The KEBS market surveillance team does regular quality checks.

### **National Environment Management Authority (NEMA)**

NEMA is a Kenyan government agency responsible for environmental regulation, conservation, and management. Its primary objective is to promote and coordinate sustainable development in Kenya by ensuring the environment is protected, conserved, and managed effectively.

In relation to BSF farming, NEMA conducts environmental impact assessments to assess potential environmental impacts due to BSF production (specifically waste handling) and ensure that BSF businesses comply with environmental regulations. When this is the case, a license is issued, and the company can proceed with its operations. All commercial producers interviewed were aware of the NEMA license and more established producers already acquired the license whereas others said to be in the process of acquiring it.

### **Other rules and norms setting organizations**

Other, general rules and norms setting organizations that are relevant for the BSF value chain are:

- Ministry of Health (MoH): for sanitation regulations in relation to bringing waste to a residential area, if a BSF producer brings significant amounts of waste to his/her home.
- Ministry of Trade, Investments and Industries (MTII): for the trade license for commercial BSF producers and the promotion of trade
- Kenya Revenue Authority (KRA): for taxation and business licenses
- County governments: for local access to waste and extension services
- Kenya Wildlife Service for management and conservation of wildlife, which BSF officially is as it has not (yet) been classified as livestock (although knowledge on BSF within KWS is reportedly limited)
- Ministry of Labour and Social protection – specifically Department of Occupational Safety and Health Services for rules and regulations of worker in commercial enterprises.

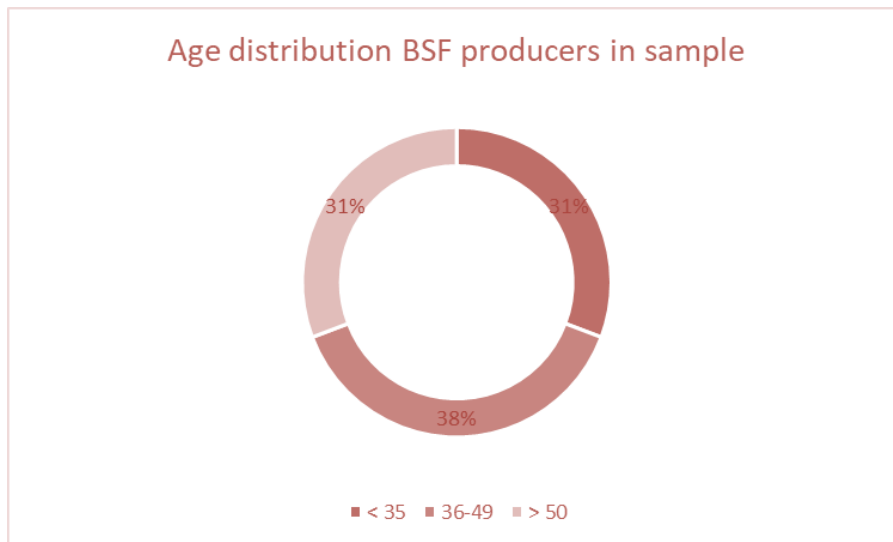
Please note that the policy landscape is described in more detail in paragraph 4.6.

#### 4.3.4 Youth and women in the BSF value chain

Overall, it can be concluded that youth and women are found across the value chain.

##### Youth

Youth were observed in specific functions in the value chain. They are engaged in production mainly as employees and in some instances as owners of the business, albeit in a youth group. However, most business owners and managers are older than 30. Even though age distribution among BSF producers in our sample is relatively even, it was observed that most youth in the sector have outspoken commercial intentions and are motivated to build profitable and sustainable BSF businesses.



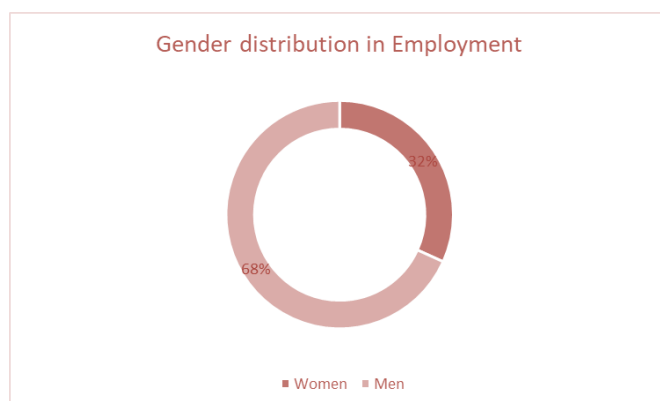
A part of the value chain in which youth are overly represented is waste collection. This is perceived as a job mainly for young males. In Nakuru, it was observed how a youth group had formed around waste collection and sorting. Youth are furthermore engaging with BSF through universities that implement student-led projects and research on the subject. Table x gives an overview of the above.

##### Women

Women are present across all stakeholders in the value chain. In production, women were found to participate in all operational activities. Some interviewees shared that they thought women are generally more precise and detailed and thus better suited to handle precious tasks like breeding and harvesting eggs. Additionally, a growing number of women have been observed to take up leadership positions as managers or owners of BSF businesses. Of the 17 interviewed BSF producers, five were female. However, this is just a small and non-

representative sample as it is also known that the Association of Insect Farming and its products counts more female members than male (60:40 ratio).

Furthermore, of the 170 full-time employees hired by all the interviewed producers combined 54 were female (32 per cent). Overall, women in BSF seem to be driving forces behind organizing themselves in groups and sectoral organization at large. It is furthermore estimated that household producers are more often women as they combine domestic work with production of BSF in their homesteads.



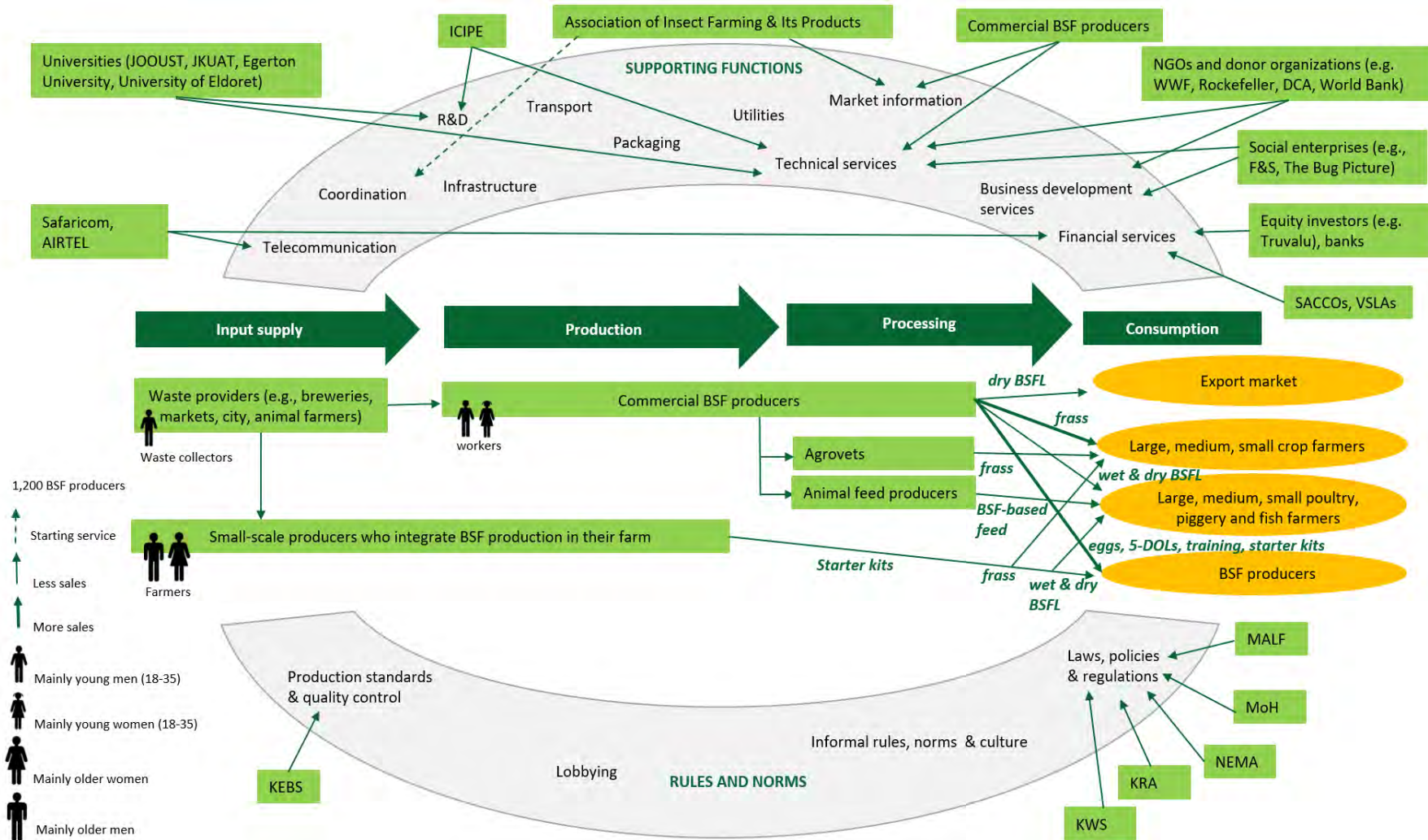
Women were also found to have leading positions within research institutions and rules and norms organizations. Relatively fewer women were observed in waste-collection as this is perceived to be a 'men's job' by most Kenyans due to the nature of the work. Table 5 gives an overview of the above.

**Table 5. Overrepresentation of youth and women in the stages of the BSF value chain**

	<b>Input supply</b>	<b>Production</b>	<b>Processing</b>	<b>Research</b>
Young men	As waste collectors	As workers in commercial BSF farms	As workers in commercial BSF farms	As students in university projects, PhD students
Young women		Harvest, breeding tasks in commercial farms	As workers in commercial BSF farms	As students in university projects, PhD students
Older men	In waste management (e.g., market managers)	As owner of small-scale farms	As owners of processors or commercial BSF farms	As head of research centres, professors and researchers
Older women		Harvest, breeding tasks in commercial farms As BSF farm owners		As (associate) professors and (PhD) researchers

Figure 8 visualises all actors and overrepresentation of youth and women in the BSF value chain in Kenya in a donut map.

**Figure 8. Donut map of the BSF value chain in Kenya**



## 4.4 Functioning of the BSF value chain in Kenya

The first part of this section describes the relationships between the different actors in the BSF value chain to understand the structure of the value chain, the interactions between different actors and the value chain dynamics. The second part will give some additional information about the presence and absence of services that are of importance to BSF value chain actors.

### 4.4.1 Relationships among value chain actors and value chain coordination

As has already been discussed in previous sections, roles and functions in the BSF value chain in Kenya are fluid and often overlapping e.g., research institutes that run commercial BSF farms and provide training, government officials who are researchers, producers who are trainers, producers who are end-users, off-takers who are service providers, etc. The lack of clearly defined roles and responsibilities creates an environment in which everyone is competing with everyone. Combining this with the newness of the sector (which is partly the reason for the lack of efficient role division) results in a rather complex field of relationships among value chain actors who are scrambling to secure a place in the sector.

*"I DON'T THINK THE SECTOR IS WELL STRUCTURED, EVERYONE IS RUNNING AROUND A BIT. I HOPE IN THE FUTURE A NICE NETWORK IS FORMED WHERE KNOWLEDGE AND IDEAS ARE SHARED OPENLY, AND PEOPLE ARE CONNECTED TO MARKETS. A COMMUNITY NEEDS TO BE FORMED AROUND BSF." - RESEARCH INSTITUTE*

It is therefore no surprise that a significant number of interviewees mentioned the high level of secrecy and mistrust in the Kenyan BSF sector. Knowledge is not shared openly, and misinformation is reportedly spread frequently. It was mentioned that especially fast growing BSF producers seem reluctant to share information due to their invested interests. An international researcher with over 15 years of experience in BSF globally stated that Kenya stands out with its low levels of sectoral collaboration and high levels of mistrust.

*"IN THE BSF WHATSAPP GROUP PEOPLE ARE ALWAYS TRYING TO FIND OUT INFORMATION FROM OTHERS THROUGH POSING AS BUYERS BUT AT THE END OF THE DAY THEY JUST WANT TO COPY WHAT YOU DO. EVERYONE IS JUST TRYING TO SURVIVE." - BSF PRODUCER*

However, zooming in on a local level we see that good relationships within the sector exist. Producers in Eldoret and Kakamega reported having good relationships with each other and collaborate where possible. In Nakuru, producers also reported good relationships with each other and even formed farmer groups to collaborate and share information. Relationships

between household producers were observed to be better and less complex because of the lack of competition for a market.

Thus far relationships are mainly built on a personal level rather than through official sectoral platforms. It is estimated that Kenya counts 1 200 active BSF farmers and with the lack of a widely adopted platform to communicate and meet, most producers are not familiar with each other and thus mistrust prevails. Many interviewees expressed that they would like relationships within the sector to improve and stressed the need for a strong association to take up the role of connector and enabler. Small- and mid-scale producers that have relationships with each other mainly base these on an informal seller and buyer basis when it comes to the market of 5-DOL and eggs. Large scale-producers often have formal contracts with their off-takers.

Relationships with other core value chain stakeholders were found to be less complex. Waste providers in particular reported to have positive relationships with BSF producers and regard working with BSF producers as a win-win situation by reducing organic waste and creating jobs for them. Overall, relationships between waste providers and BSF producers were informal. However, in some places it was observed how relationships were being formalized by contracts and official agreements. Off-takers and end-users were mostly found to have relationships with only one BSF producer that introduced them to BSF and supplied them with products. Again, these relationships were build based on the initiative of individual BSF producers that market their business within their vicinity.

*"IT IS A WIN-WIN SITUATION. THE BSF FARMERS HELP TO REDUCE THE WASTE FOR THE MARKET AND FOR THE BSF PRODUCERS IT IS AN IMPORTANT FREE INPUT." - WASTE PRODUCER IN ELDORET*

Relationships between research institutions, NGOs, donor organizations and producers vary. In some cases, close relationships were formed by working together on projects. In most cases, research institutions extend services to producers in the area (often as part of donor-funded projects) in terms of training and materials (starter kits). Although producers were overall happy with the availability of these services, the quality of training was reportedly insufficient. In Nakuru, small-scale producers were extremely positive about their relationships with service providers that had supported them in the setting up and running of their BSF units (in this case The Bug Picture and DanChurchAid) and continued to keep close ties. Some producers reported that research institutions and donors had made promises that were not fulfilled, leading to disappointment and mistrust.



Opinions varied on what the most powerful stakeholders are in the sector. Many small- and mid-scale producers were of the opinion that ICIPE, Sanergy and InsectiPro belong to the most powerful actors in the chain due to their availability of resources and extensive knowledge. Others expressed that the government is the most powerful stakeholder as it has the ability to make or break the sector with policy development. Additionally, some mentioned buyers (off-takers) have most power as they determine the demand for BSF and consequently partly dictate prices.

#### **4.4.2 Services for actors in the BSF value chain**

In Kenya, there are several services for BSF producers exist. Below an overview is given of the services that exist and the ones that are lacking.

##### **BSF-specific (training) services**

Most BSF producers got their knowledge on BSF via the internet (self-taught), via other BSF producers, via social enterprises and NGOs, or via research institutes. Most BSF farmers attended the introductory training at ICIPE in Nairobi. Although producers were happy with the chance to receive these services, it was reported that the training programs are insufficient to build a successful BSF business. In general, producers would like to see more extensive training programs that focus on the more advanced practical aspects of BSF rearing instead of merely introduction trainings.

It was especially pointed out that current training programs lack 'after sales service' and do not offer training materials (e.g. understandable manuals) and ongoing support to producers. In combination with the lack of collaboration in the sector, this leads many producers to struggle with practical and technical questions and sometimes even eventually abandon the business. The Ministry of Agriculture, Livestock and Fisheries is aware of BSF, but none of the producers interviewed has been trained by them or received extension services.

*"BSF IS NOT PLUG AND PLAY – YOU NEED TO GET THE TECHNICAL ASSISTANCE AND BUSINESS KNOWLEDGE ON HOW TO MAKE IT PROFITABLE." - DONOR ORGANIZATION*

##### **Business development services**

Business development services are available through specific donor-funded projects, often delivered through social enterprises and NGOs who design and implement programs for business accelerators. However, due to the highly competitive nature of such programs, mainly young well-educated entrepreneurs who know how to market themselves get selected. Nevertheless, these types of programs are gaining popularity among BSF farmers as they often combine grant money with training and guidance and therefore address some of the key challenges, access to capital and knowledge.

### **Quality standard and laboratory services**

The KEBS production standards are a paid-for service. However, as was discussed, most producers do not know about these standards and/or they are not relevant to them because of lack of drying options. However, quality standards were mentioned by many interviewees as needed and as the sector grows, standards will be refined and improved.

Furthermore, there are lab services available to test BSF products with private companies like Cropnuts Ltd, the government agency Kenya Plant Health Inspectorate Services (KEPHIS) and at some research institutes or universities (although these often do not come with formally approved results). These are also paid for services. Depending on the product, parameters that are tested include protein content, moisture content, fat percentage and wider nutritional values and the absence of microbiological pathogens and contaminants.

### **Financial services**

Apart from the abovementioned services that can be improved, there are a few services missing from the value chain altogether. Firstly, and arguably most importantly, access to financial services is largely lacking. Formal financial service providers like banks and investors are unfamiliar with the BSF sector and regard it as a high-risk business due to the lack of proof of concept. Especially young entrepreneurs struggle with access to capital. Producers said this capital is mainly needed to finance equipment and more professional structure to produce and process BSF. Large sums of money are being invested in the sector through donor organizations. Generally, starter kits, introduction training and materials are provided through donor-funded projects, but after that it is difficult for producers to attain the capital needed for upscaling. Additionally, due to a donor darling approach the largest funds are continuously being allocated to a few players in the industry and dissemination of funds is lacking.

*"THERE HAS TO BE SOMEONE TO PICK UP AFTER NGO PROJECTS" - RESEARCH INSTITUTE*

### **Processing services**

Processing services are missing from the value chain. It has been discussed before that most small- and mid-scale businesses do not have access to professional processing equipment. Many interviewees expressed that they would be interested in communal drying facilities and/or developing other more affordable ways of processing. Processing services could go hand in hand with aggregation services to tap into a bigger market and prevent spoilage of large amounts of larvae that are currently being produced but not sold. The most logical actors to take up these services are producer organizations that can offer these to their members or SMEs. Many interviewees pointed out how a strong sectoral association could and should take up part of these missing services. Additionally, it was mentioned that an association should provide services like marketing, public awareness creation and dissemination of validated knowledge and information.

## 4.5 Market scan for BSF products in Kenya

This section includes the estimated production of BSF products in Kenya, information of current prices and estimated sales. The section ends with projections of the economic benefit of BSF products.

### 4.5.1 Estimated production of BSF products in Kenya

Based on the production data provided, the consultant estimates that the 17 BSF producers that were interviewed produce around 130 tons of wet larvae and 435 tons of frass per month. According to ICIPE, the 1 200 active BSF farmers in Kenya produce over 5 000 tons of wet larvae per year. The interviewed producers produce around 90 tons of dried whole larvae per month using industrial dryers and additional 1.5 tons of dried whole larvae are produced using solar dryers. Considering that not all producers with dryers were interviewed, it is expected that this number is much higher. The largest two players that were interviewed are responsible for 91 per cent of the total production of wet larvae and 98 per cent of dried whole larvae. Table 6 gives an overview of the estimated production figures per month. It was impossible to accurately estimate total production volumes of eggs and 5-DOL due to a lack of monitoring and record keeping among BSF producers.

**Table 6. Overview of BSF production of interviewed BSF producers and total, per month**

	<b>Accumulated estimated production of interviewed BSF producers</b>	<b>Total estimated production</b>
Eggs	unknown	unknown
5-DOL	unknown	unknown
Wet larvae	130 tons	416.7 tons*
Dried whole larvae	91.5 tons	514.25 tons
Frass	435 tons	800 tons

\* 5,000 tons divided by 12 months

### 4.5.2 Prices of BSF products in Kenya

Prices of most BSF products vary greatly between producers as price agreements and standardization have not yet been established in the sector. In Table 7 below, the price range that was found for each product, as well as the most common prices (if possible) per product are presented.

**Table 7. Prices ranges and most common prices for BSF products**

Product	Price range	Most common price
Eggs	50 – 200 KES/gr (0.34 - 1.36 USD)	-
5-DOL	70 - 150 KES/dose (app. 10,000 larvae) (0.48 - 1.02 USD) 3,500 KES/kg (23.83 USD)	-
Wet larvae	40 – 500 KES/kg (0.27 - 3.40 USD)	100 KES/kg (0.27 USD)
Dried whole larvae	100 – 500 KES/kg (0.68 - 3.40 USD)	125-150 KES/kg (0.85 - 1.02 USD)
BSFL meal	85 - 210 KES/kg (0.58 - 1.43 USD)	-
Frass	30 – 50 KES/kg (0.20 - 0.34 USD)	40 KES/kg (0.27 USD)
Starter kits	2,000 KES (13.62 USD)	2,000 KES (13.62 USD)

The smallest price-range was found in the frass. Most producers sell their frass for KES 40 per kg. Only three producers shared the price of their starter kits, which were all KES 2,000. As discussed above, BSFL meal is not yet produced on a large scale and only a handful of producers are currently selling it. Two very different prices were found for the BSFL meal, respectively KES 85 per kg and KES 210 per kg. The price range of wet larvae is quite substantial. However, KES 500 per kg is an outlier and the most common price for a kilo of wet larvae is KES 100 per kg. Like wet larvae, the prices for dried whole larvae also vary greatly between producers. However, larvae that are dried by producers using industrial driers fall into the price range of KES 125 – 150 per kg.

Most outliers, both low and high, were found with producers that use solar dryers. It must be noted that most producers with solar dryers are not selling large quantities of dried whole larvae (yet) and their clients mostly buy larvae on experimental base which partly explains the huge price differences. Prices of BSF eggs are also very diverse, the prices that were observed range from KES 50 per gram for eggs imported from Uganda to KES 200 per gram for eggs from a mid-scale producer in Kenya. A common price is, therefore, difficult to determine. Overall, however, the trend is that prices of eggs are decreasing as more mid- and large-scale producers start focusing on breeding and selling high quality eggs for competitive prices. A common price for 5-DOL larvae is difficult to determine as only two producers shared their prices.

It was explained by interviewees that prices are not always fixed but depend on the quantity ordered and frequency of buying (e.g., loyal customers get a discount). This is especially true for small- and mid-scale businesses, large-scale businesses were found to adhere to a more fixed price structure.

Both the demand and supply of BSF products is highest in Western and Central Kenya and lower in Eastern Kenya. Table 8 provides an indication of supply and demand of BSF products in the researched areas. As formal data are lacking, the indication in the table is based on the interviews in this research.

**Table 8. Estimation of demand and supply in different Kenyan regions**

- = *low*, +- = *medium*, + = *high*, ++ = *very high*

Location	Supply	Demand
Central Kenya (Nairobi, Kiambu, Kajiado, Machakos)	++	+
Western Kenya (Uashin Guishu, Kakamega, Kisumu, Homa Bay, Siaya)	+-	+
Eastern Kenya (Mombasa, Kilifi)	-	-

The profit margin on BSFL products greatly depends on the business model, the size of operations, equipment used and operational costs and because of the heterogeneity in the sector it is difficult to quantify. However, it is known that in most current business set-ups dried BSF products have a low profit margin due to relatively high production costs and prices that need to compete with traditional protein sources. The profit margin on frass is significantly higher as it does not require processing (unless other inputs are used). One fertilizer focused BSF producer stated that his profit margin was 70 per cent. Hence, the lowest profit margin is on dry BSFL produced with industrial dryers, medium profit margins are on wet larvae and larvae dried with solar-dryers or sun-dried, frass has the highest profit margin. For eggs and 5-DOL the consultant team did not find enough data to say something about profit margins. They assume that the profit margin on these products is higher than on dried larvae.

#### 4.5.3 Estimated sales of BSF products in Kenya

The sales of BSF products differ greatly per producer. It is almost impossible to accurately make estimations of the value of the total BSF sales. However, for the sake of this report the consultants have calculated rough estimates on the value of sales of whole dried BSFL, wet BSFL and frass. The total production of wet larvae is estimated to be 5 000 tons per year. It is estimated that the top-two producers, produce around 1 500 tons of wet larvae per year and roughly 495 tons of dried larvae. This means that the rest of the sector produces 3 500 tons of wet larvae. Based on the limited availability of drying options for most producers, we are assuming that 20 per cent is dried (700 tons of larvae for drying) which equates to roughly 231

tons of dried larvae per year. If 100 per cent of dried larvae are sold for the average price of KES 125 per kg, the total sales value is KES 90 750 000. Deducting the dried larvae from the total leaves 2 800 tons of larvae to be sold wet. Based on interview data it is estimated that roughly 20 per cent of wet larvae are sold. The rest is either for own consumption or not sold at all and goes back into colonies. This means that 560 tons of wet larvae are sold yearly. With an average price of KES 100 per kgs, the total value of wet larvae sales is KES 56 000 000.

The ratio of frass to larvae differs greatly per producer and per substrate. It is known that the largest BSF producer produces on average 4,800 tons of frass per year. For the rest of the sector, we assume a ratio of 1:1.2, meaning for every kilogram of wet larvae 1.2 kilograms of frass are produced. This means an additional 4 800 tons of frass is produced, leading to 9 600 tons of frass produced yearly. Assuming 75 per cent of the frass is sold and the rest is used for own consumption adds up to KES 288 000 000. Adding the total values of the three products creates a total estimated value of BSF product sales of KES 434 750 000 yearly, see Table 9.

**Table 9. Estimated sales of BSF products in Kenya, per year**

<b>BSF product</b>	<b>Estimated production for sale</b>	<b>Sold</b>	<b>Sales</b>	<b>Average price</b>	<b>Value*</b>
Wet larvae	2,800 tons	20 per cent	560 tons	100	56,000,000 KES (381,341 USD)
Dried whole larvae	726 tons	100 per cent	726 tons	125	90,750,000 KES (617,978 USD)
Frass	9,600 tons	75 per cent	7200 tons	40	288,000,000 KES (1,961,185 USD)
<b>Total</b>					<b>434,750,000 KES (2,960,504 USD)</b>

\* Exchange rate on September 14, 2023: 1 USD = 0.0068 KES

*Note: Please note that these calculations are very rough estimates and do not accurately reflect the sales value of the sector. More extensive research and data collection needs to be conducted to be able to determine the actual sales value of BSF product sales.*

#### **4.5.4 Projections for BSF products in Kenya**

Although the BSF sector is currently in its infancy, it is growing rapidly. It is expected that in the next 5 years many important challenges will be tackled, and better market linkages will be established.

A study using experimental data found that replacing 5–50 per cent of the conventional feed sources (fishmeal, maize, and soya bean meal) with BSFL meal could potentially generate an economic benefit of 69–687 million USD (0.1–1 per cent of the total GDP). If the entire poultry sector would adopt BSFL meal this figure could go up to 16–159 million USD (0.02–0.24 per cent of the GDP). This could translate to reducing poverty by 0.32–3.19 million (0.07–0.74 million) people, increasing employment by 25 000–252 000 (3300–33,000) people, and recycling of 2–18 million (0.24–2 million) tonnes of biowaste. Furthermore, this study finds that replacing conventional feed by 5–50 per cent BSFL meal in the commercial poultry sector would increase the availability of fish and maize which could feed 0.47–4.8 million people at the current consumption in Kenya<sup>xvii</sup>.

To map out the full potential of the sector, similar studies should be conducted for pig and fish feed and organic fertilizers. All interviewees that participated in this research were positive about the growth of the sector in the upcoming five years. Provided that the current challenges of the sector are addressed, they believed that current producers can upscale their production and new producers to enter the market. One constraint that was mentioned was the competition for waste, especially around Nairobi which could prevent the sector from growing. Furthermore, the BSF sector's growth is closely intertwined with the trends in the soybean- and fishmeal sector. It is believed that the prices for these proteins will only increase the upcoming years, which creates more opportunity for BSF to flourish.

#### **4.6 The current BSF policy landscape in Kenya**

The most important rules and norms actors have been discussed in paragraph 4.3.3. This paragraph elaborates on existing policies, regulations and standards related to BSF as well as the challenges and opportunities regarding policy development in the BSF sector in Kenya.

The BSF sector in Kenya has largely been unregulated due to it bordering between the Ministry of Agriculture, Livestock and Fisheries and the Kenya Wildlife Service (KWS). This overlap of regulatory bodies resulted in a grey area in which most producers have operated informally and without guiding policies and regulations. In recent years, more attention has been drawn to the growing sector and the need for creating an enabling policy environment has been raised by many stakeholders.



### **Policies and regulations**

In relation to BSF farming, the Ministry of Agriculture, Livestock and Fisheries is currently mainly concerned with feed regulation in terms of sanitation and biosafety. This is not just limited to BSF but applies in general to livestock and fish feed. BSF is identified as a potential new source of protein within the ministry, but no official policies have been developed to specifically target the BSF sector.

The ministry is of the opinion that there should be policies on insect rearing, especially to guarantee product safety. For example, a classification of businesses between growing BSFL for feed in which case only certain types of substrates should be allowed, or rearing BSF for breeding purposes in which case any substrate would be allowed. Furthermore, the ministry stipulates that the BSF should eventually be classified as (mini) livestock. The ministry sees a role for itself in creating more awareness of BSF and to promote further development of the value chain but has no concrete policies in the pipeline at this moment.

### **Standards**

In relation to BSF, there are three relevant documents generated by KEBS: Code of Practice for Insects in food and feed, Standard for Dried insects for compounding animal feed and a Standard for Organic Fertilizer.

### Code of Practice for Insects in food and feed – KS2921/2020

The objective of this Code of Practice is to guide insect farmers in production of insects for food and feed. This Code of Practice extends beyond BSF farming and applies to all insects used in food and feed. The standard was developed to mitigate risks of insect rearing in the food chain whether in feed or in food. The Code of Practice introduces minimum requirements and guidelines to rearing including types of feed (waste), handling and processing. The prescribed practices are based on validated research from multiple (inter)national research institutes, including ICIPE.

*“WITH THIS CODE OF PRACTICE INSECT FARMERS CAN GET ACCREDITATION, AND THEIR PRODUCTS WILL BE ISSUED WITH A KENYA BUREAU OF STANDARDS (KEBS) CERTIFICATE. THIS ENABLES THEM TO MARKET AND SELL THEIR PRODUCTS IN LOCAL MARKETS AND OUT OF THE COUNTRY.” - KEBS*

### Dried insects for compounding animal feed - KS2711/2017

This KEBS standard is specifically tailored to dried insects for compounding animal feed. The standard includes quality parameters for it to qualify as animal feed input, including moisture content, protein levels, identification of minerals, fat content and more. In addition to these nutritional parameters there are safety parameters for microbiological components to prevent exposure of animals to contamination.

### Organic Fertilizer KS2290/2017

Quality parameters for organic fertilizer include pH value of the product, carbon-nitrogen ratio of the final product, moisture content, temperature, nitrogen content, organic matter content to confirm organic nature of the product, total primary NPK ratio by percentage. According to KEBS, there are already a few BSF producers with certified organic fertilizer. The standard is currently undergoing some modification. In general, the KEBS certification process is perceived as lengthy, untransparent and tedious. To the knowledge of the consultant, only very few BSF producers have applied and acquired a KEBS certificate for larvae or frass. According to KEBS, only 10 or 11 producers have expressed interest in the standards. Additionally, it must be noted that none of the interviewed producers mentioned the Code of Practice.

#### **4.6.1 Development of the BSF policy landscape in Kenya**

This section provides an overview of opportunities and challenges for the development of the BSF policy landscape in Kenya. Before discussing the specific opportunities and challenges, it must be noted that a significant number of interviewees mentioned that the focus should be on refining existing policies, implementing them effectively and streamlining procedures instead of developing numerous new policies.

## **Challenges**

Lack of a strong sectoral body to lobby for enabling policy development. Currently, a common voice is missing due to the infancy of sectoral organization in the sector. This means lobbying for policy making falls into the hands of individual stakeholders. Not only does this create a lack of urgency on the part of policy makers, but it also means that different interests in the sector are not well-represented in policy discussions.

Knowledge creation and dissemination of relevant information to policy makers is limited. Policy makers are largely unfamiliar with the specifics of BSF farming and/or do not have a clear understanding of what is needed to propel the sector forward.

Status quo of policy development impedes inclusive and enabling policy development. There are always beneficiaries to the status quo. Some powerful stakeholders have benefited from the lack of policy or punitive policies and hence are not motivated to change the status quo. This is for example the case in waste management policies where currently a lot of power is vested in individual companies and cartel forming is not uncommon.

Standardization of BSF production and products is lacking and hence it is challenging to develop policies for the entire sector. It has become clear during this report that approaches to BSF farming are varying. Especially in terms of input (waste) there is no standardization and is largely (and logically) dependent on availability. Knowing that the waste largely dictates the quality and nutrient composition of the outputs, this creates challenges for enabling policy making in terms of quality and safety standards.

## **Opportunities**

The most frequently mentioned opportunity for policy development across stakeholders was better waste management policies to improve access to waste for BSF producers. Several aspects were mentioned e.g., enforcing policies on waste separation on household level, more favourable procedures for NEMA licenses for BSF farmers and more efficient waste collection systems on county level.

Pricing agreements on various BSF products could be developed to promote transparency in the sector and eliminate the large price differences between individual producers that currently exist. A challenge surrounding pricing agreements is that prices should reflect the value of the BSF products and cover production costs while creating a competitive advantage compared to alternatives on the market.

The development of more extensive quality standards and/or a grading system for different BSF products. Some interviewees explained how they would like to have a grading system for

different qualities of BSF with each a different price. This would reward producers that put in effort to produce clean and high quality BSF.

Developing encouraging policies on insect-based feed and organic fertilizers. Subsidies on BSF-based feed and organic fertilizers could help upscale the sector, enable better market linkages and in general promote sustainable agriculture.

Finally, KEBS certification procedures could be streamlined and clarified in combination with training and information of producers on how to attain them.

## **4.7 Challenges and opportunities for BSF farming in Kenya**

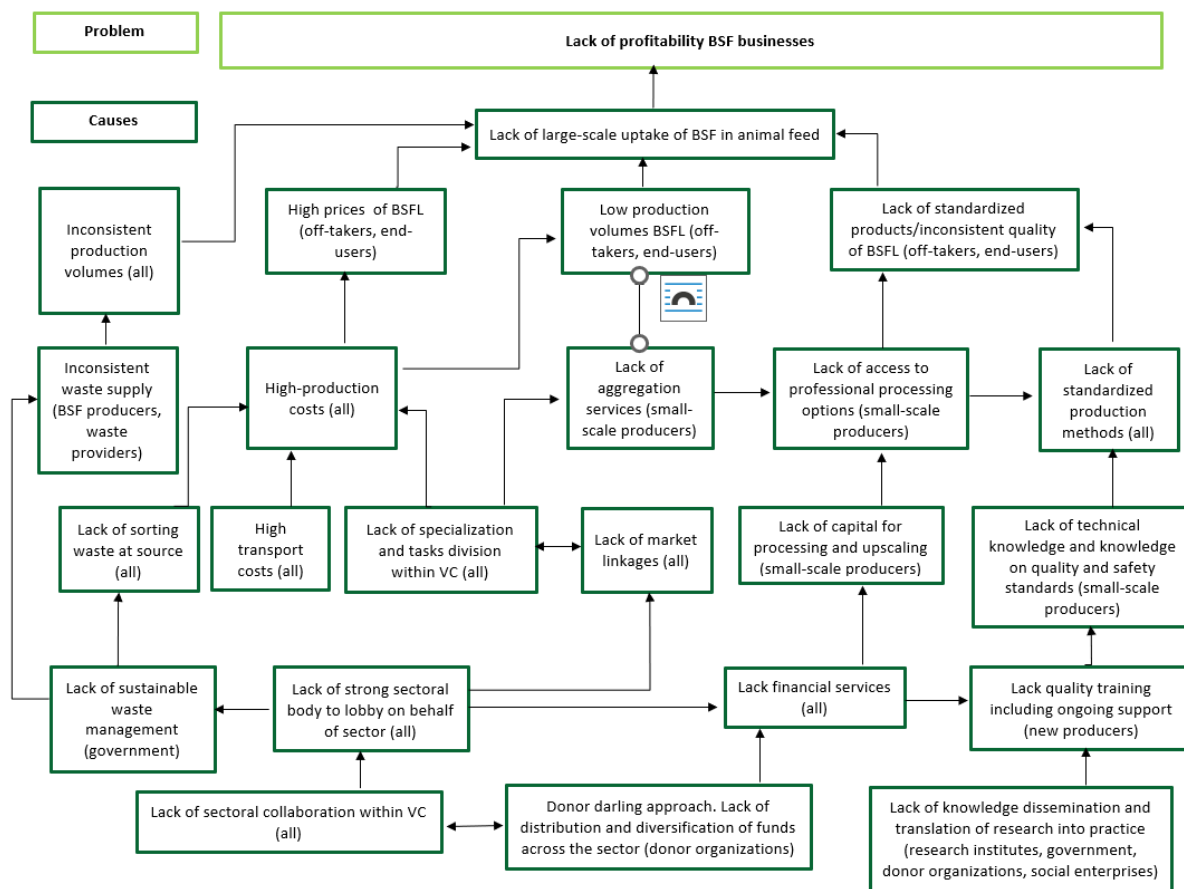
This section provides an overview of opportunities and challenges related to BSF farming in Kenya. The first part elaborates on challenges in the BSF sector in Kenya; the second part outlines opportunities for BSF farming in Kenya.

### **4.7.1 Challenges for BSF farming in Kenya**

#### **Lack of profitability BSF businesses**

The largest challenges of BSF are related to the protein (BSFL). In theory, the demand for BSF products is high as most off-takers and end-users are desperate for better alternatives to soybean meal and fish meal. However, in practice we see that the amounts of BSF products sold are much lower than amounts produced. This results in the lack of profitability of BSF businesses and BSF not yet living up to its promised potential. There are several factors that impede large scale uptake of BSFL. A problem tree was designed to visualize the interlinkages and causes of challenges within the sector (see Figure 9). Please note that this problem tree was based on what was observed during this study and only applies to commercial BSF producers that aim to sell their produce to off-takers and end-users. There might be additional causes and linkages between challenges that are not visualized.

**Figure 9. Problem tree BSF value chain in Kenya**



**Inconsistency of BSF production**

Firstly, there is a challenge with the consistency of BSF production. Respondents expressed that production of BSF is not stable and fluctuations occur either due to climatic factors and/or issues surrounding inputs, of which the most prominent one accessibility and availability of a consistent source of waste. Small and mid-scale producers are more prone to fluctuations related to climatic factors as compared to the interviewed large-scale producers as their facilities have less climate control tools/equipment. Availability and accessibility of waste was an issue that was expressed by everyone (small-, mid-, and large-scale).

**Low production volumes**

Secondly, production volumes of BSF have not yet reached the critical mark. As was described in this report the landscape of BSF producers is largely made up of small-scale producers with no drying capacity and currently there are no aggregation services or centralized drying facilities. Feed millers require a consistent supply of large volumes of dried and sometimes de-fatted BSFL and this demand cannot be met yet by the sector. This creates a seemingly contradictory situation in which the volumes that are produced are not being sold, but the volumes demanded cannot be met.

### **Pricing of BSF**

Thirdly, there is a challenge regarding the prices of BSFL products. Feed millers have expressed that even if the desired quantities and qualities can be supplied, the current prices of dried BSFL products are not competitive enough to substitute traditional protein sources in feed. During the interviews with other stakeholders, it was found that there is a lot of controversy on the pricing of BSFL and two main convictions prevail. On one hand there were respondents that argued that prices for BSFL should indeed be lowered and match feed miller's expectations to be able to better compete with traditional protein sources. On the other hand, several stakeholders argued that prices should be much higher to cover the production costs of BSF producers and to reflect the actual value of BSF compared to traditional protein sources (which is arguably much higher due to a richer nutrient composition). It was argued by some that BSF has been marketed wrongly as merely a protein whereas its actual value is much more encompassing (e.g., amino acids, fat). Whether or not this is true, the fact remains that with the current pricing off-takers are not incentivized to adopt BSF on a large scale.

### **High production costs for producers and lack of specialization**

Zooming in on the production costs of BSF producers that are in turn partly determining the prices, we see that high transport costs of waste and high labor costs are the main challenges. Labor costs include the time spent on waste sorting due to the lack of waste separation at source. Additionally, the lack of specialization within the value chain arguably increases the production costs as everyone does everything and hence invests in materials, labor and equipment that would not be needed if specialization would occur. For example, almost all producers are currently doing full-cycle BSF production and thus invest in love cages, other breeding materials and labor to take care of the colony. Partial life-cycle farming (especially on small-scale level) could reduce investment and production costs while reducing risks and increasing profit margins given that there are specialized BSF breeders that supply high-quality eggs or 5-DOL against competitive prices.

### **Lack of sectoral collaboration**

The lack of specialization and a clear division of roles furthermore creates a situation in which everyone is competing for the same place in the sector which not only impedes collaboration and sharing of information but is also inefficient in creating market linkages with off-takers and end-users. In general, collaboration within the sector is challenging. As was described in this report, mistrust and competitiveness prevail. On top of this, knowledge dissemination is almost completely lacking and new insights and research findings do not reach the majority of the sector.

### **Lack of diversification of donor-recipients**

Another underlying challenge is the current situation of donor darlings. This critical remark might be sensitive but is imperative to understanding the current situation. Most funds are continuously being allocated to a few players in the sector. Let it be clear that these actors have generated valuable insights, have created sustainable jobs and public awareness on BSF among donors, government and investors. However, as was discussed before, knowledge dissemination is almost completely lacking and insights from projects are not shared in an accessible way with the rest of the sector. Furthermore, the donor darling approach leads to a narrow scope of project design and implementation with a handful of powerful players dictating the agenda. Keeping in mind that there are estimated 1 200 producers in Kenya, of which almost all small-scale producers, it is remarkable that little to no money has been spend on solving some of this group's key issues like access to processing and aggregation services.

### **Lack of standardization due to inadequate policy implementation**

Because of the early stage of sectoral organization, a strong sectoral body that can lobby on behalf of the sector's core stakeholders is lacking. This results in a lack of awareness and urgency among policy makers and although some standards have been developed most are unknown to the majority of the sector. In turn, this creates a grey area in which production is largely unregulated/unsupervised and quality and safety standards not applied. Keeping in mind that substrate quality largely dictates larvae quality and knowing substrates differ per individual producers, the challenge of standardization and consistency of end-product quality becomes an additional challenge.

### **Challenges for women and youth**

Overall, it was found that women and youth encounter similar challenges when it comes to starting and running a BSF business. The main challenges for both groups are access to capital, land and to a lesser extent knowledge. It was especially pointed out how these groups often do not have collateral and it is therefore challenging to get a loan to cover the initial investment costs.

### **Specific challenges for the youth**

The issue of land highly depends on one's family situation. Most BSF producing youth that were interviewed mentioned that the land belonged to their relatives who had either agreed to lend or give them (a piece of) their land for BSF farming or the land was inherited from their father. However, not all young people have access to such family-owned land and/or the land has been divided among all the family's children (of which traditionally only the boys inherit land) making the parcels too small to set up a BSF farm. An additional challenge was mentioned regarding the fact that sectoral networks and high positions within sectors are overall still occupied by the older generation men which poses a challenge for youth to access

social capital and 'get a seat at the table'. Currently, they are mainly occupying the executing functions in the value chain, for example producers, employees on farms and waste collectors.

### **Specific challenges for women**

The challenges for women were furthermore linked to a wider national problem of less access to higher education for women which makes it more difficult for them to acquire knowledge on BSF. Additionally, one producer mentioned that the young women that were hired as employees faced the challenge of being mothers as well, having to balance taking care of their kids with working on the BSF farm. This led them to quit their jobs more often and quicker than their young male counterparts. It must be noted that many interviewees mentioned that the differences between men and women in terms of opportunities and challenges are becoming smaller. A women's group in Nakuru for example mentioned that they felt as empowered as their male counterparts and that challenges, they were facing were not specifically related to their gender.

## **4.7.2 Opportunities for BSF farming in Kenya**

### **Organic waste management**

Several opportunities in and for the BSF sector were identified. Firstly, the opportunity of BSF to address the organic waste management issue in Kenya. This was the most frequently mentioned opportunity by interviewees. Due to the lack of waste management, it is challenging to estimate the exact amount of organic waste produced nationally. However, it is known that most of the waste produced is organic waste. Some sources suggest that 3 000 to 4 000 tons of waste are produced nationally daily, and that organic waste makes up 70-80 per cent of the total waste produced in Kenya<sup>xviii</sup>.

Most waste is produced in- and around urban areas and Nairobi is estimated to generate the most waste, between 2 000 and 2 500 tons of waste on a daily basis<sup>xix</sup>. Opportunities mainly arise regarding the formation of mutual beneficial partnerships between BSF producers and waste providers and producers, county governments and waste collection groups. Partnerships could include allocation of land near waste sources, agreements on access to waste, sharing of transport costs, agreements on offtake of end-product against reduced prices etc. In this regard, BSF producers can be seen as service providers to waste producing companies and that service can be monetized by offering waste management solutions.

### **Addressing gaps in the Value Chain to meet the large demand for protein**

Secondly, arguably the biggest opportunity is still the large demand for protein from feed-millers. Keeping in mind the challenges to meeting this demand as outlined above, it becomes clear that there is a big opportunity for initiatives that aim at closing the gaps in the sector by creating better market linkages. For example, the establishment of aggregation and drying



services to target the market of small-scale farmers that currently have limited off-take of their products, upscaling of production, design and implementation of high-quality training programs with ongoing support. For these initiatives to work, partnerships need to be formed between different value chain actors e.g. consortiums formed with a waste provider, BSF producer and off-taker.

### **Niche markets and specialization within the Value Chain**

Thirdly, there is an opportunity for innovative entrepreneurs to create and find niche markets and/or specialization within the value chain. Examples of specialization could be breeding, high-quality frass production or locally manufactured processing equipment. The example of pet food as a niche market was discussed in this research, but more niche markets for BSF could potentially be identified. For example, in other countries, BSF is being used in aquarium fish feed, reptile feed and even monkey feed. Specialization within the value chain is not only necessary for a more efficiently functioning sector, but it also allows people to carve out their place in the market and if done well, increase profitability of businesses.

### **Product development BSF oil**

Fourthly, additional product development and research on BSF oil and its application can be regarded as an opportunity. Currently, some producers are already experimenting with the extraction and use of BSF oil (which is a by-product of de-fattened dried larvae) but have not yet started selling it as a product on its own. More research and trials are needed to determine what product applications are possible with BSF oil. Apart from being used as a feed supplement, some studies suggest that the oil could potentially be used in cosmetics. BSF fats have a fatty acid profile that is similar to coconut oil and palm kernel oil. These oils are frequently used in cosmetics and therefore it is possible that BSF fats can be used for similar applications as these plant materials<sup>xx</sup>.

### **Opportunities for women and youth**

Despite the challenges, there are some clear opportunities for women and youth in the BSF sector. A distinct focus of many donor-funded projects on women and youth. In recent years there has been more attention to women and youth entrepreneurship and projects are being designed to specifically target (entry) barriers for these groups. This creates a big opportunity for women and youth in BSF to participate in such projects and programs. Especially considering that BSF is gaining popularity among donors due to its circularity and possibilities for sustainable entrepreneurship while helping to solve waste management and feed quality issues.

**Specific opportunities for women**

It was mentioned by interviewees that women see the value of better farming practices as they are traditionally the ones that have been managing the homesteads. BSF household production can be easily combined with other tasks around the homestead and was therefore mentioned as an opportunity for women to manage their kitchen waste, lower their feed and fertilizer costs and/or have an additional income stream with minimum time investment. According to interviewees, women are also keener on details and better in precise jobs. This could create an opportunity for women in breeding BSF and accurately tracking production data.

**Specific opportunities for youth**

Waste collection and management was mentioned frequently as an opportunity for youth, especially young males. As the labor is physically challenging, this group is believed to be best suited for jobs in waste management. As the BSF sector grows, more jobs will be created for young males to satisfy the growing demand for organic waste in Kenya. Formal organization of youth in waste collecting youth groups will additionally form an interesting opportunity for youth entrepreneurship.

## 5. The BSF value chain in Uganda

This chapter will elaborate on the BSF value chain in Uganda. The chapter firstly analysis the value chain. It gives an overview, maps the key actors in the value chain (in the core value chain, support functions and rules and norms functions), describes how the value chain currently functions and estimates production and sales of BSF products. Secondly, the policy landscape in Uganda is analysed including how policies can be developed. Finally, the chapter lists the most important opportunities and challenges for BSF farming in Uganda, with a special focus on opportunities and challenges for youth and women employment and entrepreneurship.

### 5.1 Overview of the BSF value chain in Uganda

Like global demand, in Uganda there is also a growing demand for animal feed/protein and fertilizer. The current demand for animal feed in Uganda is estimated at 420,000 MT, while the annual production by commercial feed millers is estimated at 275 750 MT<sup>xxi</sup>. Taking into account a protein level of 15 per cent to 25 per cent<sup>2</sup>, the yearly estimated demand of protein in animal feed is 63 000 to 105 000 MT in Uganda. Moreover, in 2021, Uganda imported animal food with a value of 68.7 million USD; exports of animal food had a value of 398 000 USD. Animal food was the 16th most imported product in Uganda<sup>xxii</sup>.

Additionally, fertilizer consumption in Uganda in 2020 was 2.4 kg per ha of arable land<sup>xxiii</sup>. With 6 900 000 ha of arable land<sup>xxiv</sup>, fertilizer consumption is estimated to be 16.56 million kg per year. Demand for fertilizers will be at least as high as consumption, considering that there will be people who would like to use fertilizer but do not have the means. Furthermore, in 2020 imports of fertilizers to Uganda had a value of 32.5 million USD, according to UN COMTRADE<sup>xxv</sup>.

Hence, there seems to be an opportunity for BSF products. An economic surplus model study shows very positive projected results for the BSF value chain in Uganda<sup>xxvi</sup>. It projected that Uganda has the potential to produce between 3 244 tons and 1.5 million tons of insect-based animal feed per annum and 695 tons to 312,678 tons of frass, recycling 0.09 million tons to 41 million tons of biowaste. Other results of the study indicate that the substitution of insect-based feed for existing protein sources will generate net economic benefits of 0.73 billion USD in 20 years. The benefit-cost ratio is estimated at 28:1, in worst case 8:1, and the internal rate of return is 138 per cent, indicating that the insect-based animal feed industry is a profitable investment. Because of these economic benefits, 4.53 million people can be lifted above the poverty line and 1 252 to 563 302 new jobs can be created per annum.

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<sup>2</sup> The level of protein in animal feed depends on the type of animal and its level of maturity. In general, one can say that a high-quality animal feed contains between 15 per cent and 25 per cent protein.

However, at this moment these production figures are not a reality. The main BSF products currently on the market are BSF eggs, 5-day-old larvae (5-DOL), wet larvae, dry larvae and frass. Pupae, empty cocoons, dead flies and BSF oil are being produced (BSF oil mostly as trials), but the amounts that are sold are very little. Though exact demand and supply figures of BSF products in Uganda do not exist, the consultant team made a rough estimation of the monthly production and sales of the BSF products in section 5.4.

BSF production in Uganda mainly takes place in the central region with a concentration of producers in Kampala and surrounding districts of Wakiso, Mpigi, Mukono, Buyikwe, Kayunga and Jinja. There are, to the knowledge of the consultants, few other (small-scale) BSF producers in other parts of the country.

Like in Kenya, Uganda also has two main production systems or business models that shape the value chain. The first is full or partial cycle BSF production at household level, done by small-scale farmers who often have a mixed farm with both crop production and animal rearing (mainly chicken and/or pigs and /or fish). Kitchen and crop production waste are used to grow the larvae, the full-grown larvae are fed to their animals and the frass is used to fertilize their crops. This production system can be viewed in two perspectives for both animal husbandry and crop production activities. First, it is mostly used as a resilient livelihood strategy or cost-saving mechanism on agricultural inputs namely proteins, which is one of the key feed inputs; or frass, which is used as a fertilizer. In the second perspective, BSF production can be viewed as a strategy that increases the quantity and improves the quality of agricultural outputs such as chicken, pigs, fish and crops that can be sold for more household income or improved household food security in case of own consumption.

The second is BSF production with a commercial intention and at a larger scale. This means that eggs, 5-DOL, wet larvae, dry larvae and frass are produced at higher volumes with the aim to sell them to various clients ranging from small-scale farmers to feed millers and large-scale crop and animal farmers. These enterprises often have industrial set-up.

It should be noted that often small-scale farmers who use their BSF production as a cost-saving mechanism, also sell some of the wet larvae and frass to neighbouring farmers. Or commercial BSF farms that also rear animals (e.g., fish) that are fed on BSF. Hence, functions in the value chain (e.g., production, consumption) and business models are fluid, which underlines its newness. In addition, many BSF products are sold between the two production systems See section 5.2 for more details on the production models.

## 5.2 Mapping the BSF value chain in Uganda

This section provides an overview of the actors engaged in the BSF value chain in Uganda. It splits actors in the core of the value chain, supporting functions, and rules and norms functions. It also indicates where youth and women are present. And the actors are visually presented in a donut map.

### 5.2.1 Core value chain actors

#### **BSF producers**

There is a variety of BSF producers in Uganda. During the fieldwork 13 were interviewed. Table 10 summarizes their characteristics. The table includes characteristics of the farm as well as characteristics of the owner/director/manager. Though the BSF producers interviewed are not necessarily representative for all BSF producers in Uganda, the table gives a good overview of its diversity. It clearly shows the two business models. The commercial producers are large- and medium-scale. They sell BSF products on the market and train small-scale farmers to start their own BSF production. To the knowledge of the consultants, these are almost all commercial BSF producers in Uganda. Some of the commercial producers have strong ties with research institutes or also conduct research on BSF.

Small-scale BSF producers interviewed are individual farmers, a small association and a foundation. They use BSF as a cost-saving mechanism / resilience strategy. Their farms often include both crop production and animal rearing (chicken, pigs, and/or fish). Some do full-cycle BSF production, others from egg or 5-day old larvae (5-DOL) to full-grown larvae. They use kitchen and crop production waste to grow the larvae, feed them to their animals and use the frass to fertilize their crops. It can also be observed that BSF production is a new activity in Uganda. The leading commercial producer started in 2018, the rest even later. Most of the small-scale producers started in 2022 and all in 2020 or later. This clearly shows that the BSF value chain is in its infancy and may need extra support for its development.

The size of the production facilities for small-scale producers are not very large, suggesting that BSF does not need a lot of space to start. The largest facility among small-scale producers was about 10x5 meters for the insectarium and 4x7 meters for the larvaerium. Non-commercial BSF producers also employ a few workers, suggesting that BSF farming is not labour-intensive. They have on average two to three workers, often household members, who in most cases also perform other activities in the home or at the farm. The small-scale producers are mostly women (six out of eight). Large and medium players are managed by women as well as by men. BSF production is done by people from all age groups. Though the small-scale producers tended to be much older than the large commercial producers. The next paragraphs give more information on the two types of producers.

**Table 10. Characteristics of BSF producers interviewed.**

Type	Size	Cycle	location	Start	Size of insectarium	Size of larvaerium	Employees	Sex owner/ manager	Age owner/ manager
Commercial	Large	Full cycle, focus on breeding	Kampala: Namanve and Wankoko	2018	250 m2	500 m2 (waste storage 350 m2)	40, 32 per cent women	Male	35 (est)
Commercial, PPP with Makerere University	Large	Full cycle	Wakiso	2019	10x10 m	100 x 50 feet plot	6, 50 per cent women	Female	40
Commercial, not active	Small, large in potential	Partial cycle, will go to full cycle	Buyikwe	2019	5x8 m (est)	Under construction 10x60 m (est)	6, 17 per cent women	Female	45 (est)
Commercial, not active	Large (also fish farm)	Full cycle	Wakiso	2021	2 acres (many buildings)		3, 0 per cent women Before: 10, 30 per cent women 8 temp, 38 per cent women	Male	-
Commercial, youth group, link Makerere University	Mid	Full cycle	Wakiso	2021	-	4x15 m (est)	26, 46 per cent women	Male	30 (est)

Type	Size	Cycle	location	Start	Size of insectarium	Size of larvaerium	Employees	Sex owner/manager	Age owner/manager
Farmer association	Small		Jinja	2020	None	Not observed	35 members, 91 per cent women	Female	38
Foundation (poultry, pig, crops)	Small	Partial cycle	Buyikwe	2023	-	4x7 m (est)	4, 0 per cent women	Female	45 (est)
Household (pig, cattle)	Small	Full cycle	Buyikwe	2021	10x5 m	4x6 m	3	Female	35 (est)
Household (poultry)	Small	Full cycle	Kayunga	2023	1x2 m	3x4 m	2 (family)	Female	65
Household (poultry, greenhouse)	Small	Partial cycle	Kayunga	2022	6x3 m	8x4 m	4, 75 per cent women	Female	33
Household (poultry, mushrooms)	Small	Full cycle	Jinja	2022	7x5 m	7x5 m	2	Female	75
Household (poultry, rabbits)	Small	Full cycle	Jinja	2022	3x3 m	7x5 m	6, 3 workers and 3 family members	Male	60
Household (fish, pigs)	Small	Full cycle	Kayunga	2022	2x2 m	2x2 m	1	Male	47 (est)

Small-scale BSF producers who use BSF as a cost-saving mechanism / resilient livelihood strategy

Small-scale BSF producers include a variety of types of producers. The consultants estimate that most are individual farmers, but farmer/youth groups or associations and NGOs are also active in BSF. There are an estimated 450-500 small-scale BSF producers in Uganda. This number is based on the number of small-scale farmers that are trained on BSF production by commercial BSF producers. The interviewed commercial BSF producers trained approximately 3 331 farmers on BSF of which about 440 are still active (see also commercial medium- and large-scale BSF producers). As there might be some more small-scale BSF producers in other parts of the country, the consultants increased the estimate a bit. Among the small-scale BSF producers, the main BSF products produced are BSF eggs, wet larvae, dry larvae, and frass. The farmers were told high production capacities but in reality, they produce very low quantities. Table 11 summarizes the production data of the different BSF products produced by six interviewed small-scale BSF producers. It was observed that record keeping is largely absent among small-scale BSF producers. Only one farmer was able to show production records. Hence, the data in Table 11 are estimations made by the farmers.

**Table 11. Production estimates among interviewed small-scale BSF producers, per month**

	Producer 1	Producer 2	Producer 3	Producer 4	Producer 5	Producer 6
Eggs	35 gr in Feb, 50 gr in Mar, 20 gr in May 53 gr in June	Insectarium not active	Unknown	Unknown	No	No
5-DOL	1,320 gr in May, 625 gr in Jun	Unknown	Unknown	Unknown	Unknown	No
Wet larvae	15 kg in May	20 kg	50-70 kgs	300 kg	No	90 kg
Dry larvae	30 kg in Feb	No	No	yes	30 kg Sold 200 kg in February 2023.	No
Frass	43 kg in Feb, 27 kg in Mar	Unknown	400 kg	10 kg	Unknown	30 kg

*Note: Only one small-scale farmer keeps production records, so information in this table is based on verbal data. The ratio wet larvae – frass in the table vary widely. Though depending on the feed differences in ratio occur, the difference here are huge. This can be an indication that the amounts given to the consultants are not accurate.*



The table shows that one farmer showed that she harvested between 20-53 grams in the period Feb-Jun. Another farmer has a small insectarium and tried to produce eggs but it was not active during the visit. Looking at the wet larvae production, one producer who produced least produced 15 kilograms in May. The largest amount of wet larvae produced was 300 kgs per month. Two small-scale BSF farmers were found with dry larvae. One had obtained 30 kgs in February. At the time of interviews, a small farmer association had about 30 kgs of dry BSFL and reported to have sold 200 kgs in February 2023.

The frass production also differs, ranging from 10 to over 40 kgs. Though the ratio wet larvae - frass depends on what the larvae are fed on, the differences here are huge. This can be an indication that the numbers in this table, obtained during the interviews with the small-scale BSF producers, are not accurate. Furthermore, the low production figures are in line with the comments of the off-takers that the current production of BSF products is too low to meet their high demand (see off-takers).

A variety of inputs are used to feed the BSFL. Most small-scale farmers feed the BSFL on waste. One small-scale BSF producer feeds the BSFL only on cow dung from her cattle. She uses a little maize bran bought from the local feed mills for hatching BSFL eggs. Another farmer reported to feed BSF on fish offal which he collects from a nearby Fish processing factory for free. He also collects jack fruits and vegetable residuals from the Jinja central market to feed the BSFL. Only one farmer reported to buy brewers waste from Nile breweries and maize bran from millers, which she supplements with restaurant and market waste.

The type of waste believed to be the best for BSF production varied among small-scale BSF farmers. The following were reported: sweet potatoes, bread waste, maize bran, and brewers' waste. One farmer reported that vegetables do not have high nitrogen content. Others reported that restaurant waste is the best because the larvae grow very well. Another farmer, however, reported that restaurant waste was not good because all the nutritious components have been consumed.

The small-scale producers that do full-cycle BSF production often have one to three nets in a room as insectarium (see Figure 10, left). One small-scale farmer has a specialized insectarium in a wooden frame within a room (see Figure 10, right).

**Figure 10. Different types of insectariums of small-scale farmers producing full cycle BSF**



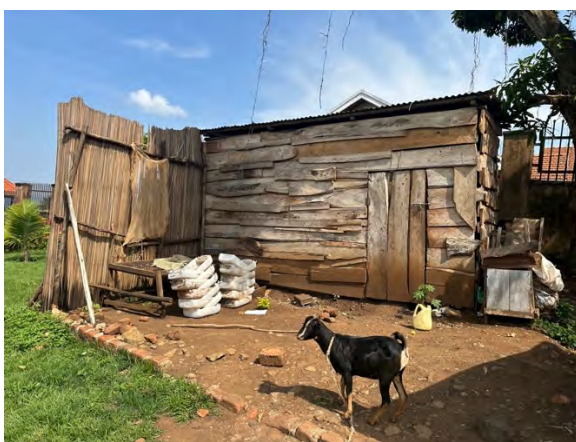
*Smallholder BSF Insectarium with nets, Kayunga*



*Wooden frame insectarium, Kayunga*

The larvaeriums are usually housed in wooden structures (see Figure 11, top left) which are shelved for the feeding trays (rest of Figure 11). The feeding trays are obtained by cutting 20 liter jerrycans into two halves. These are cheaper than the specialised feeding trays used by some commercial farmers. Some farmers also use old bath tabs as breeding trays (Figure 11, bottom pictures).

**Figure 11. Different larvaeriums of small-scale BSF producers**



*Structure of the housing of the larvaerium*



*Larvaerium in Jinja*



*Larvaerium in Kayunga*



*Larvaerium in Kayunga*

Most small-scale producers interviewed reported not to process the BSFL. The few ones who do, do not use specialised machinery for it apart from solar drying. One female BSFL farmer uses a solar dryer to dry the BSFL (Figure 12, left) which is stored in a plastic drum after drying (Figure 12, right).

**Figure 12.** *BSFL drying and storage*



*Small-holder BSFL solar drying in Kayunga*



*BSFL storage in Kayunga*

All interviewed small-scale BSF producers reported feeding the wet BSFL to their poultry, pigs and/or fish. At the time of the study (June 2023), none of the interviewed small-holder BSF farmers were selling any BSF product. However, one small association (Table 12 and Figure 13) claimed to have sold about 200 kilograms in February 2023 at UGX 7 000 per kg to fish farmers from Masese and Mbiko. In this group, different members bulked their dry BSFL, and each



member brought in 20-30 kgs of dry BSFL for sales. The reported price seemed to be very high, but association members were firm about it. Group members have earned a gross income of between UGX 140 000 (38 USD) to UGX 210 000 (USD 58 ) from dry BSFL sales. At the time of study, they were not producing because they had a challenge of getting the 3-or 5-DOL and had no insectarium. They had about two kilos of dry BSFL left (Figure 14).

**Figure 13. Interview with BSF farmer association in Jinja**



**Figure 14. Dry BSFL**



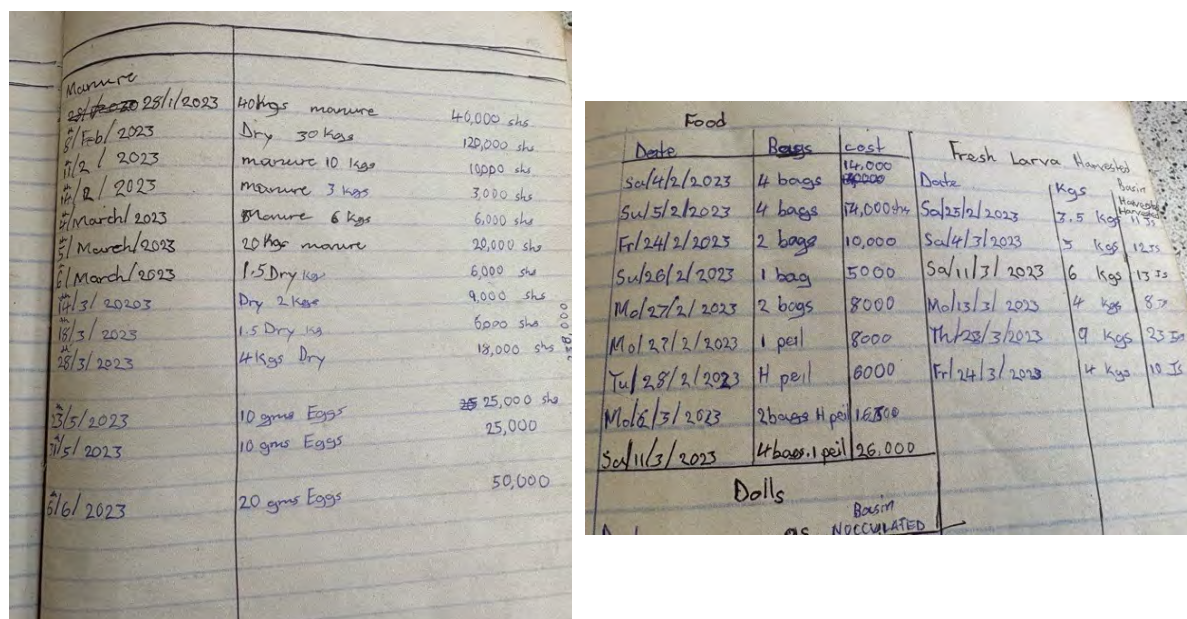
Another smallholder BSF farmer interviewed used to sell all BSFL to fish farmers in Mbiko, but she has now started rearing broilers. She will be using some of the BSF products as a protein supplement for the poultry. Her records show that she sold 79 kgs of manure (frass) at UGX 1,000 per kg, 37.5 kg of dry BSFL at UGX 4,000- 4,500 per kg and 40 gram eggs at UGX 2,500 per gram. Between the end of January and the beginning of June 2023, she was able to generate UGX 332 000 from sale of BSFL products (See Table 12 and Figure 15).

However, the farmer complained about the lack of revenue from the BSF compared to the investments she put in. This anecdotal finding suggests that BSF should not be promoted as an income-generating activity among smallholder farmers, but more as cost-saving mechanism / resilient livelihood strategy.

**Table 12. Income from BSF products from a female BSF farmer in Jinja**

Date	Item	Amount	Units	Price (UGX)	Income (UGX)	Income (USD)
28-Jan	Manure	40	Kg	1,000	40,000	11
8-Feb	Dry BSFL	30	Kg	4,000	120,000	33
11-Feb	Manure	10	Kg	1,000	10,000	3
14-Feb	Manure	3	Kg	1,000	3,000	1
4-Mar	Manure	6	Kg	1,000	6,000	2
5-Mar	Manure	20	Kg	1,000	20,000	5
6-Mar	Dry BSFL	2	Kg	4,000	6,000	2
14-Mar	Dry BSFL	2	Kg	4,500	9,000	2
18-Mar	Dry BSFL	4	Kg	4,500	18,000	5
23-May	Eggs	10	Gr	2,500	25,000	7
31-May	Eggs	10	Gr	2,500	25,000	7
6-Jun	Eggs	20	Gr	2,500	50,000	14
<b>Total</b>					<b>332,000</b>	<b>91</b>

**Figure 15. Record book of from a female BSF farmer in Jinja**



Income

Costs of "food" (waste) and fresh larvae harvested

Regarding the investments needed to start BSF production, all smallholder BSF producers interviewed reported to use own finances or savings to finance their businesses. They did not receive loans or credits from formal financial service providers for their BSF activities. One farmer stated to have gotten a loan from a farmer group SACCO with an interest rate of 3 per cent per month.

#### Medium- and large-scale commercial BSF producers

The number of medium- and large-scale commercial BSF producers in Uganda is limited. Interviews were held with five commercial BSF producers: Marula Proteen, Protein Kapital, Ento feeds, Ento organic farm and CIRD. To the knowledge of the consultants, these companies are the only commercial BSF producers in Uganda. At this moment, four of them (Marula Proteen, Ento organic farm, CIRD and Ento feeds) put BSF products on the market; one of them are currently not producing (anymore?) (Protein Kapital) . Ento organic farm can be seen as a medium-scale BSF producer, Marula Proteen and CIRD are producing BSF on a large-scale scale. Ento feeds is currently only producing eggs and 5-DOL, but will start other BSF products once their insectarium is ready (August 2023).

Though most of them see themselves as BSF producers, there is one that frames itself as a waste collector and processor. Though not confirmed in the interview, this strategy might have a positive influence on creating goodwill for the business at government level and for fundraising.

The main products that the commercial BSF producers produce are BSF eggs, 5-DOL, wet larvae, dry larvae and frass. Table 13 gives a summary of their production of the different BSF products. Also, here the ratio wet larvae - frass varies widely. Even though the ratio changes slightly depending on the diet of the larvae, the differences here are huge. This can be an indication that the numbers in this table, obtained during the interviews with the commercial BSF producers, are not accurate.

**Table 13. Production estimates of active commercial BSF Producers, per month**

	<b>Producer 1</b>	<b>Producer 2</b>	<b>Producer 3</b>	<b>Producer 4</b>
Eggs	1-2 kg	1 kg	1.1-1.3 kg (250-300 gr per week)	1.5 kg (50 gr per day)
5-DOL	2.4-3.3 tons (80-110 kg per day)	1 ton	Unknown	1-1.5 ton
Wet larvae	None at the moment, used to be 21 tons (700 kg per day)*	1.2 tons	2.1 tons (500 kg per week)	None at the moment

	Producer 1	Producer 2	Producer 3	Producer 4
Dry larvae	Infrequent, only done on order	No	1,1 tons (250 kg per week)	None at the moment
Frass	20 tons	4.5 tons	4.3 tons	None at the moment
BSF oil	Infrequent, only done on order	Sample of 5 litre (May 2023)	No	None at the moment

\* *Producer 1 is now focusing on breeding, so only producing eggs and 5-DOL.*

*Note: The ratio wet larvae - frass in the table vary widely. Though depending on the feed differences in ratio occur, the difference here are huge. This can be an indication that the amounts given to the consultants are not accurate.*

Commercial BSF producers in Uganda feed their BSF on various sources of waste: brewery waste (from Nile brewery and Uganda breweries), market waste, maize, expired pig feed, kitchen or food waste from hotels and restaurants, and poo from surrounding poultry farmers. Most of the producers combine market/kitchen/food waste (mainly vegetables and fruits) with brewery waste and maize/pig feed. They mention that brewery waste also serves as back-up when they have obtained less market waste than foreseen. Producers indicated that the use of poultry or pig poo has more risks: risks of infections, a bad smell for neighbours of the BSF farm, and a limitation of the end market consumers as Muslims are not allowed to eat meat from animals that have, via BSF feed, eaten pork waste.

There is no consensus among BSF producers on what is the best diet for BSFL. Mentioned were: market waste mixed with brewery waste, maize bran mixed with poultry poo (ratio 2:1), and slaughterhouse waste mixed with grains. However, the reality is that most commercial BSF farmers combine market waste with brewery waste.

Three out of four of the active commercial producers all do full-cycle BSF production, though the size of their larvaerium and insectarium varies (see Table 10). There is one commercial BSF producer who only produces eggs at the moment, though they hope to open their larvaerium in August 2023.

Looking at the insectarium, the largest producer is technically most advanced (Figure 16, left). They have 95 love cages in a controlled greenhouse environment with shading nets, windows, an automated fogging system, and a constant temperature between 27-34 degrees Celsius. The performance of each cage is checked by weighing the number of eggs it produces. Once the eggs are laid, they are removed within three days and put in a hatchery with brewing waste and chicken feed and a constant temperature of 30-34 degrees Celsius.

The eggs hatch in 3-4 days and brewery waste is used as a started feed. The two other insectaria (out of three) that were observed, were technically less advanced and much smaller.



They mainly consisted of love cages in a room without nets and no controlled environment (Figure 16, right). However, breeding time is approximately the same for all.

**Figure 16.** *Insectariums of commercial BSF producers*



*Many nets in a green house in Namanve*



*Insectarium in a room without nets in Buyikwe*

Looking at the three larvaeria the size varies (see Table 10) but differences in technology are not that big. Two larvaeria visited consist of shelves with crates/jerry cans with waste and larvae. One has 1,800 crates with larvae; the other 736 jerrycans. There is one larvaerium that breeds the larvae in boxes made of cement that were used for worm farming before.

There is one commercial BSF producer who regularly dries the larvae. They sun-dry the larvae in their larvaerium, on the top selves. One of the other producers has a dryer, but as already mentioned in Table 10, they dry infrequently only when they receive a large order. The large-scale producer that is not active at the moment also has a dryer. Both dryers were bought with a grant and only work when a large quantity of larvae is put in. This is also valid for the oil press that the same two businesses own. Both were bought via a grant and not (often) used because they need large quantities of larvae to function. also have an oil press,

All commercial farmers sell part of their BSF products. See Table 14 for more information. The active producers all put part of the eggs and 5-DOL back in the colony. All of the frass that is produced is sold, although one of the commercial BSF producers states that the demand is low and it takes time to be bought. Luckily the frass has a relatively long shelf life. Regarding wet larvae and dry larvae: there are two commercial BSF producers who produce them. One has a drier and the other one has poultry, so when they are not able to sell all wet larvae produced, they can dry them or feed them to their chicken.



**Table 14. BSF products, percentage sold, buyers and prices**

BSF product	per cent of production sold	Type of buyers	Price range
Eggs	33-60 per cent	Small-scale farmers	1,200-1,500 UGX per gr (start-up) (0.32-0.41 USD) 2,500-10,000 UGX per gr (0.68-2.71 USD)
5-DOL	30 per cent	Small-scale farmers	20,000 UGX per kg (5.42 USD)
Wet larvae	36-70 per cent	Commercial and to a lesser extent small-scale poultry, pig and fish farmers	2,000–3,500 UGX per kg (0.54-0.95 USD)
Dry larvae	0 per cent (bulking at the moment)	Animal (chicken, fish) feed producers, commercial poultry, pig and fish farmers	4,000–4,500 UGX per kg (1.08-1.22 USD)
Frass	100 per cent	Commercial and small-scale (agro-ecologic) farmers producing crops (e.g., flowers, rice, maize, coffee, avocado and other vegetables)	980-1,200 UGX per kg (0.27-0.32 USD)

*Note: Small-scale farmers are here seen as farmers who mainly produce at subsistence level, though they might sell the surplus of their produce. They use the BSFL to feed to their chicken, pigs or fish and use the frass on their land. Commercial farmers produce mainly for the market.*

Table 14 also shows the buyers of the BSF products. Generally speaking, small-scale farmers buy eggs and 5-DOL and frass, larger and commercial poultry, pig and fish farmers buy wet and dry larvae, larger and commercial crop farmers buy frass and animal feed producers buy dry larvae and oil. Animal feed producers also want to receive information on the nutritional composition of the dry larvae. All commercial BSF producers indicate that most of their clients, for all BSF products, are based in the central region with a concentration of clients in greater Kampala. Though one of the commercial producers reported to sell the dry BSL to a fish farmer in Eastern Uganda.

There are two BSF producers who export eggs to other East African countries, to Kenya, Tanzania, The Democratic Republic of Congo and Burundi. The export markets have more requirements than national sales. High quality packaging is a must. Once exports of other BSF products will start, lab data will be needed as well, to make sure that the BSF products meet the food safety standards (e.g., no heavy metal contamination, no residues)

Table 14 also shows that the prices of the different BSF products vary widely, especially for the eggs. This could be a sign of the novelty of the value chain. In addition to the prices for the BSF products in the table, the commercial BSF producers interviewed also give training to small-scale farmers that accompanies the sales of eggs and 5-DOL. This training itself ranges from 10,000-100,000 UGX per person (USD 2.71-27.10). The largest BSF producer gives the people trained 500 gr of 5-DOL free' and they also sell waste to them for UGX 350 per kg ( USD 0.10). One of the other commercial producers, who also sees themselves as a research centre, also sells BSF production equipment to farmers. This includes:

- Love cage nets for UGX 40,000 per piece (USD 10.83)
- Timber to make a shelf, 18 pieces for UGX 10,000 ( USD 2.71)
- BSF manual for UGX 10 000 (USD 2.71)

Another BSF producer provides farmers with a starter kit, which includes a love cage net, five kgs of pupae, two grams of eggs, timber, two to three trays, training and a training manual. The total costs of this is less than UGX 500 000 ( USD 135.40).

**Table 15. Income streams of the active commercial BSF producers**

	Producer 1	Producer 2	Producer 3	Producer 4
Grants	x	x	x	x
Loan	x		x	
Equity investor	x			
Savings owner	x			x
Sales	x	x	x	x

The commercial BSF producers have a mix of revenue streams to finance their BSF business, see Table 15. All of them receive grants (e.g., from USAID, ABI Development Ltd, Challenge Fund for Youth Employment, and Dutch Enterprise Agency). These grants are often given in the context of (youth) employment. This means that they are used to do outreach in communities, train small-scale farmers on BSF, and cover (part of) the costs for the production of eggs or 5-DOL given to them. In addition, two of them have a loan (one loan is UGX 50 million / USD 13 800) and are paying it back at the moment.

The largest commercial producer also has two equity investors who want to see return on investment on the medium term. One commercial BSF producer states that she also invested her savings in the business; she paid for the land on which the business is set up, the labour and the 3-phase power.

At this moment, it seems like none of them is making profit. Because of the grants they are able to continue their production. The largest producer changed it operations from wet larvae

production to becoming breeding centre in November 2022, because the production costs to produce wet larvae are higher than the price than they can sell it for. It is not profitable. As a breeding centre, they are now not breaking even yet, though during the rainy season they came close when sales for frass went up.

The main costs of operations seem to be the logistics around waste. That is why the largest producer also markets itself as a waste collector. One of the other commercial producers states:

*"THE OPERATIONAL COSTS ARE UGX 4 MILLION PER MONTH. THE LOGISTICS AROUND WAS IS 50 PER CENT OF THESE COSTS." – COMMERCIAL BSF PRODUCER*

### **Waste providers**

To get more insight into waste providers for BSF producers, the two major types of waste providers were included in the research: markets and breweries. Interviews were held with the market masters of Jinja Central Market and Jinja farmers market (Amber Court), and the company contracted to dispose the brewer's waste from Nile Breweries in Buikwe near Jinja.

In the Jinja Central market, all types of goods are sold and a lot of waste is generated. The waste manager estimates that organic waste forms about 80 per cent of the waste from Jinja Central Market. The market produces approximately 8 tons of waste every day. Four times per day the waste is collected and taken to the landfill. Hence, no one buys the waste from the market.

For the farmers market in Jinja, the main waste produced is organic waste (vegetables, fruits, tubers), which is approximately seven to eight lorry loads per week. Via a public tender a company was contracted to collect the waste and bring it to the dump site twice a week. However, there are some individuals who also collect waste. Among them, there is at least one BSF producer who sends two boys every two days to pick and sort waste for him. The amount of waste that they collect is relatively small. There is thus no formal agreement for these individual and informal waste collectors to collect waste. The market master also states that they do not need his permission to collect waste.

A company that obtained the tender to remove the brewer's waste from Nile Breweries was also interviewed. The person interviewed could not estimate the quantity of brewer's waste produced per month. Based on eye estimation of the trucks taking the brewer's waste, the approximate quantity of waste sold per day is more than 12 tons. Most, if not all the waste is sold to livestock farmers.

Most types of waste are free of charge for BSF producers. The largest BSF producer even has an MoU with Kampala Capital City Authority (KCCA) that they can recycle the market waste of certain areas in the city. According to them, waste provision is a key determinant of their business.

*"WE ARE SEEN AS A WASTE COLLECTION COMPANY. IN THE END, THE COMPETITION FOR WASTE WILL DETERMINE THE SUCCESS OF BSF PRODUCTION." – COMMERCIAL BSF PRODUCER*

Commercial BSF producers only pay for brewery waste: UGX 90,000 per ton (USD 2) with a minimum of one ton. The price for liquid yeast is UGX 135 per kg and malt culm, sorghum and malt dust is sold at UGX 500 per kg. The prices are exclusive of transport costs. The transport costs of waste (from for instance a market or brewery to the site of BSF producers) are high. BSF producers complain that these costs are one of the highest cost item of their business.

Factors that BSF farmers take into account when choosing the types and sources of waste are availability, consistency, nutritional value, and price of waste and transport. Sorting of waste is an issue, many commercial BSF providers complain about plastics and non-edible items in the market/kitchen/food waste that they receive. They often have to sort it before it can be grinded. In addition, the waste should not contain too much water. Pineapples and watermelons, for instance, are less suitable as BSFL feed. If there is too much water in the waste, it should first be drained before being fed to the BSFL. Also, some waste should not be fed directly to the BSF before being fermented (wait two days). Some BSF farmers, depending on their location, face competition with pig farmers for market waste.

### **BSF off-takers**

Wet and dry larvae can be BSF end-products that are consumed directly by the chickens, pigs and/or fish of animal farmers (see BSF product consumers below), but they can also serve as inputs for the development of animal feed. Actors that buy wet or dry larvae to process are mainly animal feed and pet feed producers.

In general, one can say that there are currently not many off-takers for BSF products in Uganda yet. The consultants have spoken to four (potential) off-takers of which three did not buy BSF yet. Two were interviewed at length and two others gave brief comments about BSF.

The off-takers spoken to are three animal feed manufacturers/millers and one agrovet. They produce animal feeds and protein concentrates for various animals (e.g., poultry, pigs, cattle, fish). They distribute their products nationwide; some also exports to Kenya and Tanzania.

A complete animal feed should contain protein, carbohydrates, enzymes and fibers. As protein source, the off-takers mainly use soy cake/oil and to a lesser extent fish (Enkeje or Mukene), mini-shrimps or sunflower oil. The protein content of the protein source should be at least 45 per cent. They buy their protein inputs from oil millers for soy or sunflower or via fish farmers.

They sometimes face challenges with sourcing protein, especially soy. Last year there was a soy scarcity. In addition, often fish prices in Tanzania are lower than in Uganda, also because harvest seasons differ from Uganda, so one of the off-takers imports a lot of fish from there.

One of the animal feed producers asks his suppliers for certificates with the nutritional value of their products. If they do not have these, he tests the products himself to get the nutritional parameters. When the feed is ready, he sometimes goes to UNBS or the Ugandan Industrial Research Institute (UIRI) to make sure it meets the standards.

Off-taking of BSF products in Uganda has some key challenges, according to the (potential) off-takers spoken to: high prices, lack of consistent supply of BSFL in terms of quantity and quality, lack of de-fattened BSF products and lack of drying capacity among producers. Section 5.5 will dive deeper in these challenges.

### **BSF products consumers**

This section will only the end-consumers; the buyers of eggs, 5-DOL, frass, wet and dry larvae. As buyers of pupae, empty cocoons, dead flies and oil are only mentioned by one respondent, we do not take them into account as end-consumers at this moment. We also did not encounter BSF-based animal feed on the market (see also off-takers), so we also do not take this BSF product into account.

It is important to note that the largest group of end-users are also BSF producers themselves. These are the small-scale farmers who buy eggs or 5-DOL as input for their own BSF production. The strategy of all of the active commercial BSF farms is to train farmers to do part of the BSF-cycle and become reoccurring customers for eggs or 5-DOL unclear how many of these small-scale farmers, being BSF producers and end-consumer, there are at the moment. From the interviews it became clear that the commercial BSF producers and research institutes trained over 3 300 farmers on BSF production (non-full-cycle). About 450 picked it up. So, our estimation is that there are circa 500 buyers of eggs and 5-DOL in the country at the moment. Ugandan BSF eggs are also exported to other East African countries. Hence, there is an export market as well, though the number of buyers and quantities of eggs exported are unknown to the consultants.

Frass is bought by commercial and small-scale (agro-ecologic) farmers producing crops. In the interviews came to the fore that BSF producers sell to flower, rice, maize, coffee, avocado and

other vegetable farmers. It is difficult to estimate how many farmers buy the frass, but considering the estimated amount of frass sold, it will be a limited number. The BSF producers who indicated the location of their frass clients, all state that they are around Kampala and in the central region.

The frass is relatively cheap, compared to chemical fertilizer that have higher prices (UGX 250,000 for urea) due to the war in Ukraine. It also holds the water, which makes the soil more fertile, according to a professor of Makerere University.

Wet larvae and dry larvae are consumed by commercial and to a lesser extent small-scale poultry, pig and fish farmers. As the estimated quantities sold are small, the number of farmers that consume the wet and dry larvae will be small as well. In interviews with commercial BSF producers who sell BSFL came to the fore that they have only a couple of clients for their wet and dry larvae. As dry larvae are produced less than wet larvae, wet larvae have to be consumed quickly and most of the BSF producers are concentrated around Kampala and Jinja, our estimation is that also most consumers are based here. We estimate that there is a handful of buyers of fresh or dry larvae who buy these from commercial farmers.

*“SELLING FRESH LARVAE IS EASY IN KAMPALA, BUT NOT FURTHER AWAY” – COMMERCIAL BSF PRODUCER*

Then there are the small-scale farmers who consume their own produced wet larvae. They are satisfied with the quality. The ones with poultry were happy with the quality of their poultry which they attributed to feeding them on wet larvae. Another farmer stated that their pigs grew bigger since they have been fed on a combination of silver fish and BSFL. Moreover, BSFL are much cheaper than silver fish: the costs for silver fish per month are equal to the costs for BSFL for five months.

## **5.2.2 Support functions**

### **Research institutions**

There are various research institutes that do research on BSF in Uganda. During the fieldwork three were interviewed: Makerere University, CIRDS<sup>3</sup> and NARO. Though we received information that the African Centre of Excellence in Agro-ecology and Livelihood Systems (ACALISE) at the Uganda Martyrs University (UMU) is also involved in research on BSF.

It is important to note that all research institutes interviewed also do their own BSF production, BSF product sales and train people on BSF. That makes them not fully independent and could cause conflicts of interest.

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<sup>3</sup> CIRDS is also seen as a BSF producer and included in the section on BSF producers section as well.

Researchers, and other actors in the value chain, interviewed have similar opinions on the most pressing research gaps on BSF in Uganda at the moment. These include:

- Understanding what the best diet for BSFL is, given the availability of inputs in Uganda, to get the best nutritional value.
- Development of various BSF-based animal feed products for various animals (e.g., poultry, pigs, fish, piglets, chicks, pets). What is the best combination of ingredients, given the availability of inputs in Uganda?
- Researching which crops grow best on frass. Also, how much frass to use and how to best apply the frass to get the most optimal results.
- How does BSF production work in rural areas, where there is less (municipal) waste than in (peri-)urban areas.
- To a lesser extent there is still a research and knowledge gap in how BSF farming can be best adapted to the Ugandan context. This includes finding out what are the most efficient and effective production methods for BSF producers at different scales (small, medium, large) and with different types of farms (only animals, only crops, combination of both).

#### Makerere University

There are researchers in several departments of Makerere University that are engaged in research on BSF. The consultant team has spoken to researchers in the department of agricultural production.

This department is researching BSF and other insects (e.g., meal worms, crickets) since 2016. They do different (research) activities related to BSF:

- Develop curriculum and a training program on BSF production
- Working with youth groups to set up BSF farms
- Train farmers and youth on BSF production and give out starter kits
- Produce BSF and sell eggs, 5-DOL and larvae
- Do research on BSF or supervise research that students do related to BSF (e.g., how to influence the oil content of BSFL, best methods for oil extraction, grading of BSF, best diets for BSFL, best BSF-based diets for poultry (broilers and layers), fish and pigs)
- BSF product development (e.g., soap and gasoline made of by-products of BSF oil)

Makerere also wants their BSF training program to become accredited by the Ministry of Education. In this way, they can educate more people on BSF production and create a critical mass to drive policy change in favour of BSF production. They see an opportunity for other organizations to do this:

*“RESEARCH IS IMPORTANT, BUT TO TAKE IT TO COMMUNITIES IT WORKS BETTER FOR AN NGO. THEN YOU CAN GET MORE YOUTH INVOLVED.” – MAKERERE UNIVERSITY*

### Centre of Insect Research and Development (CIRD)

CIRD is a public-private partnership with support from Makerere University, Michigan State University, ICIPE Nairobi and USAID. It aims to be a centre of excellence for research and product development from insects (BSF and bees) in Uganda and beyond by generating evidence-based innovative solutions for sustainable utilization of insect resources for income, employment, conservation, healthy humans and animals.

CIRD started in 2019 and has four different pillars:

- Supply of breeding stock and conduct trainings to farmers to establish BSF and beekeeping
- Support development of insect VC by developing input supply for small scale farmers and commercial farmers
- Strengthen value addition
- Support education and research to optimize and upscale insect technologies and policy advocacy Business incubator of insect related business VC.
- Community mobilization and extension on BSF. Currently working with Alcode and Woord & Daad to develop BSF businesses in the cities of Soroti, Lira and Gulu

CIRD has developed a small-scale BSF production model to reach communities and increase their income levels This entails 2-10 love cages, max 100 kg per cycle which is max 200-300 kg per month, though the trained farmers are now only producing 20-30 kgs. Hence, the model has to be improved and CIRD has set up their own production facility to develop and optimize this process. The fact that they are running the facility as a business also helps them to understand the economics of BSF production and exchange knowledge when building the capacity of others. Nevertheless, it is not entirely clear how the research side of the institute is separated from the business side.

### National Agricultural Research Organization (NARO)

NARO is a governmental research institute. Its mandate is to do research, generate information and disseminate this knowledge. They started research on BSF one year ago with their own colony. Knowledge on BSF farming that NARO is producing via research and wants to disseminate include:

- Inputs/feed needed to produce BSFL with a consistent and a high nutritional value
- Technologies to defat larvae
- Getting more insights into the genetics of BSF

In addition, NARO is developing and contextualizing BSF farming procedures and protocols to fit with the Ugandan context.

The knowledge will be disseminated via the district entomologists to (potential) BSF farmers via awareness creation activities and training,



### **District entomologists**

To develop insect value chains in Uganda, with BSF being one of them, the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is reaching out to communities via the district entomologists. See also the section on Department of Entomology below. The district entomologists do awareness raising that BSF can be an additional source of income, establish demonstration farms and give BSF eggs to farmers. These services are free of charge for community members. Awareness raising and demonstration farms are paid by the government and the eggs are distributed to the communities via CIRD and paid by donors (e.g., USAID).

At this moment, not all district entomologists are sufficiently aware of BSF or are not trained on BSF yet. Hence, they are not able to reach out to all communities in Uganda. Because of this, and because of the concentration of BSF farming and availability of BSF eggs around Kampala, women and (unemployed) youth in this area are targeted first for awareness raising on BSF farming.

### **Formal financial service providers**

There are several financial service providers active in Uganda that offer services that are of interest to actors in the BSF value chain. During the fieldwork, The Manager of Business Banking of Centenary Bank in Mukono was interviewed. Centenary Bank provides saving, deposit and credit services, and forex trading in Uganda. It started in 1983 as a trust to extend credit to rural people. Women, youth and rural people are still its main target groups. The bank is present nationwide with 77 branches. By 2022, the number of female customers was 994 732 and youth 969 198 (Centenary Bank Annual Report 2022).

The bank only offers individual loans to SMEs and high-end corporates for varying loan limits and interest rates. In addition, the bank offers loans to certain target groups with special features. It is hard for subsistence level farmers and informal companies that do not have records to get a loan, which is why they introduced the special loan types without collateral. Giving a loan to these types of people/organizations it is important to first look at their capacity to pay back and then at the level of risk. Table 16 gives an overview of all the loans that Centenary Bank offers.

Overall, the minimum loan amount is UGX 100 000, and the maximum amount is UGX 40 billion. The loan period varies between one month and two years. For the loans for which no collateral is needed, Centenary Bank secured some guarantees from international and national organizations (e.g., USAID, ABI, Asceri Africa, government of Uganda through the Bank of Uganda which provides the Agricultural Credit Fund).

**Table 16. Characteristics of loans that Centary Bank offers**

<b>Type of loan</b>	<b>Loan size in UGX</b>	<b>Interest per annum</b>	<b>Type of clients</b>	<b>Specialities</b>
<b>General loans</b>				
Micro	100,000 – 5 million	40 per cent (3.3 per cent per month)	SMEs without records, people without collateral	High risk group, no collateral needed
Small	5-20 million	28 per cent (2.3 per cent per month)	anyone	Collateral needed
Medium	20-50 million	21 per cent (2.1 per cent per month)	Anyone	Collateral needed
<b>Special loans</b>				
Super woman loan	100,000 – 5 million	25 per cent (2.1 per cent per month)	Women in business without collateral,	No collateral needed, loan accompanied with 3 financial literacy training, special treatment in bank
Youth loan	100,000 – 5 million	25 per cent (2.1 per cent per month)	People between 18-35 without collateral.	No collateral needed, present 2 personal guarantors
Micro-business loan	100,000 – 5 million	25 per cent (2.1 per cent per month)	Micro-businesses without records	No collateral needed
Mobile loan	Depends on scoring by bank using AI.	Depends on scoring by bank using AI.	Anyone with an account	1-6 months
Agricultural loan	100,000-40 billion UGX	Depends on the loan size	People who want to use the loan for agricultural marketing, production, and processing	Grace period depends on commodity

The bank does not have any actors in the BSF value chain as clients, as far as the interviewee knows. But, as Table 16 shows, there are loan options for different types of BSF actors. However, the interviewee also acknowledges that people often come to the bank with too many expectations. They think that they can get a bigger loan and are disappointed that they can only get a small loan.

### **Informal financial service providers**

Services of informal financial service providers, such as SACCOs and VSLAs, are widely used in Uganda. In 2018, 56 per cent of the Ugandan used their services<sup>xxvii</sup>. It is plausible that actors in the BSF value chain also use these services for their BSF activities. Of the interviews with five small-scale BSF producers, one of them lent money via a SACCO, with an interest rate of 3 per cent per month, to start up the BSF business. The rest used their own savings. Of the commercial BSF providers, no one used the services of informal financial service providers.

### **NGOs and donors**

There are not that many NGOs active in the BSF value chain at the moment. The commercial breeders are working with USAID and the Challenge Fund for Youth Employment (funded by the Netherlands government), Woord & Daad and Alcod (in North Uganda) to train farmers on BSF. Other NGOs interested in BSF are in Caritas (North Uganda), CARE (West Uganda), and World Bank. For them BSF is a relatively new value chain to be involved in and they are mainly interested in working with small-scale farmers. This is also the case for the FAO office in Uganda. They are not active in BSF yet but are eager to hear the results of this study.

## **5.2.3 Rules and norms functions**

### **Department of Entomology, Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)**

MAAIF, under the Directorate Animal Resources, the Department of Entomology. This department has several tasks:

- Vector control (diseases by insects)
- Development of Productive Entomology value chains (e.g., BSF, beekeeping (apiculture), silkworm farming (sericulture) and grasshopper (Ensenene).
- Policy development for the above value chains
- Training and managing the district entomologists of which there are 86 at the moment.

The interest of the Ministry in BSF started recently, in 2015. The Ministry is currently developing a national livestock development policy; 'productive insects' will also be included. Some policy makers have been trained by CIRI so they understand the BSF production process, which will help them to write the part of the policy on insects. The policy will be ready by September 2024.

### **Ugandan National Bureau of Standards (UNBS)**

UNBS is a para-statal agency that falls under the Ministry of Trade. It promotes fair trade of all products produced in Uganda (except for medicines) and protection of health and safety. UNBS has four types of services: standardization, measurement and quality assurance of these products. The product standards that UNBS sets and enforces are demand driven. When the need for a standard is justified, UNBS can develop a standard. UNBS has set approximately 5 000 standards in Uganda.

The services that UNBS offers are paid services. Prices differ per product (e.g., testing a product on a certain aspect, obtaining a certificate of standards for a certain product). UNBS charges more for large-scale companies than for smaller players.

UNBS has recently developed a standard in place for dried insect products for compounding animal feeds and a standard for edible insects<sup>4</sup>. In addition to these standards, all food and feed products made in Uganda, including BSF products, need to adhere to the general food and feed end/processed products. These standards include product quality and food safety parameters. For more information on relevant standards for BSF products, see section 5.5.

### **National Environment Management Authority (NEMA)**

NEMA a government agency responsible for monitoring, coordinating, supervising and regulating the natural environment and the environmental policy of Uganda. NEMA advises the government and spearheads the development of environmental policies, regulations, laws, guidelines and standards.

In relation to BSF farming, NEMA would conduct an environmental impact assessment to assess if a BSF company, large-scale companies only, is working in line with environmental laws and policies. When this is the case, they give out a license and the company can proceed with its operations.

Other, general rules and norms setting organizations that were mentioned in the interviews are:

- Ministry of Health (MoH): for sanitation regulations in relation to bringing waste to a residential area, if a BSF producer brings significant amounts of waste to his/her home.
- Ministry of Trade, Industries and Cooperatives (MTIC): for the trade license for commercial BSF producers and the promotion of trade
- Ugandan Revenue Authority (URA): for taxation

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<sup>4</sup> BSFL are not included in the standard for edible insects.

## 5.2.4 Youth and women in the BSF value chain

When looking at where youth and women are present in the BSF value chain, it becomes clear they are mainly active in the lower part of the value chain (input supply, production) or in functions such as workers. The upper part of the value chain, where most value is added, is dominated by older men. Table 17 gives an overview.

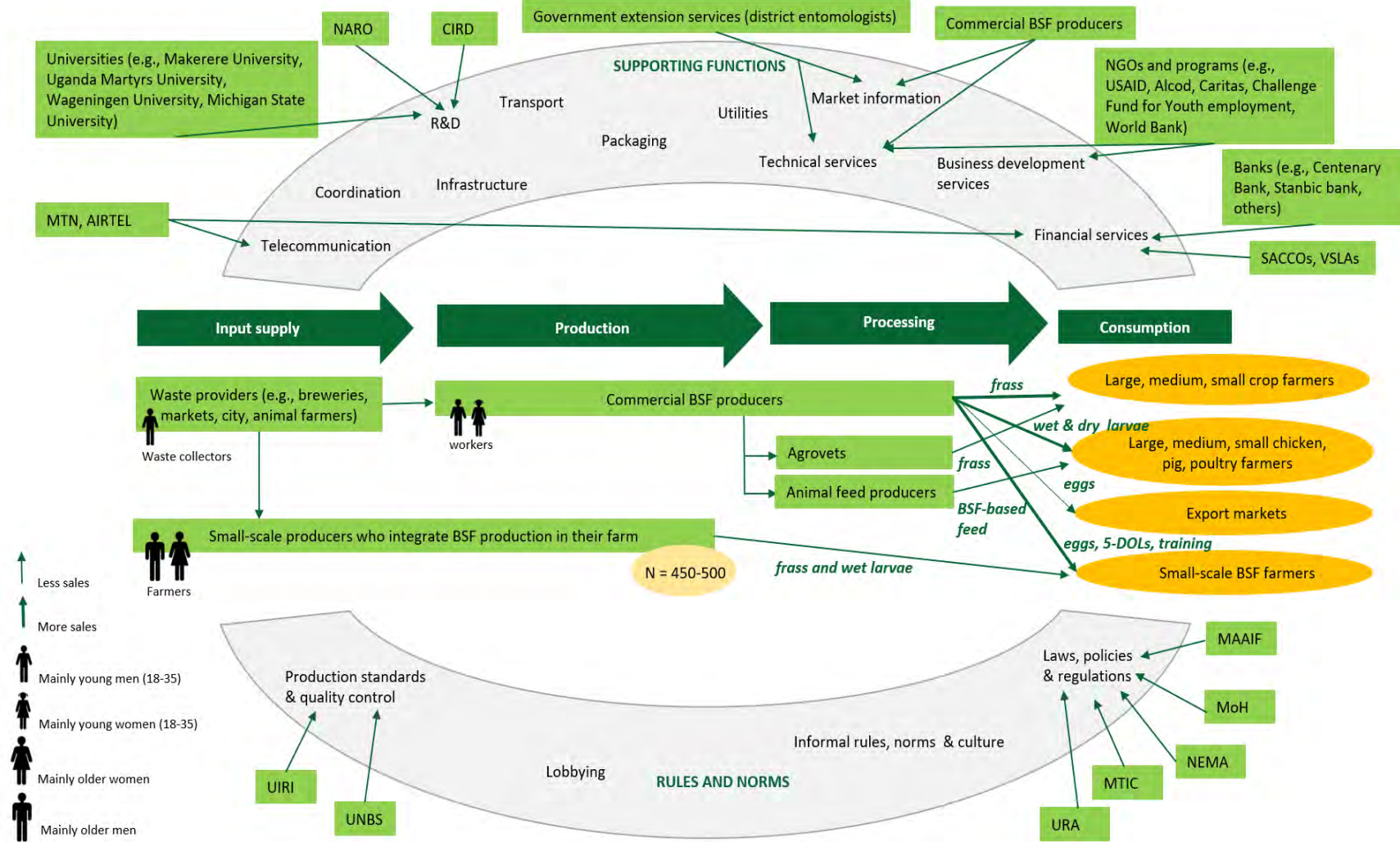
**Table 17. Overrepresentation of youth and women in the stages of the BSF value chain**

	<b>Input supply</b>	<b>Production</b>	<b>Processing</b>
Young men	As waste collectors	As workers in commercial BSF farms	As workers in commercial BSF farms
Young women		As workers in commercial BSF farms	As workers in commercial BSF farms
Older men		As owner of small-scale farms	As owners of processors or commercial BSF farms
Older women		As owner of small-scale farmers, often in poultry	

Looking at Table 17 at youth in the BSF value chain: most interviewees state that the majority of the small-scale farmers that adopt BSF are older people as youth do not own land. Most youth and children of the farmers are only involved in the farm (and thus the BSF production) when they have holidays. One commercial BSF producer who has trained young small-scale farmers states that it is important to have a follow-up plan for them after they have trained them on BSF. Otherwise, they receive the training but cannot put it into practice. The commercial farmers all employ mainly youth, partly because it is physical work. Young men are also relatively overrepresented in the collection of waste.

Looking at Table 17 and the presence of women in the BSF value chain, they are mainly present as small-scale farmers or as workers. Marula Proteen states that they want to train at least 60 per cent small-scale female farmers on BSF production, but that it is hard to get to these numbers. They have only reached 54 per cent thus far. This is countered by Ento feeds who stated that 80 per cent of the small-scale farmers that they have trained are women, mainly poultry farmers. They are interested in BSF production, because they want to improve the food of their poultry and because it is done at their home. However, even when small-scale female farmers are trained it is often the male head of the household who dictates whether to start BSF production and how to do it. Figure 17 visualizes all actors and overrepresentation of youth and women in the BSF value chain in Uganda in a donut map.

Figure 17. Donut map of the BSF value chain in Uganda



## **5.3 Functioning of the BSF value chain in Uganda**

The first part of this section will focus on the relationships between the different actors in the BSF value chain to understand the structure of the value chain, the interactions between different actors and the value chain dynamics. The second part will give some additional information about the presence and absence of services that are of importance to BSF value chain actors.

### **5.3.1 Relationships among value chain actors and value chain coordination**

As the BSF value chain in Uganda is still in its infancy, there are not that many actors active in BSF. Therefore, all of the commercial BSF producers know each other. They also work or have worked together with the research institutions spoken to and know or have contacts with relevant government institutions (e.g., NEMA, UNBS). Though the number of commercial BSF producers is limited, there is no monopoly or cartel. The largest BSF producer has the most influence on the prices of the BSF products but does not influence the whole sector.

The commercial BSF producers all train small-scale farmers, but these are only on the radar of the BSF producer that trained them. The small-scale BSF producers do not know many other small-scale producers, nor other actors in the value chain. Only the largest BSF producer has a WhatsApp group (circa 230 members) with all the people that they trained or that are buying BSF products from them. Hence, most of the small-scale farmers are not organized, and therefore, they cannot process nor store their BSF products or organize communal transport. This is not relevant at the moment, as their current production is low and most of it is consumed at their own farm. But in the future, this might become a constraint.

Some of the interviewees also stress the importance of consumers of BSF products and parties that offer waste (e.g., municipality waste authorities) to pull the value chain. As can be seen from section 5.2.1, at this moment the number of consumers is still limited. Waste is sufficiently available at the moment, but this can become a constraint once the BSF value chain develops.

There are only a few formal relations between value chain players. For instance: the largest BSF producer has an MoU with the Kampala Capital City Authority for waste provision and some other producers have contracts with a couple of their clients for the provision of BSFL. However, most of the transactions (buying/collecting of waste, selling of BSF products) in the value chain are informal, without a contract. Nevertheless, these relationships are good, according to all people spoken to.

*“ALL BSF PRODUCERS AND RESEARCH INSTITUTES ARE WORKING IN THEIR OWN SILOS, THEY ARE VERY PROTECTIVE ON FOR INSTANCE THEIR FUNDERS, NETWORK AND WAY OF WORKING.” – COMMERCIAL BSF PRODUCER*

However, there is no stage of open dialogue yet. There have been already some efforts made to coordinate the value chain. UNBS has started quality control with their standards for dry insects that are used for animal feed (see section 5.5). Research institutes have published research, this knowledge is not disseminated to all BSF producers. In general, one can say that commercial BSF producers have more access to knowledge as they can exchange information with bigger global producers. The small-scale farmers are dependent on training of the commercial BSF producers or via district entomologists, the latter being still in at infant stage. One of the commercial BSF producers has developed a web training portal for (small-scale) BSF producers with information on BSF production to fill the gap.

Furthermore, some BSF actors are involved in multiple functions of the value chain. One of the commercial BSF producers for instance, is also a research centre (cooperation with Makerere University) and has trained government entomologists. Besides the cooperation with the research centre, Makerere University also supported students to set up BSF enterprises and do their own research on BSF. The various interests that these organizations have, could cause conflicts of interest and perhaps hamper development of the sector as a whole, according to the consultant team.

The two largest BSF producers emphasize that it is important to set up a BSF platform or BSF association to improve the coordination, and thus development, of the BSF value chain in Uganda. Such an organization will support in lobbying and bring stakeholders together. One of the commercial BSF producers that is also into beekeeping has seen that a stakeholder platform in agriculture has been an engine for development of that value chain. According to them: a stakeholder platform should bring together producers, funders and the government with workshops/meetings at least one time per year to synthesize all the views and get a sense of direction how to develop the value chain. The commercial BSF producers in Uganda are very interested to learn from the experiences of the BSF association in Kenya.

### **5.3.2 Services for actors in the BSF value chain**

There are not many BSF-specific services (knowledge transfer on BSF and BSF farming, marketing of BSF) available. Below an overview is given of services that BSF producers use.

#### **BSF-specific (training) services**

Commercial farmers got knowledge on BSF via the internet (self-taught) and via other BSF producers or research institutes in the world (e.g., Wageningen University, Michigan State University, ICIPE Nairobi). Though the Department of Entomology of MAAIF states that district entomologists are trained to create awareness and give training in BSF, none of the small-scale producers interviewed has been trained by them. They were trained by the commercial BSF



producers or the research institutes. One of the commercial BSF producers even stated that government extension workers do not understand how the BSF business works. This was echoed by one of the research centres that stated that government extension workers need to be trained more on BSF. In addition, there are no production standards for BSF products. As people from NARO indicate:

*"THERE IS NO STANDARD, PEOPLE USE CUT-OUT JERRY CANS FOR BSF PRODUCTION. THERE IS NO STANDARD IN EQUIPMENT FOR ANY OF THE STAGES OF REARING BSF." - NARO*

### **Business development services**

More general services are available, but do not work optimal for actors in the BSF value chain. Looking at general business development support and training, one of the commercial farmers received these via a GIZ-funded programme (for instance on how to do fundraising, occupational health and safety, customer care, environmental, social and governance (ESG) standards). However, this type of services does not seem to be widely available for BSF producers.

### **Laboratory services**

Furthermore, there are lab services available to test larvae (for instance on their nutritional value, microbiological pathogens and contaminants) but these are only available in Kampala. And some tests can only be done abroad. This means that people have to travel or send their samples there, which has a cost and time implication.

### **Financial services**

Finally, financial services are there, but according to the respondents the interest rates are too high for (small-scale) BSF producers and they do not understand the business. Financial services would mainly be needed to finance equipment to produce and process BSF (mentioned were love cages, sif, crusher, mixer, (solar) dryer, blancher).

*"THEY (BANKS) DO NOT UNDERSTAND BSF. IT TAKES LONG TO EDUCATE THEM ABOUT BSF SO THAT THEY KNOW WHERE THEY PUT THEIR FINANCIAL PRODUCTS." – COMMERCIAL BSF PRODUCER*

## 5.4 Estimated production and sales of BSF products in Uganda

This section provides insight into the estimated production and sales of BSF products in Uganda. The amounts are based on many assumptions; hence one should be careful when using them.

### 5.4.1 Estimated production of BSF products in Uganda

The main BSF products that are currently on the market in Uganda are eggs, 5-DOL, wet larvae, dry larvae and frass. Table 18 shows the estimated production of these products per month in Uganda, split between interviewed commercial BSF producers and small-scale BSF producers. The production data of the commercial BSF producers is based on the data collected during the interviews. The production data of BSF eggs and 5-DOL of small-scale producers are also based on the data collected during interviews; the production data of wet larvae, dry larvae and frass are based on assumptions. Annex 5 gives more details on how the calculations were done and which assumptions are behind them. It is important to note that the all the production data should be interpreted with caution and are considered to be very rough estimated, because there are many assumptions behind them.

**Table 18. BSF products production estimates, per month**

	Production of commercial BSF producers	Production of small-scale BSF producers	Total
Eggs	5.2 kg	2.5 kg	7.7 kg
5-DOL	5.1 tons	0.08 tons	5.2 tons
Wet larvae	3.3 tons	15 tons*	19.3 tons
Dry larvae	1.1 tons	400 kg*	1.5 tons
Frass	28.8 tons	16 tons*	44.8 tons

\* Data based on assumptions, see Annex 5.

*Note: as this table is based on a lot of assumptions, one has to treat the numbers in this table with care. They are rough estimations. As can be seen from the table, and in line with section 5.2.1, commercial producers produce relatively large amounts of eggs, 5-DOL and frass, while small-scale producers produce more wet larvae and frass.*

## 5.4.2 Estimated sales of BSF products in Uganda

When looking at market demand and BSF products sold, it is important to note that this only refers to the commercial part of the value chain. Small-scale farmers who do full-cycle BSF production themselves buy a starter kit with eggs or 5-DOL and can, if everything goes well, continue production without having to buy new BSF inputs (e.g., eggs or 5-DOL). They consume their own production of wet larvae and frass and these BSF products are, therefore, not on the market.

Hence, the amounts of BSF products sold are much less than the amounts produced. Small-scale farmers might sell only small amounts of their BSF products to neighbouring farmers, mainly wet larvae and frass. The commercially produced BSF products are also not all sold (e.g., part of the eggs and the 5-DOL have to be put back in the BSF colony).

The consultants have made sales estimations of eggs, 5-DOL, wet larvae, dry larvae and frass. Table 19 gives an overview. It is important to note that the numbers are rough estimations, with a lot of assumptions behind it. Annex 5 gives a more detailed explanation of the estimations.

**Table 19. Estimated sales of BSF products in Uganda, per month**

BSF product	Estimated production	Sold	Sales	Average price	Value
Eggs	Commercial: 5.2 kg Small scale: 2.5 kg	50 per cent 5 per cent	2.6 kg 0.1 kg <b>2.7 kg total</b>	4,000 UGX / gr (1.07 USD)	10.8 million UGX (2,900 USD)
5-DOL	Commercial: 5.1 tons Small-scale: 0.08 tons	30 per cent 5 per cent	1.5 tons 0 tons <b>1.5 tons total</b>	20,000 UGX / kg (5.37 USD)	30 million UGX (8,055 USD)
Wet larvae	Commercial: 3.3 tons Small-scale: 15 tons	50 per cent 5 per cent	1.7 tons 0.75 tons <b>2.45 tons total</b>	2,750 UGX / kg (0.74 USD)	6.7 million UGX (1,813 USD)
Dry larvae	Commercial: 1.1 tons Small-scale: 400 kg	0 per cent	0. tons 20 kg <b>20 kg</b>	4,250 UGX / kg (1.14 USD)	85,000 UGX (22.8 USD)

BSF product	Estimated production	Sold	Sales	Average price	Value
		5 per cent			
		100 per cent	28.8 tons		
Frass	Commercial: 24.5 tons Small-scale: 16 tons	5 per cent	0.8 tons <b>29.6 tons total</b>	1,100 UGX / kg (0.30 USD)	32.6 million UGX (8,880 USD)
<b>Total</b>	-	-	<b>ca. 33.6 tons</b>	-	<b>+81 million UGX (ca. 21.670 USD)</b>

*Note: as this table is based on a lot of assumptions, one has to treat the numbers in this table with care.*

Per month, 33.6 tons of BSF products are sold. This would be approximately 403 tons per year. Frass makes up about 88 per cent of the sales in terms of quantity. The estimated value of sales of BSF products is UGX 81 million (USD 21 670) per month. Sales per annum would be UGX 972 million (USD 260 040). These amounts are very rough estimations and should be taken with care. Of all BSF products, the value of frass sales is the highest, because of the relatively high volumes. The value of 5-DOL sold is ranked second, as they have a relatively high price.

## 5.5 The current BSF policy landscape in Uganda

The support functions and rules and norms functions part of section 5.2.3 gives an overview of the relevant government actors for the BSF value chain, with the most important being: the Department of Entomology and the district entomologists of the Ministry of Agriculture, Uganda National Bureau of Standards (UNBS) and the National Environment Management Authority (NEMA).

Government actors that were also mentioned in the interviews as important once the BSF value chain further develops are:

- Ministry of Health: for sanitation regulation and sensitization related to waste and BSF production. This Ministry is already relevant for the BSF value chain (see rules and norms functions), but its importance will grow when BSF is produced at a higher scale and/or by more farmers.

- Ministry of Education: for the accreditation of BSF training
- Ministry of Science, Innovation and Technology: for funding research on BSF. According to the Department of Entomology of MAAIF, the Ministry intends to engage in the BSF value chain, as it is innovative. They can for instance speed up drying and processing of BSF.
- Uganda Export Promotion Board: for supporting BSF producers and processors with exporting BSF products, when that becomes more prevalent.

### **Policies and regulations**

At this moment, there is no specific policy that takes BSF into account. BSF production falls under general agricultural policies. There is also no policy yet that specifically mentions or accepts BSF by-products, like frass as an input for agriculture.

Nevertheless, 'productive insects' will be part of the new national livestock policy that is currently in development (see section 5.2.3.). It will be an 'open policy', which means that there is no specific policy for each productive insect. When the policy is finalized (Sept 2024), five-year implementation plans will be made. Though the exact content of the policy is not clear yet, it will probably include training of 25 000 households in the central region to start BSF production, according to the Department of Entomology. Besides this, a new animal feed bill is almost being passed through the Parliament that includes the use of insects in animal feed. The policy is being complemented with the UNBS standards for dried insect products for compounding animal feeds and for edible insects (for more information see standards below).

Looking specifically at the input supply part of the value chain, the waste supply and use, there are policies in place to minimize the risks for the environment and public health that all commercial enterprises — including BSF producers — should adhere to. This is included in the NEMA assessment and license. There are no laws or regulations that prevent waste managers from selling/giving waste to BSF producers.

Finally, there are more general production and trade policies that all commercial actors in the core of the BSF value chain need to adhere to. These include, for instance, trade and tax regulations (e.g., business registration and obtaining a trade license at MTIC and payment of taxes at URA) and general agricultural policies.

### **Standards**

Recently, UNBS put a standard in place for dried insect products for compounding animal feeds and a standard for edible insects. Though the first includes BSF, the latter does not. Both standards are based on scientific data; research for these standards was undertaken by Makerere University and ICIPE in Kenya. Hence, they supported the development of the

standards. The reason the standards are for dry insects specifically is because it is the easiest transportable insect product, as it has a longer shelf life than wet insect products.

The standard for dried insect products for compounding animal feeds specifies requirements, sampling and test methods. It includes 10 species of insects, including BSF larvae and pupae, in dried form: whole insects, ground insect products and defatted insect products. To download the standards is not for free, costs are 40,000 UGX. The UNBS representative interviewed estimates the costs for the certification itself at less than 1,000 USD. However, at this moment no dry BSFL have been certified.

Parameters for the BSF standard for dried insect products for compounding animal feeds include product quality and safety. Table 20 gives an overview of the nutritional requirements. Regarding contaminants the dried insect products must comply with the maximum pesticide and veterinary drug residue limits, the maximum metal contaminant residue limits and have a maximum content of aflatoxins of 20 µg per kg. They also must have an absence of microbiological pathogens (salmonellae and e-coli). Finally, the standard includes requirements for packaging and labelling.

In addition to the specific insect standards, UNBS has recently been developing and implementing enforcement of general standards that are suitable for multiple products. Certification used to be voluntary but is mandatory since 2021. One of these general standards is a standard for food and feed end/processed products (for example: the standard is valid for tomato paste, not for tomatoes). This standard includes food safety, such as the absence of microbiological pathogens and contaminants. Hence, all food and feed products made in Uganda, including BSFL products, need to adhere to these standards.

**Table 20. Specific requirements for dried insect products**

Parameter	Requirement			Test method
	Whole or ground insects (low protein)	Whole or ground insects (high protein)	Defatted insect meal	
per cent dry matter				
Energy, Kcal/100 g, min.	284.2	284.2		-
Moisture content, per cent, max.	13	13	13	US ISO 6496
Crude protein, min.	25	40	45	US ISO 5983-1
Fat, max.	40	30	12	US ISO 6492
Fibre, max.	17	17	20	US ISO 6865
Total ash, max.	15	15	20	US ISO 5984

Parameter	Requirement			Test method
	Whole or ground insects (low protein)	Whole or ground insects (high protein)	Defatted insect meal	
per cent dry matter				
Acid insoluble ash, max.	4	4	4	US ISO 5985
Calcium, max.	5	5	5	US ISO 6490-1
Phosphorous min.	0.6	0.6	0.6	US ISO 6491
Lysine, min.	1.0	2.4	1.0	US ISO 5510
Methionine, min.	0.4	0.7	0.4	ISO 13903
Zinc, max.	0.02	0.02	0.02	US ISO 6869
Manganese, max.	0.01	0.01	0.01	US ISO 6869

Source: UNBS, 2023

UNBS has started surveillance in trucks on roads and in supermarkets to check if food and feed products are certified. In a country with a large informal economy, this is quite a challenge. The supply of food to urban centres may reduce resulting in high food prices to urban consumers on one side, and the market or food items will decline among farmers resulting in lower producer prices. The Ministry of Trade has been trying to formalize the economy for the last ten years, according to UNBS, by supporting informal producers and promoting the UNBS standards to get them on board. If small-scale producers cannot afford to pay for the certification, they can organize themselves in groups and be certified as a group. UNBS is sure that standardization will boost demand for Ugandan products. Especially in export markets, Ugandan products will be recognized if they are certified.

### 5.5.1 Development of the BSF policy landscape in Uganda

This section provides challenges and opportunities for the development of the BSF policies in Uganda.

#### Challenges

Most challenges for policy development find their origin in the fact that BSF is a new value chain. Though the government entomologist and the representative of UNBS stated that there is political willingness for BSF, awareness on this value chain is still low within the government. Not all district entomologists have knowledge on BSF. Government officers should be made more aware of the potential of the sector.

According to one of the commercial BSF producers, other government institutions also do not know how to deal with BSF. This is related to the fact that there are almost no policies for BSF yet, on which they can base their standards.

*“NEMA IS NOT CLEAR ON THEIR TERMS OF ENGAGEMENT FOR BSF PRODUCERS. WHAT ARE THE MINIMUM CONDITIONS FOR A BSF FARM, WHAT ARE THE STANDARDS? THAT IS NOT CLEARLY DESCRIBED.” – COMMERCIAL BSF PRODUCER*

Furthermore, the process to get policies relevant for BSF (e.g., the animal feed bill, national livestock policy) approved is long and tedious, according to NARO. This is hindering the awareness and development of the value chain. According to NARO there are also “politics going on” in the development of the new policies.

Even if the government is more aware of BSF and has policies in place, introducing an innovation like BSF to communities requires patience. According to the entomologist at MAAIF, farmers will stop BSF production if it does not give results fast, only when they see they can profit from it, they will continue. Hence, if it does not work out in the beginning, they are not inclined to pick it up later. Perseverance and continuous awareness raising and training by district entomologists or others is thus key.

### **Opportunities**

When policies for BSF are developed they have the opportunity to create conditions for fair trade, quality assurance and capacity improvement of the BSF sector, according to the entomologist of MAAIF. Once a policy is in place it will give guidance to technology access (from abroad) and put in place opportunities for training and capacity building. Related to this, an off-taker adds that it is good to have regulations on drying BSF, so food safety risks are lowered.

Opportunities that commercial BSF producers and BSF off-takers see are tax exemption for BSF equipment and for waste collection/management. A reason for the tax exemption can be that BSF production is supporting environmental protection and the reduction of waste. A tax exemption would encourage people to get into waste management and the feed industry.

Waste is now not seen as a valuable input by the government, while it is for BSF production. NEMA should take this into account when doing its environmental impact assessments for BSF producers, according to one of the commercial BSF producers. Another commercial BSF producers adds that if NEMA and city or market authorities include waste segregation in their policies, it is easier for BSF producers to use the waste. Sensitization of the population to segregate waste should be part of this. According to one of the commercial BSF producers it is important that the government regularly sits down with actors in the BSF value chain to get input for policy development. Most of the actors in the core of the BSF value chain are positive towards this. Hence, it is an opportunity. In the meetings, BSF stakeholders should discuss: what should policies relevant for BSF look like? What should it govern?



## 5.6 Challenges and opportunities for BSF farming in Uganda

This section elaborates upon the main challenges and opportunities for BSF farming in Uganda. Special attention is given to challenges and opportunities for women and youth.

### 5.6.1 Challenges for BSF farming in Uganda

The main challenge in the BSF value chain is that though there is a high market demand for protein and frass (see opportunities in 5.6.2), sales of BSF products are low. This is especially the case for BSFL (wet and dry larvae), less for frass. The low sales of BSFL have several reasons, according to the (potential) off-takers and end-consumers spoken to: high prices, lack of consistent supply of BSFL in terms of quantity and quality, lack of de-fattened BSF products and lack of drying capacity among producers.

#### **High prices of BSF products**

Firstly, BSFL are overpriced compared to other sources of protein, according to the (potential) off-takers. The retail price of soy cake ranges from 2,500-2,700 UGX per kg. Enkejje (Sprat) costs approximately 2,000 UGX per kg and Mukene or Omena (Silver Cyprinid, Latin name: *Rastrineobola Argentea*) cost about 3,500 UGX per kg. They are even imported from Tanzania if the prices are lower there. The price for a kg of dry larvae is 4,000-4,500 UGX, which is about 37-45 per cent more than soy. Even though the protein and fat content of dry BSF larvae is higher than those levels in soy, which means that less kgs of dry larvae are needed to create a feed with the same levels of protein and fat as in a soy-based feed, the price difference is larger.

Potential off-takers state that, to become a suitable alternative for soy, the price of dry larvae should be lower. How much exactly is difficult to say as this depends on the protein (and fat levels) in the larvae as compared to soy, which are currently not consistent. One potential off-taker stated that the dry larvae must be sold at a much lower retail price than soya (half the price, suggesting a range of about 1,000-1,250 UGX per kg) as it is an alternative. This is contradicted by one of the BSF producers that state that the price of BSFL should actually be higher as it also contains amino acids and fat, so less other inputs are needed to produce a well-balanced animal feed.

#### **Low consistency (quality and quantity) of BSF products**

Secondly, the consistency of BSFL varies. All BSF producers spoken to feed their larvae on a market and kitchen waste, often in combination with other inputs (see section on BSF producers). Considering the diverse range of products in market and kitchen waste, its daily variety and the fact that BSF producers all have their own mix of inputs to feed the larvae, the

consistency of the BSFL varies in terms of size and nutritional value. For example, some respondents noted that larvae fed on mostly brewer waste do not grow very fast. Nevertheless, the UNBS standard for dried larvae only contains minimum requirements. So, one can argue that if BSFL meet these the quality is good enough.

In addition to this, most BSF producers in Uganda are small-scale and produce very small quantities of BSFL, of which most is used on their own farms. Most of the commercial BSF producers are more focused on training farmers and selling eggs or 5-DOL to them as opposed to creating a BSFL product for the (animal feed) market. Hence, the quantity of BSFL available on the market is small. The current BSF production seems suitable for small-scale farmers who use the BSFL as a protein supplement to their poultry, pigs or fish, but not for feed manufacturers that have much higher demands. One of the feed manufacturers who considers himself as not a very large producer, uses 100 tons of soy cake per month for animal feed concentrates. Defatted BSF would be 25-40 per cent of that, which means 25-40 tons per month. Another feed producer states that he currently uses 20 tons of soy cake, 18 tons of Enkejje and 3 tons of mini-shrimps per month to produce his feed. In this peak season this is even more.

BSF production is also seasonal. The quantity and quality of the BSFL and frass depends on the waste fed to them. As a consequence, not all small-scale BSF producers or end-consumers of eggs and 5-DOL have access to sufficient waste, especially in the dry season. Hence production of BSFL and frass is limited during this season, just like soy production.

Furthermore, most potential sellers of BSF products do not have a certificate of analysis which shows the nutritional contents of their products. One of the potential off-takers, for example, stated that the quantity of amino acids in dry BSFL is not assessed and thus nowhere mentioned, while it is important information for him. In addition, crop farmers would like to know the content of the frass and how it should be applied to their crops. BSF producers often do not have this information.

Off-takers also highlight that most BSF is not defatted. Non-defatted BSFL has a too high fat content, which is a challenge for the animal feed production and for prolonged storage. In addition, most of the BSF producers that sell BSFL, only sell wet larvae, which cannot be milled directly into feeds.

### **Lack of inputs to produce BSF**

BSF producers and off-takes face a lack of finance for equipment to dry or extract oil from BSFL, dry frass and/or grinding machines for the waste, and protective gear. Availability of low-tech and relatively cheap processing equipment that can be bought tax-exempt would be a solution for this according to them.

Small-scale BSF producers face some additional challenges. They do not have sufficient knowledge on BSF production, for instance on how to maintain the colonies (if they do full cycle) and what the best sources of waste are for a good nutritional profile. The lack of parent stock / 5-DOL to arrive on time is mentioned by them; there is no consistent supply. Aggregation and storage of BSF products is also an issue, even though production volumes are still low.

### **Waste issues**

BSF producers also mention challenges in relation to waste. Their most pressing challenge is the lack of sorting of waste. Organic waste (from markets) is often mixed with other types of waste (e.g., plastic, metal, and glass) that needs to be sorted by the BSF producers before it can be ground and fed to the larvae. Hence, there is a need for sensitization of market users about sorting waste. High transport costs to get the waste to the farm is another challenge. This is experienced by commercial farmers as well as small-scale farmers. One small-scale farmer uses a wheelbarrow to collect waste from the market; he would need a pickup truck to expand his production. In relation to this, some roads are of poor quality, which hampers the transport of waste. The smell of the waste and health risks are considered another challenge by BSF producers and their neighbours.

### **Lack of awareness and knowledge of BSF**

There is still a lack of awareness about the BSF among potential BSF farmers, but also among community leaders, in the government, among (potential) off-takers, and among formal financial services providers. According to BSF producers and off-takers many people still have the perception that BSF farming is dirty. They relate it to the larvae in the lavatories and think BSF can make them sick. Some also fear the flies and the larvae. Related to this, and already mentioned above is the lack of knowledge on how to do BSF production among small-scale farmers. More awareness raising and sensitization on (the benefits of) BSF, training in BSF production and establishment of demonstration farms to show communities and their leaders what BSF farming is, would be a solution. Related to this lack of awareness and the lack of knowledge is the lack of knowledge dissemination, which was mentioned by small-scale producers and the government. Though research has been done on BSF in Uganda and globally, the results of this do not reach (small-scale) BSF producers. Makerere University and NARO acknowledge this issue.

### **Lack of services**

Lack of services is also mentioned as a challenge for actors in the BSF value chain. These include lack of extension services (see also above), lack of availability of testing services as the lab is only in Kampala and for some tests samples need to be exported and the lack of financial services. As mentioned above and in section 5.2.1. small-scale BSF producers and off-takers do not have the financial means to buy equipment. The interest rate is often too high.

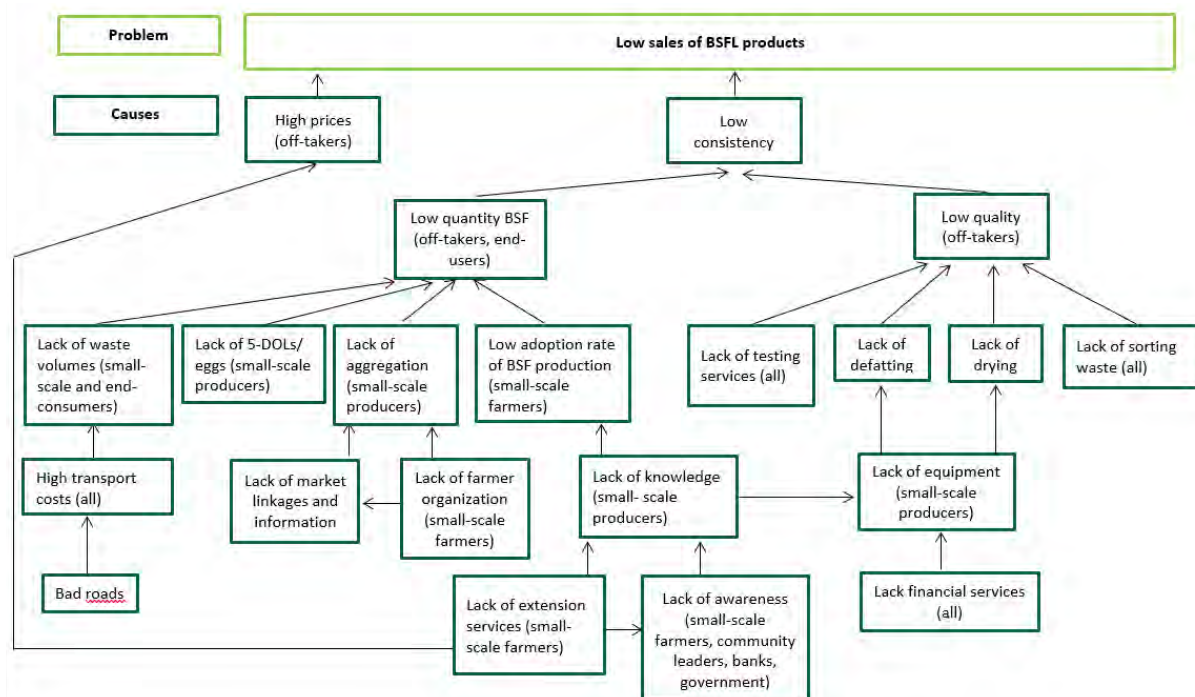
Commercial BSF producers state that most of their finance comes from abroad. Though banks have developed adapted financial products for certain target groups like women, youth or farmers (see section 5.2.2), this is not sufficient according to the interviewees. They would like loans with lower interest rates or tax exemption for BSF processing equipment.

### Lack of cooperation and value chain coordination

Related is the lack of cooperation and coordination of the BSF value chain. Though there are contacts between actors in the value chain, there is no coordination of the value chain present (see section 5.3.1). The lack of organization of small-scale farmers makes it difficult to increase production and to link the ones that want to sell BSF products to potential clients. If more farmers were organized in groups, they could also buy communal equipment, organize communal transport or create communal storage. Furthermore, some players also have a conflict of interest, as they are research centres but at the same time BSF producers.

Figure 18 shows a problem tree of the causes of the low sales of BSFL products, based on the above. The focus is on BSFL products (mainly: wet and dry larvae) and not so much on frass and eggs, because lack of sales of these products were mentioned as most pressing. Furthermore, Table 21 give a summary of the challenges mentioned above and for which actors they are relevant.

**Figure 18. Problem tree of causes of low sales of BSFL products in Uganda**



Note: In between brackets is mentioned which actors stated the cause.

**Table 21. Summary of challenges and for which value chain actors they are relevant**

Challenge	Small-scale BSF producer	Commercial BSF producer	Off-taker
Price BSFL is too high			x
Consistency BSFL is low (quantity and quality)			x
Lack of equipment	x	x	x
Lack of knowledge	x		
Lack of parent stock	x		
Sorting of waste	x	x	
Lack of waste	x		
High transport costs	x	x	
Smell of waste and health risks	x	x	
Lack of awareness	x		x
Lack of financial services	x	x	x
Lack of other services	x	x	x
Lack of VC coordination	x	x	x

### Specific challenges for youth

Youth are seen by some interviewees as a difficult target group to get interested in BSF production (or other agricultural activities). They are mainly interested in business where they have a quick and high return on investment (RoI), according to the government entomologist. Though the short life cycle of BSF allows for a relatively quick RoI, it takes trial-and-error and thus persistence to get the production up. Youth is lacking this, according to him.

Commercial BSF producers mention the lack of access to capital as a challenge specifically that young people face. Starting with BSF, whether it is as a commercial farmer or for a cost-reduction mechanism, requires start-up capital to buy crates/basins, wood for shelves, love cages and a starter kit. If this money is not available in terms of savings or an informal loan with family or friends, it will be hard for youth to get a formal loan because they lack a guarantee and do not have a credit history.

Though banks are trying to overcome this with specific loan products for youth (see section on formal financial service providers), it remains a challenge. Finally, lack of access to land is mentioned as a youth-specific challenge by the government, though the interviewee also stated that BSF farming does not require a lot of land.

### **Specific challenges for women**

Most of the challenges for women to become engaged in the BSF value chain, mentioned by the interviewees, are in line with the challenges for youth. Lack of access to finance and land are also mentioned as challenges for women, according to the same interviewees who mentioned these for youth.

An additional challenge is related to awareness raising among women and training them to start BSF production. Currently, interested farmers have to come to training centres of commercial BSF producers demo farms with government extension workers. As most women are bound by household chores in and around the farm, they are not able to come to the training, according to the government entomologist. A solution would be on-the-farm training, but there are not many of those yet.

Another women-specific challenges in the BSF value chain that were mentioned are related to gender norms. The interviewee from Makerere University stated that both waste collection and commercial BSF ventures are seen as a men's jobs. According to him, that is the reason why so few women are involved in these two stages of the BSF value chain.

### **5.6.2 Opportunities for BSF farming in Uganda**

The BSF value chain links to many other value chains, for instance the waste sector (as input/feed for BSFL), livestock keeping (BSFL being fed to poultry, pig, fish), crop farming (frass being used by for instance coffee farmers). It is, therefore, that opportunities can be found in various different directions. The main opportunities are mentioned here, and Table 22 gives an overview of which opportunities are relevant for which actors.

#### **High demand for protein and fertilizers**

Commercial BSF producers and the government entomologist see a high demand for protein and fertilizers in Uganda, especially in the poultry, fish and pig industry (BSFL) but also for coffee farmers (frass). In some seasons there is even a scarcity of protein, according to one of the off-takers. And, as one of the commercial BSF producers stated, there are currently high imports of animal feed, different types of protein and chemical fertilizers. BSF could therefore also contribute to import substitution.

The government entomologist even sees an opportunity for the export of BSF products in the medium term. A requirement for this is that BSF production needs to be expanded, in terms of quantity of produce and number of farmers who produce BSF products. To achieve this, the government should increase its training capacity and intensify mobilization of farmers for BSF, according to the government entomologist.

### **Innovative BSF products**

In addition, BSF can also be used for a range of new and innovative products. All mentioned were BSFL-related. One of the off-takers suggest that BSF producers focus on specialized animal feed (e.g., pet feed or starter feed for piglets and chicks), as the prices for these types of feed are less limited to existing market prices. At the longer term, the interviewee from Makerere University stated that soap or bio-diesel can be produced from by-products of BSF. This is of interest for the energy (bio-diesel) and the medical industry (soap made of BSF oil that has disinfecting characteristics). However, more research should be done on the production process. The largest commercial producer adds that BSFL break down aflatoxin. This means that their nutritional content and that of the frass that they produce do not have these high levels of aflatoxin anymore. This can have a huge implication for the maize industry in Uganda and in many other African countries, where a lot of maize is wasted due to the high levels of aflatoxin. The commercial BSF producer has recently started BSF production in Rwanda, where maize with high levels of aflatoxin is being sorted, to test this premise.

### **Reduction of organic waste**

BSF production has the potential to decrease organic waste considerably. BSF production can solve this issue. This will affect the price for BSF products, according to BSF producers and off-takers. If the availability of waste increases, the price of the waste will decrease and thus the price of BSF products, as waste collection is the largest cost to produce BSF on a commercial scale.

*"WE HAVE TOO MUCH ORGANIC WASTE. IT IS NOT USED, PILED UP AND IT BECOMES TOXIC WITH A LOT OF NITROGEN." – BSF OFF-TAKER*

*"WASTE IS GETTING VALUABLE BECAUSE OF BSF. SO, WASTE COLLECTION, AND THUS THE AVAILABILITY OF WASTE, WILL INCREASE." – COMMERCIAL BSF PRODUCER*

### **Create additional jobs and income**

There seems to be an opportunity to train more (small-scale) farmers on BSF production to create additional jobs, income and/or save costs. All commercial BSF producers have received grants for this purpose and the government is also training district entomologists to reach out to communities, though not all entomologists and communities are aware of BSF yet. In this way, experience with BSF in the country can grow.

### **Set-up of a BSF association or platform**

Two commercial BSF producers also state that there is an opportunity to set up an BSF association or stakeholder platform of people and organizations engaged in BSF. This will help to organize and coordinate the sector and disseminate knowledge.

**Table 22. Summary of opportunities and for which value chain actors they are relevant**

<b>Opportunity</b>	<b>Small-scale BSF producer</b>	<b>Commercial BSF producer</b>	<b>Off-taker</b>	<b>Government</b>	<b>Researcher</b>
High demand for protein and frass	x	x	X	x	
Innovative BSF products	x	x	x		x
Solve organic waste problem		x	x	x	
Additional jobs and income	x	x			
Set-up of a BSF association	x	x	x	x	x

### **Specific opportunities for youth**

Even though the government entomologists mentioned the RoI, lack of access to finance and land were mentioned as challenges, a commercial BSF producer and the representative of UNBS mentioned the same aspects as opportunities. When comparing BSF with other agricultural value chains, BSF requires little investment, has low operational costs, does not require a large piece of land and has a relatively quick RoI.

BSF is a new value chain and, generally speaking, youth want to get into new terrains, according to UNBS. A commercial BSF producer adds that the BSF value chain itself has several stages in which there are opportunities for youth, such as in production (as employees in commercial companies or at a small-scale level), in marketing and it even connects to waste collection. Especially the latter is seen as a good sector to create economic opportunities for male youth.

Furthermore, youth (and women) groups are good entry points for extension officers and commercial BSF farmers to reach out to communities to make them aware and train them on BSF. Via groups it is relatively easy to reach a large group of people quickly (quantity) and they are already organized (sustainability). Entering the community via these groups will directly benefit youth and women.

Finally, there are currently a lot of funds for youth employment and entrepreneurship in Africa, such as the Challenge Fund for Youth Employment and programmes of Mastercard Foundation to name a few. They fund organizations that create employment and entrepreneurship opportunities for youth. This creates a potential for actors in the BSF value chain to fund their activities to make youth aware and train them on BSF. Most of the commercial BSF farmers in Uganda already received grants from these types of funds. And it seems like that this opportunity will remain.



### **Specific opportunities for women**

Some of the opportunities mentioned for youth are also mentioned as opportunities for women by the same interviewees. These include the advantages of BSF when comparing it with other agricultural crops, which make it relatively easy to start with small-scale BSF production, and the entry points via women groups.

An additional opportunity for women is that small-scale BSF production can be easily achieved nearby the household's house. This makes it a very suitable economic activity for women, according to a commercial BSF producer and the government entomologist, they are often around the house and can easily combine it with their other chores.

Moreover, it gives women an additional source of income, if they sell the larvae or feed it to their chicken to grow them bigger and sell them for more money. This can even bring harmony at home as they can buy domestic items from their own resources.

Finally, just like there are funds available for youth employment, there are also funds available for women economic empowerment (e.g., Embassy funds). BSF can be a mean for this, according to one of the commercial BSF producers.

## 6. Synthesis

The two preceding chapters analyzed the BSF value chains in Kenya and Uganda, including the policy environment and challenges and opportunities to develop the value chains. In this chapter, a synthesis of the most important similarities and differences will be made. Though there are many similarities, generally speaking one can say that in most aspects of the Kenyan BSF value chain are further developed than the Ugandan one.

### **Core value chain actors**

The type of BSF value chain actors in both countries are relatively similar. Both countries have similar BSF production systems with many small-scale producers who predominantly use BSF as a cost-saving mechanism/strategy to increase their resilience and a limited number of commercial mid- and large-scale producers. All producers use a combination of fruits and vegetables in combination with other types of waste, of which the fruits and vegetables are mostly sourced from local markets (mid- and large-scale producers) or from kitchen waste (small-scale producers). BSF processing, drying BSFL or producing enhanced frass, is done by BSF producers themselves; so far, only a few feed millers use dried BSFL to process it to animal feed.

Relationships between value chain actors are often informal except for large-scale producers who have formalized relationships with their waste providers and off-takers. The presence of youth and women in both value chain is similar. However, the Kenyan BSF value chain is further developed. With more actors present in BSF production (an estimated number of 1,200 compared to 450-500 in Uganda) and more variation in terms of scale, level of professionalism (e.g., Sanergy being at the top-end in East Africa, no equal company is found in Uganda), level of specialization (e.g., a business that focuses on BSF-based dog food production, a business that focuses on enhanced frass production, a business that focuses on liquid BSF fertilizer production) and more small-scale producers being organized in producer groups.

Moreover, though interviewees in both countries mention the lack of cooperation and mistrust between actors in the BSF value chain, this seems to be a bigger issue in Kenya than in Uganda. A reason for this can be that the value chain is already developed further, hence that there is more competition between commercially oriented BSF producers and processors.

### **BSF production and sales**

Most sold BSF products in both countries are BSF eggs, 5-DOL, wet larvae, dried whole larvae, BSFL meal (on experimental basis and only by two or three producers) and frass. The consumers of the various BSF products are also similar: mainly small- and mid-scale animal farmers for BSFL, all sizes of crop farmers for frass, and BSF producers for BSF eggs, 5-DOL, 5-DOL and training on BSF. Nevertheless, in Kenya there is BSF-based dog food on the market,

which adds a different group of BSF consumers. Looking at the rough production estimates of BSF products in Kenya and Uganda that the consultants made, it becomes clear that in Kenya production is at a much higher level than in Uganda, see Table 23.

While wet larvae and frass production in Uganda is a bit more than half of Kenya's production, the difference between the two countries of dried whole larvae production is enormous. The main reason being that in Kenya there are some large-scale BSF producers that dry larvae, while in Uganda there are not that many.

**Table 23. Monthly and yearly BSF products production estimates in Kenya and Uganda**

	Kenya		Uganda	
	Monthly	Yearly	Monthly	Yearly
Eggs	unknown	unknown	7.7 kg	92.4 kg
5-DOL	unknown	unknown	5.2 tons	62.4 tons
Wet larvae	416.7 tons	5,000 tons	19.3 tons	231.6 tons
Dried whole larvae	514.25 tons	6,171 tons	1.5 tons	18 tons
Frass	800 tons	9,600 tons	44.8 tons	537.6 tons

*Note: This data should be treated carefully, as they are very rough estimates and based on many assumptions.*

Looking at the sales of BSF products, there is again a big difference between Kenya and Uganda for all BSF products, see Table 24. Uganda's estimated sales volumes of BSF products are almost 40 per cent of Kenya's.

**Table 24. Yearly estimated sales, prices and value of BSF products in Kenya and Uganda**

BSF product	Sales		Average price		Value (USD)	
	Kenya	Uganda	Kenya	Uganda	Kenya	Uganda
Eggs	unknown	32.4 kg	unknown	1.07 USD / gr	unknown	34,800
5-DOL	unknown	118 tons	unknown	5.37 USD / kg	unknown	96,660
Wet larvae	2,800 tons	29.4 tons	0.27 USD / kg	0.74 USD / kg	381,341	21,756
Dry larvae	726 tons	240 kg	0.85 USD / kg	1.14 USD / kg	617,978	273.60

BSF product	Sales		Average price		Value (USD)	
	Kenya	Uganda	Kenya	Uganda	Kenya	Uganda
Frass	9,600 tons	355.2 tons	0.27 USD / kg	0.30 USD / kg	1,961,185	106,560
<b>Total</b>	<b>13,126 tons</b>	<b>502.6 tons</b>	-		<b>2,960,504</b>	<b>260,040</b>

*Note: This data should be treated carefully, as they are very rough estimates and based on many assumptions.*

Table 24 also shows the estimated average prices of the various BSF products in USD. As can be seen from the table, the price for frass is quite similar in both countries. Wet and to a lesser extent dry larvae are much cheaper in Kenya than in Uganda. The average price of wet larvae is almost 2.8 times higher in Uganda than in Kenya! A reason could be that there is already more competition in Kenya than in Uganda and that prices of BSF in Kenya are competing with soy-bean meal and fishmeal while in Uganda BSF is not yet at a stage where it tries to compete with that market. However, these are merely speculations, and this should be researched more in depth to come to a more accurate conclusion.

Finally, looking at the roughly estimated production value, despite the higher prices for BSF products in Uganda, the value of Kenyan BSF products is more almost 11.5 times higher. This is because of the much larger sales volumes. This shows again that the BSF sector in Kenya is more developed than in Uganda.

*Note: It is important to note – again – that the figures in the table are all very indicative. They are rough estimations based on many assumptions. Therefore, these figures should be treated with caution.*

### **Support functions**

Looking at the BSF supporting functions, they are quite similar in both countries. There are a lot of research institutes that conduct research on BSF, while they are at the same time BSF producers. Research on BSF is further developed in Kenya than in Uganda, mainly due to the presence of ICIPE in Nairobi. . General formal and informal financial service providers are present in both countries, but none of them offers financial products tailored to BSF production.

In Kenya, however, it seems like there are more investors and donors engaged in BSF projects. Moreover, in Kenya a BSF association is already set up, though its outreach and impact are limited at the moment. In Uganda interviewees expressed the wish for a similar platform. Finally, in Kenya there are a couple of social enterprises that provide services (e.g., technical

training, finance) to (aspiring) BSF producers. Again, even though support functions in both countries are in an early stage, support functions in the Kenyan BSF sector seems to be ahead of the Ugandan. In both countries, the availability and lack of services for actors in the BSF value chain are similar. BSF technical training services are present, though they are often insufficient to build a successful BSF business.

There are NGOs that provide services to BSF producers, but these are not widely available. Financial service providers are there, but most BSF producers do not meet their requirements. There are limited standards and laboratories to test the BSF products. Finally, there is a need for a (stronger) sectoral association.

### **Policy environment**

Looking at the rules and norms environment, in both countries the Ministry of Agriculture, KEBS/UNBS and NEMA are the main government authorities that deal with the BSF value chain. Though in both countries there are standards for the use of insects (among which BSFL) in animal feed, Kenya additionally has a code of practice for insects in food and feed. In Uganda, however, a new animal feed bill is almost being passed through the Parliament that includes the use of insects in animal feed. Moreover, 'productive insects' (among which BSF) will be part of the new national livestock policy that is currently in development. Hence, it seems that in terms of policies Uganda is ahead of Kenya.

Despite these first steps, the main challenge in policy development in both countries is that BSF production is relatively new and still largely unknown to the government at all levels, from policy makers to governmental extension workers. Standardization of BSF production and products is lacking and hence it is challenging to develop policies for the entire sector. In addition, in both countries there is no (strong) sectoral BSF body to lobby for a more enabling policy environment. At the same time, the innovative and environmentally friendly character of BSF production (contribution to circular economy, reducing waste, adding an alternative source of protein) has opportunities to improve waste management (policies), and development of encouraging policies on organic fertilizers, quality standards, and tax advantages for BSF producers and processors.

### **Challenges and opportunities**

The challenges to develop the BSF value chain, to increase sales of BSF products and thus the profitability of BSF businesses, are quite similar in Kenya and in Uganda. The most important challenges being lack of consistent quality and supply, low production volumes and a high price for BSFL products (though the latter is debated by some actors). There are some differences between the countries, but these are gradual.

In Kenya the lack of access to sufficient waste seems more pressing than in Uganda, which could be explained by the lack of waste management, climatic conditions in certain areas and the fact that there are more and larger BSF producers active that require larger volumes of waste compared to Uganda. In addition, the lack of specialization is perceived as a bigger challenge. As there is more competition in the BSF value chain in Kenya, BSF producers are fighting for their place in the market system. Finally, the focus of donors and investors on a limited number of actors has made it more difficult for other players to develop. Though the consultants also see in Uganda that the number of BSF producers that are funded by donors is limited, this has not been mentioned in the interviews. This might also have to do with the fact that these commercial BSF businesses all train small-scale BSF producers. In Uganda, the lack of awareness and knowledge on BSF was more on the forefront than in Kenya. Again, a reason for this can be that the value chain is less developed than in Kenya.

The opportunities that the BSF sector has to offer in the two countries are also similar. Main opportunities are the contribution that BSF production can make to address the organic waste management issues in the two countries and to the large demand of protein and fertilizer. In addition, there are opportunities for innovative BSF products, ranging from specialized animal feed for pets, reptiles or starter feed, to the use of BSF oil for cosmetics or biodiesel. In Uganda, there was also the opportunity mentioned to set up a BSF association or platform.

Challenges and opportunities for youth and women to become active in the BSF value chain are also similar for both countries. The main challenges for both groups are considered to be access to capital, land and to a lesser extent knowledge. Regarding opportunities, the focus of donors on youth and women employment and entrepreneurship creates prospects for women and youth that want to become engaged in BSF. An additional opportunity for women in both countries is that BSF production at small-scale level can be done at the household farm and can easily be combined with household chores. Waste collection is mentioned as an opportunity for youth in both countries, especially for young men.

## 7. Recommendations

This study has attempted to give an overview of the BSF value chain in Kenya and Uganda at this moment. In this chapter, recommendations are made on how to further develop the value chain in Kenya and Uganda, including recommendations for policy development and recommendations for youth and women entrepreneurship and employment in the value chain.

### **BSF business models**

BSF production can be a solution to multiple problems. It reduces organic waste, produces an alternative protein source, organic fertilizer and it creates employment and/or additional income for the producer(s). However, the extent to which it creates a solution depends on the context.

As the study showed, BSF farming can be done in several settings, but it is important to **adapt the BSF production approach to the situation or context**. For instance, BSF can be done at small-scale. However, as stand-alone economic activity it might not be commercially viable, so it should be integrated in a resilient livelihood strategy with other agri-economic activities. In this case, the integration of BSF in other farming activities has several benefits that indirectly increase income of small-scale farmers. Firstly, it reduces the costs of animal feed and fertilizers by producing alternative protein and organic fertilizer and thus reduces the reliance on, and investment in, purchased inputs. Secondly, the use of BSF can increase yields in both animal and crop farming as was seen in sources and case-studies throughout this report.

Related to the above, BSF producers interviewed in this study mention benefits that BSF production and/or processing gave them, but at the same time it is not clear to what extent the various BSF business models the researchers have seen are viable and sustainable. Hence, **more research about the economic viability and sustainability of various BSF business models is needed**. The proof-of-concept study done by FAO and guided by F&S is a first step. However, this is a limited exercise as it includes only three business models and is only conducted in the Kenyan context. The development of a tool to calculate BSF business models at different scales and in different contexts can be helpful in this respect. It can be insightful for people who want to start with BSF production, whether it being with a commercial or a cost-saving/resilience incentive.

To boost the commercial part of the BSF value chain in Kenya and Uganda, it is important to find solutions for the low sales of BSF products. Hence, it is recommended to design and implement projects that aim at 'closing the gaps' and create market linkages. This can be done by **creating BSF product-market combinations that are commercially attractive**. This includes firstly a good understanding of the exact needs (e.g., quality requirements, volumes, standards, etc.) of potential BSF product consumers: animal feed producers, poultry, pig and

fish farmers (wet and dry larvae), household farmers (5-DOL, eggs) and crop farmers (frass). This study explored their needs in general, but a more detailed insight is required. In addition, a good understanding is needed of the exact value that BSF products can bring to the (potential) consumers and how these products can meet their needs. This means more research and testing to find the best diets for BSFL that lead to certain nutritional values of BSFL and frass, to develop of recipes for high-quality BSF-based animal feed products made with locally available ingredients and equipment, to get insight into the results of using BSFL and frass when feeding animals or growing crops (e.g., increase of size or volume), how to ensure product safety, etc. (see also research gaps mentioned in Chapter 4 and 5).

Most BSF producers and processors are currently involved in full-cycle BSF production, while it could be more beneficial to **specialize in part of the cycle** (e.g., breeding vs. maturing larvae vs. processing) as well as in end-products (e.g., frass, high quality dried larvae, niche markets for pet food and other animals, even within the animal food sector specialization in BSFL feed for young animals vs. adult animals and for layer hens vs. broilers etc.). Especially with the current prices and production volumes it seems that **targeting niche markets for BSFL products** could be a good strategy to increase sales. Though, as the above, more detailed research should be done to find out if this is really the case. Specialization in the value chain could furthermore create better market linkages for small- and mid-scale producers by setting up professional processing businesses or businesses that focus on aggregation.

The lack of affordable professional processing equipment is one of the largest challenges for mid- and small-scale BSF producers. Hence, it is recommended to devote attention to addressing this gap in future projects. This includes conducting more **research on (alternative) processing methods, prototyping, manufacturing and testing equipment locally, training local workers on building this machinery and training mid- and small-scale BSF producers on correct usage and handling of machines**. Additionally, this poses an opportunity for entrepreneurship and job creation and business cases can be developed and supported accordingly.

### **Awareness raising on BSF**

To develop the BSF value chain, **public awareness on BSF should be raised**, including its benefits such as how it can decrease costs for small-scale farmers and off-takers. This should be done at several levels. Potential BSF off-takers (e.g., animal feed producers) and consumers about the benefits of using BSF in their products (see above). Furthermore, awareness should be raised about sorting of (market) waste to make it easier for BSF producers to use the waste for their BSF production.

To create opportunities for women and youth employment and entrepreneurship in the BSF value chain, it is important that the **awareness raising activities and BSF training and knowledge reach women and youth**. Hence, approaching them via existing (VSLA) groups



would be an option or adapting the training locations (on-the-farm training) and times so it suits their availability. As there are many youth overrepresented as workers in commercial BSF farms at the moment, all efforts done to grow these businesses will increase opportunities for youth.

### **Capacity building**

As the BSF value chains in the two countries are evolving quickly, it is important to continue capacity building and knowledge dissemination. **Better knowledge dissemination** is needed to ensure that new and existing knowledge on BSF reaches all relevant stakeholders. BSF producers from both countries mentioned that they lack knowledge on BSF production and processing. At the same time, a lot of research is being conducted and manuals, guides, training tools, etc. are being produced. And (donor-funded) pilot projects are done. However, few of these research results, tools or lessons learned from projects are shared openly and/or presented in an accessible way for other BSF stakeholders. Additionally, more effort should be put in translating scientific research into practice. For example, via action research or action-based learning methods, where researchers and (small-scale) BSF producers do joint research and put it into practice. As commercial BSF producers often have more access to knowledge, this issue is extra pressing for small-scale producers.

**Improving the quality of training for BSF producers** is also important. High-quality training is another mean to disseminate knowledge and stimulate networking. This includes designing extensive training courses with different modules and levels that consider the realities of BSF rearing in Kenya and Uganda. Apart from more advanced knowledge on BSF, such training programs should include training on business, marketing, monitoring and record keeping. A vital part of any training program should be offering ongoing support and advice to BSF producers for a set period after the training is completed

### **Networking and coordination**

There is an urgent need for formal and informal ways to build capacity, enhance knowledge dissemination and experience sharing, increase networking and stimulate value chain coordination. To achieve this, linking value chain actors to each other is very important. The recommendations below give directions for that.

First of all, **organization of small-scale farmers** is not only easing awareness raising and capacity building on BSF, but also easing access to BSF knowledge and enhancing networking and experience sharing. Some of the respondents were keen to find out whether there are associations or associations that can be set up to support farmers in terms of BSF production, management, facilitation and marketing irrespective of the suppliers that are only there for business. In a later stage, farmer groups can play a role in BSF product aggregation, facilitation of access to finance, representation of the (small-scale) farmer's voice, etc. The main issue for

organizing farmers is to find a way to motivate them to form groups to cooperate for mutual benefits. This will take some time. An option could be to link access to BSF inputs and technical knowledge on the one hand and access to buyers on the other hand. Women or youth groups or VSLAs can play a key role as a base for farmer organization. An advantage of VSLAs is that they are supported by creditor loans via MFIs or banks.

**Better value chain coordination and dialogue between stakeholders** in the BSF value chain is needed to develop the sector. In Kenya this can be done via strengthening the Association for Insect Farming & Its Products; in Uganda an association/platform should be set up (see below). Value chain coordination should focus on:

- Development of strategies to increase awareness about BSF production (see above)
- Dissemination of new BSF knowledge and research findings among value chain actors, especially (small-scale) producers (see above)
- Dialogue between BSF producers and off-takers / end-consumers to create attractive BSF product-market combinations (see above)
- Discussions and lobby to the government on how to change policies to be more favourable for BSF producers and processors (see below)

A specific recommendation for Uganda is the **setting up of a nationwide BSF platform or association**. A stakeholder platform/association that includes BSF producers (commercial and grouped small-scale producers), waste providers, off-takers and relevant actors in supporting and rules and norms functions (e.g., research institutes, financial service providers, NGOs with BSF projects, MAAIF, UNBS can address the challenges that these actors face and improve dialogue among value chain actors and coordination of the value chain. This platform/association should have the aim to develop the BSF value chain by serving the interests of the value chain actors and making sure that more BSF products are put on the market that meet the demand of the off-takers and end consumers. This also includes lobbying to the government.

The formation of such a platform/association should be done very carefully, and good leadership of people who will finally lead the platform is key. As a start, the focus should be for the potential association/platform members to get to know each other, exchange experiences, and build relationships. It should be explored whether a shared vision for the chain already exists or can be built and how the different actors would want to realize this. The funding model of the platform/association should also be developed from its start. NGOs and the government should also be approached to see if they can play such a role in this and whether they are able to provide seed finance.

### Box 3: Possible interventions for FAO (for internal use only)

Based on the interviews and the recommendations above, the consultant team sees particular areas in which FAO could intervene. We believe that a Market Systems Development (MSD) approach is an appropriate approach to develop the BSF value chains. The MSD approach addresses the root causes of challenges and underperformance of, for example, BSF value chains and aims to create lasting changes with widespread impacts. It investigates the underlying causes of constraints that hinder people and organizations (e.g., producers, retailers) from effectively engaging in the system. With (existing) market players, including private sector and governmental entities, partnerships are developed, and viable business models are created to improve participation of marginalized people in the market system. The success of the MSD approach hinges on envisioning improvements for large numbers of people that sustain without continuous external interventions and driven by market players themselves. This is an important distinction from traditional projects that target specific beneficiaries rather than the holistic market system.

Specific possible interventions could be:

- Funding or conducting economic viability studies of BSF business models or BSF product-market combinations
- Support initiatives that aim at addressing gaps, promote specialization or create niche markets (e.g., locally manufacturing processing equipment, piloting communal drying facilities and commercial aggregation/outgrower schemes)
- Support and capacitate existing value chain actors (e.g., government) to speed up BSF awareness-raising activities, with a focus on awareness raising on youth and women
- Support with set-up (Uganda) and strengthening of BSF associations, including support to create a funding model for the associations
- Support financial service providers to give loans to BSF producers (e.g., modalities to decrease the risk for financial service providers)

In addition, an important recommendation to FAO is to actively share this report (or give the consultant team permission to share the report) with all interviewees and the wider BSF sectors in both Kenya and Uganda.

### Government involvement

There is a need for more government involvement in the two BSF value chain. Most challenges in the policy landscape are due to the fact that the BSF value chain is quite new, and people are not aware about it. Hence, an effort should be made to quickly make more **people in governmental bodies aware of the value chain, its benefits and opportunities.**

In addition, especially in the current state where there is competition between producers (more in Kenya than in Uganda) **a broker is needed to regulate the value chain.** The Ministries of Agriculture can play a role here, at the national level via policy development and at the local level via governmental extension workers who can train farmers on BSF production and thus work on scale up.

### **Access to finance**

Next to developing and proving different BSF business models, it is needed to support financial service providers to get into the BSF value chain. As only one BSF producer interviewed secured a bank loan, it should be looked into how financial service providers can make their **loan products more accessible to BSF producers**, specifically for women and youth. In the meantime, informal financial products, such as credit services of SACCOs and VSLAs, are opportunities to pursue.

Additionally, it is recommended to **diversify the donor-recipient portfolio to avoid donor darlings** and to maximize the impact on the whole value chain. So far, projects are often implemented with a handful of players in the industry, mostly large-scale commercial BSF producers, research institutes or social enterprises in BSF as local partners. Donors have set up projects to train small-scale farmers or community members on BSF production, often with a focus on youth and women. In addition, donors support a few commercial BSF producers with the set-up or expansion of their business (often in the form of a PPP). The focus on working with or via a few commercial BSF producers and social enterprises has helped them to further develop their BSF business, get more insight into how BSF works in East Africa and start with outreach to small-scale farmers in communities.

However, as a large part of the sector are small-scale producers' projects should focus on addressing their challenges to enable the full potential of the sector. Furthermore, often small-scale farmers in communities received subsidized or free starter kits and equipment without proper follow-up training. This has resulted in a situation where many have tried BSF production but did not manage to continue it, because they lacked proper support and/or motivation. We, therefore, recommend a Market Systems Development (MSD) approach to develop the value chain, whereby donors work on removing constraints and seizing opportunities for BSF producers (small-, mid-, and large-scale) so they are able to (better) engage in BSF production and harness the full potential of the sector. Depending on the specific constrain or opportunity could imply working with organizations in the supporting functions and/or rules and norms functions to remove a constraint/seize an opportunity for BSF producers.

As can be seen from the above, the recommendations (except one) are applicable to both Kenya and Uganda, as they address issues that are found in both countries. However, as Chapter 6 has shown, there are some gradual differences in the BSF value chains between the countries. Therefore, the consultant team has made a prioritization (top-5) of recommendations for both countries. However, keep in mind that the recommendations are at different levels. As can be seen from Table 25, there are differences in the priorities of the recommendations between the countries.

**Table 25. Top-5 prioritization of recommendations for Kenya and Uganda**

<b>Recommendation</b>	<b>Kenya</b>	<b>Uganda</b>
Adapt the BSF production approach to the situation or context.		
Conduct more research on the economic viability and sustainability of BSF business models	2	4
Create commercially attractive BSF product-market combinations that are (e.g., specialize in part of the cycle, targeting niche markets for BSFL products)	1	3
Raise public awareness on BSF, with a focus on women and youth		
Better knowledge dissemination	3	
Improve the quality of training for BSF producers		5
Organize of small-scale farmers		2
Better value chain coordination and dialogue between stakeholders	5	
Set up a nationwide BSF platform or association.		1
Raise awareness among government workers		
Make loan products more accessible to BSF producers	4	
Diversify the donor-recipient portfolio to avoid donor darlings		

## Annexes

### Annex 1: List of interviewed people

#### Kenya

Name organization	Type of actor	Remark
Sanergy	BSF producer, large	
F&S IF Nekesa Ltd.	BSF producer, mid	
Mzuri Organics	BSF producer, mid	
Mana Bio Systems	BSF producer, mid	
Hydro Victoria Fish & Insect Farm	BSF producer, mid	
Ololo Farm & Lodge	BSF producer, mid	
Biobuu	BSF producer, large	
Camlpo Ltd.	BSF producer, small	
Protein Master	BSF producer, mid	
Dudu Protein	BSF producer, small	
Mixa Feeds	BSF producer, small	
Kings World Youth Group	BSF producer, small	
Hilda Mwachiuri	BSF producer, small	
Jeffrey	BSF producer, small	
Jane Muruga	BSF producer, small	
Ann Njeri	BSF producer, small	
Isaac	BSF producer, small	
Dr. Chrystanus Tanga	Research	ICIPE
Linnet Gohole	Research	University of Eldoret
Dr. Elijah Museve	Research	JOUST
Charity Kelsey	Research	Egerton University/RESSECT
Laura Stanford	Off-taker	Loop Petfood
George Nyongese	End-user	Chicken farmer
Grace	End-user	Household farmer bought frass
Lea	End-user	Commercial pig farmer
Wycliff Omondi	End-user	Chicken farmer
Alex Kubasu	NGO	WWF
Marian Peters	Social Enterprise	New Generation Nutrition
Domitila Njoke	Government	Livestock department
Peter Mutua	Government	KEBS
Flamingo Youth Cleaners	Waste provider	Youth group waste collection
Richard	Waste provider	Market master Bahati Kiruma market

<b>Name organization</b>	<b>Type of actor</b>	<b>Remark</b>
Boniface and Abugo	Waste provider	Mwakulima market waste collectors
Maarten Hasselman	Financial Service	Truvalu Group
Roseanne Mwangi	Association of Insect Farming & Its Products	

## **Uganda**

<b>Name</b>	<b>Organization</b>	<b>Contact details</b>	<b>Location</b>
Mr. Musenero NASIF	Guide/ Extension / Student	+25677950698 8	Jinja City, Buikwe
Lawrence Vini Semaganda	Jinja Central Market	+25675641833 0	Jinja
Idah Mulungwa	Producer	+25675218318 3	Jinja
Keneene Daniel	Producer	+25670560220 3	Kayunga
Winfred	Ruharo Animal Feed	+25620099664 7	Jinja
Ayiko Eunice	Producer	+256 778348202	Kayunga
Kizito Ronald	Kizito Ronald	+25675162944 4/ 772629494	Jinja City
Mukyala Hasfa	Mukisa Group	+25675604123 2	Jinja City
Maria Wamala	Producer	+25677241515 6	Kayunga
Philp Boral	BSF off-takers	+25675276476 4	Jinja on phone
Mr. Sam Masawuli	Biyinzika Feeds Mill Manager	+25678841806 2	Kampala on phone
Fredson Ziebi Oyintubo	PKL, Protein Kapital Limited	+25677455300 / 0706790150	Wakiso
Ass Prof. Fred Kabi	Makerere University, Department of Agricultural Production	+25677256715 5	Kampala
Terjanian, James (FAOUG) and Coleages	FAO Uganda		Kampala

Name	Organization	Contact details	Location
Ssali Godfrey	Marula Proteen Wankoko	+25678805878 7	Kampala
Kayanja Nathan	Marula Proteen CURAD Namanve	+25670728226 4	Kampala
Dr. Kizito	Bulemezi Agrovvet Ltd	+25678329465 3	Kampala
Tusiime Muhangi	Commissioner of Entomology, Ministry of Agriculture Animal Industries and Fisheries	+25677266376 3	Entebbe
Omulangira Kitamirike	Ambercourt Market Jinja	+25675265384 6/0709700233	Jinja
Bella Katooro	Ento Feeds	+25677247903 9 / 0702479039	Buyikwe
Muganwa Lameke	Nsava Feeds	+25677245263 7	Mukono
Patrice Kasangaki	Program leader of Livestock Entomology Research	+25677269324 1	Wakiso, Nakisasa
Tommie Hooft	Marula Proteen	+25670596709 0	Jinja
Laurine Ndagire	Producer	+25675059858 0	Buyikwe
Kivumbi Dennis	Loans officer, Centenary Bank, Mukono Branch	+25677732035 6	Mukono
Hakim Mufumbiro	Uganda National Bureau of Standards	+25677251368 0	Jinja
Martin Tenwa	Ento Organic Farm	+25675954681 1/ 0780712322	Wakiso Kabanyolo
Dr Deborah Ruth Amulen	Centre for Insect Research and Development	+25678231563 6	Wakiso Kawanda



## Annex 3: Topic lists for interviews

### BSF producer

#### General questions

- Date of the interview
- Location of the interview and of producer itself
- Name organization
- Name respondent
- Position respondent
- Gender respondent
- Age respondent
- Phone number

#### Characteristics own organization

- Foundation year
- Size of BSF production area
- Number of employees (temporary and permanent/male and female)

#### BSF production

- What type of BSF products (wet larvae / dry larvae / frass / other BSF products) do you produce?
- How many kgs of wet BSF and frass do you harvest per month?
- Do you see a change (increase/decrease) in the productivity of your BSF in the past 5 years? What are the reasons for this?
- If you process BSFL how many kgs of processed BSFL do you produce per month?
- How much BSFL can you process on full capacity?

**DEEP DIVE ONLY** Could you describe the production process and the materials that you use?

**DEEP DIVE ONLY** If they process: Could you describe the processing process and the materials that you use?

**DEEP DIVE ONLY** What equipment (larger machines) do you use for this type of production?

**DEEP DIVE ONLY** What equipment (larger machines) do you use for this type of processing?

**DEEP DIVE ONLY** Are you satisfied with the quantity of BSF products (wet larvae / dry larvae / frass / other BSF products) that you produce? Why (not)?

**DEEP DIVE ONLY** Are you satisfied with the quality BSF (wet larvae / dry larvae / frass / other BSF products) that you produce? Why (not)?

**DEEP DIVE ONLY** Are you satisfied with the consistency of the BSF products that you produce? Why (not)?

## Inputs

- Do you buy inputs for the production/processing of BSF? What inputs do you buy? Where are they coming from?
- Do you have any problems getting these inputs? If yes, what are the main problems?
- What type(s) of waste do you use for the BSF production?
- How do you source the waste for BSF production?
- Why did you choose for this type of waste?
- What factors are important to consider regarding waste selection for BSF production?
- What type of waste do you believe to be the best for BSF production?

**DEEP DIVE ONLY** Where are (the best) local waste streams present in your area?

**DEEP DIVE ONLY** Are you satisfied with the quantity of waste that you use/buy? Why (not)?

**DEEP DIVE ONLY** Are you satisfied with the quality of the waste that you use/buy? Why (not)?

**DEEP DIVE ONLY** Are you satisfied with the consistency of the waste supply?

## BSF sales and market

- What part of your BSF products (wet larvae / dry larvae / frass / other BSF products) do you sell, estimation in percentage?
- How many BSF producers (estimation) are in your area?
- To whom do you mainly sell your BSF products (wet larvae / dry larvae / frass / other BSF products)?
- To whom do you currently not sell and would you like to sell to / who are potential new buyers? Why?
- What is the lowest / normal / highest price offered for BSF products (wet larvae / dry larvae / frass / other BSF products), per kg?
- Where do you sell (region/area) your BSF products (wet larvae / dry larvae / frass / other BSF products)?
- Do prices for BSF products (wet larvae / dry larvae / frass / other BSF products) differ in different areas? If yes, explain difference?
- Which are potential new markets (locations) for you?
- Do different markets have different requirements? If yes, could you give some examples?
- What is your annual turnover? / For small-scale producer: what is your net income from BSF and frass per year?

**DEEP DIVE ONLY** What is the trend (decline, increase) in your sales of BSF products (wet larvae / dry larvae / frass / other BSF products) in the past 5 years, per product?

**DEEP DIVE ONLY** How do you think that the sales of BSF products (wet larvae / dry larvae / frass / other BSF products) will change (decline, increase) in the coming 5 years, per product?

**DEEP DIVE ONLY** How do you think that the price for BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

## **Cost and margins**

**DEEP DIVE ONLY** What were your investment costs to get the farm up and running?

**DEEP DIVE ONLY** What are your operational expenses per month?

**DEEP DIVE ONLY** What is your biggest cost per month?

## **Credit**

- How did/do you finance your business?
- Did you get a loan from an MFI or bank?
- If yes, what type?

## **Characteristics key stakeholders BSF value chain**

- How would you describe the relations between the main stakeholders in the BSF VC?
- What actors have the most power in the BSF VC? How do they use and maintain this power? (e.g., market power, monopoly vs fair competition)
- Where are youth present in the value chain (under- or overrepresentation in certain parts of the value chain)?
- Where are women present in the value chain (under- or overrepresentation in certain parts of the value chain)?

## **Services**

- What organizations are there to support BSF farmers (e.g., research institutes, extension services, financial services, training on BSF farming and/or processing, packaging, transport)?
- Which services did you use?
- How do you perceive their services?
- Which support services would you like to use that are currently not available in the BSF VC?
- Do you feel these services are in high demand amongst fellow farmers?

## **Challenges and opportunities**

- What are currently your biggest challenges in relation to BSF?
- What would you need to overcome these challenges?
- What are the biggest challenges for youth who are engaged or want to become engaged in the BSF VC as BSF producers?
- What are the biggest challenges for women who are engaged or want to become engaged in the BSF VC as BSF producers?
- What are your biggest opportunities in relation to BSF?
- What are the biggest opportunities for youth who are engaged or want to become engaged in the BSF VC as BSF producers?

- What are the biggest opportunities for women who are engaged or want to become engaged in the BSF VC as BSF producers?

### **Policy landscape**

- Which governmental organizations have you dealt with as a BSF producer?
- What relevant activities does this governmental organization do (establish regulations, services, etc)?
- Which existing policies are relevant for BSF (think about quality standards, regulations, requirements, environmental licenses)?
- In what way are these policies relevant?
- Do you see any opportunities for policy development for the BSF VC?
- Have you encountered any challenges related to policy development for the BSF VC?

### **Finalization**

- Do you have any other questions?
- Do you have any data on the BSF VC? If yes, can you share it with us?
- Do you know other people we should speak to for this research? If yes, can you give us their contact details?
- Would you be interested to cooperate in a cost-benefit analysis and business case analysis done by FAO for your company?

### **OFF-TAKER**

#### **General questions**

- Date of the interview
- Location of the interview and or off-taker
- Name organization
- Name respondent
- Position respondent
- Gender respondent
- Age respondent
- Phone number

#### **Characteristics own business**

- Foundation year
- What services or products do you provide?
- Why did you decide to work/produce with BSF?
- When did you start incorporating BSF in your products?

## **BSF processing**

- What type of BSF products (wet larvae / dry larvae other BSF products) do you produce?
- How many tonnes/kgs of BSF products (wet larvae / dry larvae other BSF products) to you produce per month?
- How many kgs of BFSL do you process per month to make your end product (e.g., for every kg of feed, how many grams of BSF are needed)?
- How many kgs of BFSL can you process per month on full capacity?
- Who are your main BSF suppliers?
- What BSF products (wet larvae / dry larvae / frass / other BSF products) do you buy from them?
- For what price do you buy BSF products (wet larvae / dry larvae / frass / other BSF products), per kg?
- How many kgs/tonnes of BSF products (wet larvae / dry larvae / frass / other BSF products) did you buy in the past year?
- How many kgs/tonnes of BSF products (wet larvae / dry larvae / frass / other BSF products) did you use in the past year?
- How would you describe the relationship with your suppliers?
- Did you lend money to your suppliers/producers? If yes, how many suppliers and how much money?
- Do you provide 'free' services (such as advice, training, inputs, ...) to BSF producers?
- If you do not source from small-scale farmers, what are the main reasons?

**DEEP DIVE ONLY** Could you describe the processing process and the materials that you use?

**DEEP DIVE ONLY** What equipment (larger machines) do you use for this type of processing?

**DEEP DIVE ONLY** What aspects do you take into account when buying BSF products (e.g., price, protein content, fat content, consistency of supply, quantity)?

**DEEP DIVE ONLY** Are you satisfied with the quantity of BSF products (wet larvae / dry larvae / frass / other BSF products) that you buy? Why (not)?

**DEEP DIVE ONLY** Are you satisfied with the quality BSF (wet larvae / dry larvae / frass / other BSF products) that you buy? Why (not)?

**DEEP DIVE ONLY** Are you satisfied with the consistency of the BSF products that you buy? Why (not)?

**DEEP DIVE ONLY** Are you satisfied with the quantity of BSF products (wet larvae / dry larvae / frass / other BSF products) that you produce? Why (not)?

**DEEP DIVE ONLY** Are you satisfied with the quality BSF (wet larvae / dry larvae / frass / other BSF products) that you produce? Why (not)?

**DEEP DIVE ONLY** Are you satisfied with the consistency of the BSF products that you produce? Why (not)?

## Inputs

- Apart from the BSF, are there any additional inputs you buy to produce your product?
- Where do you buy them from?
- Do you have any problems getting these inputs? If yes, what are the main problems?

## BSF sales and market

- What part of your BSF products do you sell, estimation of percentage?
- How many BSF off-takers (estimation) are in your area?
- To whom do you mainly sell your BSF products (wet larvae / dry larvae / frass / other BSF products)?
- To whom do you currently not sell and would you like to sell to / who are potential new buyers? Why?
- What is the lowest / normal / highest price offered for BSF products (wet larvae / dry larvae / frass / other BSF products), per kg?
- Where do you sell (region/area) your BSF products (wet larvae / dry larvae / frass / other BSF products)?
- Do prices for BSF products (wet larvae / dry larvae / frass / other BSF products) differ in different areas? If yes, explain differences?
- Which are potential new markets (locations) for you?
- Do different markets have different requirements? If yes, which?
- What is your annual turnover?

**DEEP DIVE ONLY** What is the trend in your sales of BSF products (wet larvae / dry larvae / frass / other BSF products) in the past 5 years, per product?

**DEEP DIVE ONLY** How do you think that the sales of BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

**DEEP DIVE ONLY** How do you think that the number of BSF producers (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

**DEEP DIVE ONLY** How do you think that the number of buyers of BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

**DEEP DIVE ONLY** How do you think that the price for BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

## Costs and margin

**DEEP DIVE ONLY** Did you have any additional investment costs when incorporating BSF production? If yes, how much?

**DEEP DIVE ONLY** did you need additional finance when you incorporated BSF production?- If yes, what was the source? How much was needed?

**DEEP DIVE ONLY** what are your operational expenses for your BSF products per month?

**DEEP DIVE ONLY** What is the margin on your BSF products compared to other products that you sell (estimation: higher/lower)?

### **Characteristics key stakeholders BSF value chain**

- How are your relations with the end users of your BSF products (your clients)?
- If you have relations with other actors in the BSF VC, how are these relations?
- What actors have the most power in the BSF VC? How do they use and maintain this power? (e.g., market power, monopoly versus fair competition)
- Where are youth present in the value chain (under- or overrepresentation in certain parts of the value chain)?
- Where are women present in the value chain (under- or overrepresentation in certain parts of the value chain)?

### **Services**

- Where did you get your knowledge on BSF from?
- Are there organizations that supported you to incorporate BSF in your business?
- How do you perceive their services?
- Which support services would you like to use that are currently not available?
- Do you feel these services are in high demand amongst fellow off-takers?

### **Challenges and opportunities**

- What are currently our main challenges regarding BSF?
- What would you need to overcome these challenges?
- What are the biggest challenges for youth who are engaged or want to become engaged in the BSF VC as BSF off-takers?
- What are the biggest challenges for women who are engaged or want to become engaged in the BSF VC as BSF off-takers?
- What are your biggest opportunities in relation to BSF?
- What are the biggest opportunities for youth who are engaged or want to become engaged in the BSF VC as BSF off-takers?
- What are the biggest opportunities for women who are engaged or want to become engaged in the BSF VC as BSF off-takers?

### **Policy landscape**

- Which governmental organizations have you dealt with as a BSF off-taker? What relevant activities does this governmental organization do in relation to BSF (establish regulations, services, etc)?
- Which existing policies are relevant for BSF (think about quality standards, regulations, requirements, environmental licenses)?
- In what way are these policies relevant?
- Do you have any certificates, HACCP, other? If yes, which? Which do you want to obtain?
- Do you see any opportunities for policy development for the BSF VC?

- Have you encountered any challenges for policy development for the BSF VC?

### **Finalization**

- Do you have any other questions?
- Do you know other people we should speak to for this research? If yes, can you give us their contact details?
- Would you be interested to cooperate in a cost-benefit analysis and business case analysis done by FAO for your company?

### **END-USER**

#### **General questions**

- Date of the interview
- Location of the interview and of end-user
- Name organization
- Name respondent
- Position respondent
- Gender respondent
- Phone number

#### **Characteristics organisation**

- Foundation year
- Type of end-user (home user or commercial animal farmer)
- What services or products do you provide?

#### **Use of BSF products**

- Which BSF products do you buy?
- How many kgs/tonnes of BSF products (wet larvae / dry larvae / frass / other BSF products) did you buy in the past year?
- How many kgs/tonnes of BSF products (wet larvae / dry larvae / frass / other BSF products) did you use in the past year?
- How do you use BSF products in your business, per product?
- When did you choose to start using BSF products? And why?
- What has your experience been so far with using BSF products?
- How has the use of BSF products impacted your business? (e.g., reducing other inputs and thus costs, improving production)

**DEEP DIVE ONLY** What aspects do you take into account when buying BSF products (e.g., price, nutrient content, consistency of supply, quantity of supply)?

**DEEP DIVE ONLY** Are you satisfied with the quantity of BSF products (wet larvae / dry larvae / frass / other BSF products) that you buy? Why (not)?



**DEEP DIVE ONLY** Are you satisfied with the quality BSF (wet larvae / dry larvae / frass / other BSF products) that you buy? Why (not)?

**DEEP DIVE ONLY** Are you satisfied with the consistency of the BSF products that you buy? Why (not)?

### **BSF sales and market**

- From whom do you buy BSF products? For, per kg?
- Do prices for BSF products (wet larvae / dry larvae / frass / other BSF products) differ in different areas? If yes, can you explain differences?
- Do you communicate the use of BSF as a unique selling point for your products when you sell them to your clients?
- How many BSF end-users (estimation) are in your area?
- Who are your main clients?
- What is the price of the services or products that you provide?
- What is your annual turnover?

**DEEP DIVE ONLY** How do you think that the number of BSF end-users (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

**DEEP DIVE ONLY** How do you think that the number of buyers of BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

**DEEP DIVE ONLY** How do you think that the price for BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

### **Costs and margin**

**DEEP DIVE ONLY** has the use of BSF products impacted your profit margin? If yes, how?

### **Services**

- Where did you get your knowledge on BSF from?
- Are there organizations that supported you to incorporate BSF in your business?
- How do you perceive their services?
- Which support services would you like to use that are currently not available?
- Do you feel these services are in high demand amongst fellow end-user?

### **Challenges and opportunities**

- What are currently your main challenges regarding BSF?
- What would you need to overcome these challenges?
- What are your biggest opportunities in relation to BSF?
- What do you need to seize those opportunities?

## **Finalization**

- Do you have any other questions?
- Do you know other people we should speak to for this research? If yes, can you give us their contact details?

## **WASTE PROVIDER**

### **General questions**

- Date of the interview
- Location of the interview and of waste provider
- Name organization
- Name respondent
- Position respondent
- Gender respondent
- Phone number

### **Characteristics organisation**

- Foundation year
- Type of waste provider? (e.g., market, commercial food processor, farm)
- What services or products do you provide?

### **Waste**

- What types of waste do you produce?
- How much waste do you produce per month?
- What is your waste management approach?/What happens to the waste that is produced?
- Who buys/collects your waste?
- To whom would you like to sell/collect your waste?
- Do you sell/give waste to BSF producers? If so, which part of your organic waste do you sell/give to BSF producers? If not, why?
- How many tonnes is this per week/month?
- Do the BSF producers pay for the organic waste? If yes, what is the price per kg?
- To which BSF farmers do you give/sell your waste?
- How would you describe the relationship between your organisation and BSF producers?
- If any, from whom do you buy BSF products (wet larvae / dry larvae / frass / other BSF products)?

**DEEP DIVE ONLY** Do you know any other organisations in your area that produce organic waste?

### **Opportunities and challenges**

- What are currently your main challenges, in relation to your organic waste?
- What would you need to overcome these challenges?
- What are your biggest opportunities in relation to organic waste?
- What do you need to seize those opportunities?
- What role do BSF businesses play in addressing those challenges and opportunities?

### **Policy environment**

- Are there any laws or regulations that prevent you from selling/giving waste to BSF producers?

### **Finalization**

- Do you have any other questions?
- Do you know other people we should speak to for this research, including contact details?

## **BSF ASSOCIATION**

### **General questions**

- Date of the interview
- Location of the interview
- Name organization
- Name respondent
- Position respondent
- Gender respondent
- Phone number

### **Characteristics organisation**

- Foundation year
- Number of members (male, female, young male, young female)
- What services do you provide?
- To whom do you provide these services / whom are your main clients?
- What is the membership fee, per member per year?
- Which services that you provide are free of charge / partly subsidized or full paid by the user?
- How many people benefitted from your services / support? per cent women, per cent youth

## Market

- What BSF products (wet larvae / dry larvae / frass / BSF oil / BSF eggs / other BSF products) are currently on the market?
- Could you estimate national production volumes per BSF product?
- Where are the main markets for these BSF products?
- Do these different markets have different needs and requirements? If yes, which?
- What are the main buyers of BSF products?
- What is the demand for the BSF products (wet larvae / dry larvae / frass / BSF oil / BSF eggs / other BSF products), per product?
- What is the lowest / normal / highest price of BSF products (wet larvae / dry larvae / frass / other BSF products), per kg?

**DEEP DIVE ONLY** Are you satisfied with the quantity of BSF products (wet larvae / dry larvae / frass / other BSF products) that is produced? Why (not) ?

**DEEP DIVE ONLY** Are there differences between different regions in terms of quantity of BSF products? If yes, why?

**DEEP DIVE ONLY** Are you satisfied with the quality BSF (wet larvae / dry larvae / frass / other BSF products) that is produced? Why (not) ?

**DEEP DIVE ONLY** Are there differences between different regions in terms of quality of BSF products? If yes, why?

**DEEP DIVE ONLY** Are you satisfied with the consistency of the BSF product supply? Why (not)?

**DEEP DIVE ONLY** Are there differences between different regions in terms of consistency of BSF products? If yes, why?

**DEEP DIVE ONLY** What is the trend in sales of BSF products (wet larvae / dry larvae / frass / other BSF products) in the past 5 years, per product?

**DEEP DIVE ONLY** How do you think that the sales of BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

**DEEP DIVE ONLY** How do you think that the number of producers of BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

**DEEP DIVE ONLY** How do you think that the number of buyers of BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

**DEEP DIVE ONLY** How do you think that the price for BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

## Characteristics key stakeholders BSF value chain

- How would you describe the role of the association in the BSF VC?
- Has this role changed over the past years? If so, why?
- What is the association's vision for the sector?
- Has this vision changed over the past years? If so, why?
- How are the relations between the main stakeholders in the BSF VC?

- What actors have the most power in the BSF VC? How do they use and maintain this power?
- How does the system function around the BSF VC? (think about government services and laws, services of banks, market information, transport, research, etc). Probe: what is missing, what is functioning well?
- Where are youth present in the value chain (under- or overrepresentation in certain parts of the value chain)?
- Where are women present in the value chain (under- or overrepresentation in certain parts of the value chain)?

**DEEP DIVE ONLY** How does the landscape of BSF producers look like? Could you give a breakdown of small-, medium- and large-scale (in per cent) and where they are clustered?

**DEEP DIVE ONLY** How does the landscape of BSF off-takers look like? Could you give a breakdown of small-, medium- and large-scale (in per cent) and where they are clustered?

**DEEP DIVE ONLY** How does the landscape of end-users look like? Could you give a breakdown of small-, medium- and large-scale (in per cent) and where they are clustered?

### Services

- Which services (e.g., training on BSF farming, training on processing, transport, packaging) are there for BSF farmers and off-takers?
- Which support services are currently missing in the BSF sector?

### Opportunities and challenges

- What are currently the main challenges of the BSF sector?
- What is needed to overcome these challenges?
- Which organizations should help to overcome these challenges?
- What are the biggest opportunities of the BSF sector?
- What is needed to seize those opportunities?
- Which organizations should help to seize these opportunities?
- What role does the BSF association in overcoming those challenges and seizing those opportunities?
- What do you need to expand your organization?
- What are the challenges for youth who are engaged or want to become engaged in the BSF VC?
- What are the challenges for women who are engaged or want to become engaged in the BSF VC?
- What are the opportunities for youth who are engaged or want to become engaged in the BSF VC?
- What are the opportunities for women who are engaged or want to become engaged in the BSF VC?

### **Policy landscape**

- Which governmental organizations are relevant for the BSF VC?
- What relevant activities does this governmental organization do (establish regulations, services, etc)?
- Which existing policies are relevant for BSF (think about quality standards, regulations, requirements, environmental licenses)?
- In what way are these policies relevant?
- What are the main opportunities for policy development for the BSF VC?
- What are the main challenges for policy development for the BSF VC?

### **Finalization**

- Do you have any other questions?
- Do you have any data on the BSF VC? If yes, can you share it with us?
- Do you know other people we should speak to for this research? If yes, can you give us their contact details?

## **DONOR**

### **General questions**

- Date of the interview
- Location of the interview and of donor
- Name organization
- Name respondent
- Position respondent
- Gender respondent
- Phone number

### **Characteristics own organization**

- Type of donor (e.g., INGO, NGO, CBO)
- Foundation year
- Mission and vision of organization
- What services do you provide?
- To whom do you provide these services / who are your main beneficiaries?
- Which services that you provide are free of charge / partly subsidized or full paid by the user?
- How many people benefitted from your services / support? per cent women, per cent youth

### **Interest in BSF**

- What is your interest in the BSF sector?
- What is the role of your organization in the BSF sector?
- Do you have running projects on BSF? If yes:
  - How many?
  - Location of projects
  - What type of projects?
  - Partnerships with which (type of) BSF actors?
  - Main result of the project(s)?
  - Youth and gender component in project(s)?
- What is your opinion on how the BSF sector is functioning now? What is going well, what is missing?
- Which services (e.g., training on BSF farming, training on processing, transport, packaging) are there for BSF farmers?
- For what kind of support services (new or existing) would you like to use / have the highest demand in the BSF VC?

### **Opportunities and challenges**

- What are currently the main challenges of the BSF sector?
- What is needed to overcome these challenges?
- Which organizations should help to overcome these challenges?
- What are the biggest opportunities of the BSF sector?
- What is needed to seize those opportunities?
- Which organizations should help to seize these opportunities?
- What role do you see for yourself in overcoming those challenges and seizing those opportunities?
- What are the challenges for youth who are engaged or want to become engaged in the BSF VC?
- What are the challenges for women who are engaged or want to become engaged in the BSF VC?
- What are the opportunities for youth who are engaged or want to become engaged in the BSF VC?
- What are the opportunities for women who are engaged or want to become engaged in the BSF VC?
- What role do you see for yourself in overcoming the challenges and seizing the opportunities for youth and women?

## **Policy landscape**

- Which governmental organizations are relevant for the BSF VC?
- What relevant activities do these governmental organizations do (establish regulations, services, etc)?
- What are the main opportunities for policy development for the BSF VC?
- What are the main challenges for policy development for the BSF VC?

## **Finalization**

- Do you have any other questions?
- Do you have any data on the BSF VC? If yes, can you share it with us?
- Do you know other people we should speak to for this research? If yes, can you give us their contact details?

## **FINANCIAL SERVICES**

### **General questions**

- Date of the interview
- Location of the interview and of financial service provider
- Name organization
- Name respondent
- Position respondent
- Gender respondent
- Phone number

### **Introduction**

#### **Characteristics own organization**

- Foundation year
- Type of organization (e.g., MFI, bank, impact investor, VSLA / SACCO)
- What services do you provide?
- To whom do you provide these services / whom are your main clients?
- What is the price of the services that you provide?
- How many people benefitted from your services / support? per cent women, per cent youth
- What loan modalities do you have? (group/individual loan, duration loan, size loan, interest rates?)
- Do you have specific financial products for the agricultural sector / BSF producers / off-takers? If yes, what?
- Do you have specific financial products for youth or women? If not, why? If so, what are the different conditions of these products?



- What other financial services do you provide besides lending?
- How would you describe the relationships between you and your (BSF) clients?

### **Opportunities and challenges**

- Are there any specific challenges to provide financial services to BSF clients?
- What is needed to overcome these challenges? What do you expect from your potential clients to overcome these challenges?
- What can you do to overcome these challenges?
- Are there any specific opportunities to provide financial services to BSF clients?
- What is needed to seize these opportunities? What do you expect from your potential clients to seize these opportunities?
- What can you do to seize these opportunities?

### **Finalization**

- Do you have any other questions?
- Do you know other people we should speak to for this research? If yes, can you give us their contact details?

## **RESEARCHERS / RESEARCH INSTITUTIONS**

### **General questions**

- Date of the interview
- Location of the interview and of the researcher / research institute
- Name organization
- Name respondent
- Position respondent
- Gender respondent
- Phone number

### **Characteristics organization**

- Type of organization (e.g., university, independent researchers, research institute)
- Foundation year
- Type of research done on BSF

### **Market**

- What BSF products (wet larvae / dry larvae / frass / BSF oil / BSF eggs / other BSF products) are currently on the market?
- Could you estimate national production volumes per BSF product (wet larvae / dry larvae / frass / BSF oil / BSF eggs / other BSF products)?
- Where are the main markets for these BSF products?

- Do these different markets have different needs and requirements? If yes, which?
- What are the main buyers of BSF products?
- What is the demand for the BSF products (wet larvae / dry larvae / frass / BSF oil / BSF eggs / other BSF products), per product?
- What is the lowest / normal / highest price of BSF products (wet larvae / dry larvae / frass / BSF oil / BSF eggs / other BSF products),

**DEEP DIVE ONLY** Are there differences between different regions in terms of quantity of BSF products? If yes, why?

**DEEP DIVE ONLY** Are there differences between different regions in terms of quality of BSF products? If yes, why?

**DEEP DIVE ONLY** Are there differences between different regions in terms of consistency of BSF products? If yes, why?

**DEEP DIVE ONLY** What is the trend in sales of BSF products (wet larvae / dry larvae / frass / other BSF products) in the past 5 years, per product?

**DEEP DIVE ONLY** How do you think that the sales of BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

**DEEP DIVE ONLY** How do you think that the number of producers of BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

**DEEP DIVE ONLY** How do you think that the number of buyers of BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

**DEEP DIVE ONLY** How do you think that the price for BSF products (wet larvae / dry larvae / frass / other BSF products) will change in the coming 5 years, per product?

### **Characteristics key stakeholders BSF value chain**

- How would you describe the role of research (institutes) in the BSF sector? What can you contribute?
- How are the relations between the main stakeholders in the BSF VC?
- What actors have the most power in the BSF VC? How do they use and maintain this power?
- How does the system function around the BSF VC? (think about government services and laws, services of banks, market information, transport, research, etc). Probe: what is missing, what is functioning well?
- Where are youth present in the value chain (under- or overrepresentation in certain parts of the value chain)?
- Where are women present in the value chain (under- or overrepresentation in certain parts of the value chain)?

**DEEP DIVE ONLY** How does the landscape of BSF producers look like? Could you give a breakdown of small-, medium- and large-scale (in per cent) and where they are clustered?

**DEEP DIVE ONLY** How does the landscape of BSF off-takers look like? Could you give a breakdown of small-, medium- and large-scale (in per cent) and where they are clustered?

**DEEP DIVE ONLY** How does the landscape of end-users look like? Could you give a breakdown of small-, medium- and large-scale (in per cent) and where they are clustered?

### **Services**

- Which services (e.g., training on BSF farming, training on processing, transport, packaging) are there for BSF farmers and off-takers?
- Which support services are currently missing?

### **Opportunities and challenges**

- What are currently the main challenges of the BSF sector?
- What is needed to overcome these challenges?
- Which organizations should help to overcome these challenges?
- What are the biggest opportunities of the BSF sector?
- What is needed to seize those opportunities?
- Which organizations should help to seize these opportunities?
- What are the challenges for youth who are engaged or want to become engaged in the BSF VC?
- What are the challenges for women who are engaged or want to become engaged in the BSF VC?
- What are the opportunities for youth who are engaged or want to become engaged in the BSF VC?
- What are the opportunities for women who are engaged or want to become engaged in the BSF VC?
- What research gaps are there in relation to BSF?

### **Policy landscape**

- What is the objective of your organization in relation to the BSF VC?
- Which governmental organizations are relevant for the BSF VC?
- What relevant activities does this governmental organization do (establish regulations, services, etc)?
- Which existing policies are relevant for BSF (think about quality standards, regulations, requirements, environmental licenses)?
- In what way are these policies relevant?
- What are the main opportunities for policy development for the BSF VC?
- What are the main challenges for policy development for the BSF VC?

### **Potential regions**

**DEEP DIVE ONLY** What are the climatic conditions needed (humidity, temperature, changes in season, ?) for BSF rearing?

**DEEP DIVE ONLY** What are the best regions in Kenya for BSF farming? Why?

**DEEP DIVE ONLY** Where are (the best) local waste streams present?

**DEEP DIVE ONLY** Which type of waste is the best for production of BSF (quality larvae)?

### **Finalization**

- Do you have any other questions?
- Do you have any data on the BSF VC? If yes, can you share it with us?
- Do you know other people we should speak to for this research? If yes, can you give us their contact details?

## **GOVERNMENT**

### **General questions**

- Date of the interview
- Location of the interview and location of the government office
- Name organization
- Name respondent
- Position respondent
- Gender respondent
- Phone number

### **Characteristics own organization**

- Type of government organization
- What services do you provide?
- To whom do you provide these services / whom are your main clients?
- Which services that you provide are free of charge / partly subsidised / paid full by the user?
- For the (partly) paid services: what is the price?

### **Policy landscape**

- Which existing policies are relevant for BSF (think about quality standards, regulations, requirements, environmental licenses)?
- In what way are these policies relevant?
- Do different governmental institutions or different governmental levels have different responsibilities in relation to the BSF sector? If yes, what are the differences?
- What are the main opportunities for policy development for the BSF VC?
- What are the main challenges for policy development for the BSF VC?
- Do you see any particular challenges / opportunities for the BSF sector considering its newness / innovativeness?

### **Opportunities and challenges**

- What are currently the main challenges of the BSF sector?
- What is needed to overcome these challenges?
- Which organizations should help to overcome these challenges?
- What are the biggest opportunities of the BSF sector?
- What is needed to seize those opportunities?
- Which organizations should help to seize these opportunities?
- What role do you see for your organization in overcoming those challenges and seizing those opportunities?
- What are challenges for youth who are engaged or want to become engaged in the BSF VC?
- What are challenges for women who are engaged or want to become engaged in the BSF VC?
- What are opportunities for youth who are engaged or want to become engaged in the BSF VC?
- What are opportunities for women who are engaged or want to become engaged in the BSF VC?
- What role do you see for your organization in overcoming the challenges and seizing the opportunities for youth and women?

### **Finalization**

- Do you have any other questions?
- Do you have any data on the BSF VC? If yes, can you share it with us?
- Do you know other people we should speak to for this research? If yes, can you give us their contact details?

## Annex 4: Fieldwork planning

### Kenya

Location	Date	Activities
<b>Phase 1</b>		
Nairobi	June 7	Kick-off fieldwork meeting with FAO
Nakuru	Jun 12	Drive to Nakuru
		Interview Ann and Isaac
Nakuru	June 13	Interview + observation Geoffrey Murira
		Interview + observation Jane and women group
Nakuru	June 14	Interview Peter (off-taker frass)
		Interview Grace (end-user frass)
		Interview + observation RESSECT
		Interview + observation Boniface and Abugo (waste collection)
	June 15	Interview + observation Calmpo Ltd.
		Interview Flamingo Youth Group (waste collection)
Eldoret	June 15	Drive to Eldoret
		Interview + observation F&S Insect Farms Nekesa Ltd.
Eldoret	June 16	Interview + observation Mzuri Organics
		Interview + observation Bahati Kirumu Market
		Interview + observation Leah (end-user)
		Interview + observation George Nyongese (end-user)
Eldoret	June 17	Interview Eldoret University
		Drive to Kisumu
Kisumu	June 19	Interview + observation Mixa Farms
		Interview Hydro Victoria Fish & Insect Farm
Kisumu	June 20	Interview + observation JOOUST
		Interview + observation Kings World Youth Group
		Interview Wycliff Omondi (end-user)
		Interview + observation Dudu Protein
Kisumu	June 21	Drive to Nairobi
Nairobi	June 26	Interview Sanergy
Nairobi	June 27	Interview Loop Petfood
		Interview Ololo Lodge & Farm
Nairobi	June 28	Interview Protein Masters
Nairobi	June 29	Interview + observation Mana Bio Systems
<b>Phase 2</b>		
Nairobi	August 3	Interview Association for Insect Farming & Its Products
Mombasa	August 4	Interview WWF

Location	Date	Activities
Nairobi	August 18	Interview Truvalu
Mombasa	August 21	Train to Mombasa
	August 22	Interview + observation Biobuu Interview + observatoin BSF producer Paul and family
Mombasa	August 23	Train to Nairobi
Nairobi	September 4	Interview KEBS
Nairobi	September 5	Interview Ministry of Agriculture
Nairobi	September 6	Interview ICIPE
Nairobi	September 11	Interview Marian Peters NGN

## Uganda

Location	Date	Activities
Jinja City and Buikwe	21-Jun	Interview Mr. Musenero NASIF (Guide/ Extension / Student)
Jinja	21-Jun	Interview Lawrence Vini Semaganda (Jinja Central Market)
Jinja	21-Jun	Interview Idah Mulungwa (Producer)
Kayunga	21-Jun	Interview Keneene Daniel (Producer)
Jinja	22-Jun	Interview Winfred (Ruharo Animal Feed)
Kayunga	22-Jun	Interview Ayiko Eunice (Producer)
Jinja City	22-Jun	Interview Kizito Ronald (Producer)
Jinja City	22-Jun	Interview Mukyala Hasfa (Mukisa Group)
Kayunga	23-Jun	Interview Maria Wamala (Producer)
Jinja on phone	23-Jun	Interview Philp Boral (BSF off-takers )
Kampala (phone)	23-Jun	Interview Mr. Sam Masawuli (Biyinzika Feeds Mill Manager)
Wakiso	26-Jun	Interview Fredson Ziebi Oyintubo (PKL, Protein Kapital Limited)
Kampala	26-Jun	Interview Ass Prof. Fred Kabi (Makerere University--Department of Agricultural Production)
Kampala	26-Jun	Interview Terjanian, James (FAOUG) and Coleages (FAO-Uganda)
Kampala	27-Jun	Interview Ssali Godfrey (Marula Proteen Wankoko)
Kampala	27-Jun	Interview Kayanja Nathan (Marula Proteen CURAD Namanve)
Kampala	27-Jun	Interview Dr. Kizito (Bulemezi Agrovvet Ltd)
Entebbe	27-Jun	Interview Tusiime Muhangi (Commissioner of Entomology, Ministry of Agriculture Animal Industries and Fisheries)

Location	Date	Activities
Jinja	28-Jun	Interview Omulangira Kitamirike (Ambercourt Market Jinja)
Buyikwe	28-Jun	Interview Bella Katooro (Ento Feeds)
Mukono	28-Jun	Interview Muganwa Lameke (Nsava Feeds)
Wakiso, Nakisasa	28-Jun	Interview Patrice Kasangaki (Program leader of Livestock Entomology Research)
Jinja	29-Jun	Interview Tommie Hooft Alex (Marula Proteen)
Buyikwe	29-Jun	Interview Laurine Ndagire (Producer)
Mukono	29-Jun	Interview Kivumbi Dennis (Loans officer, Centenary Bank, Mukono Branch)
Jinja	29-Jun	Interview Hakim Mufumbiro (Uganda National Bureau of Standards)
Wakiso Kabanyolo	30-Jun	Interview Martin Tenwa (Ento Organic Farm)
Wakiso Kawanda	30-Jun	Interview Dr Deborah Ruth Amulen (CIRD)



## Annex 5: Calculations regarding BSF production and sales in Uganda

**Table 26. Production estimates of active commercial BSF producers, per month**

	Producer	Producer 2	Producer 3	Producer 4	Total
Eggs	1-2 kg Av. 1.5 kg	1 kg	1.1-1.3 kg Av. 1.25 kg	1.5 kg	5.2 kg
5-DOL	2.4-3.3 tons Av. 2.85 ton	1 ton	?	1-1.5 ton 1.25 ton	5.1 tons
Wet larvae	No	1.2 tons	2.1 tons	No	3.3 tons
Dry larvae	Infrequent	No	1.1 tons	No	1.1 tons
Frass	20 tons	4.5 tons	4.3 tons	No	28.8 tons

**Table 27. Production estimates of interviewed small-scale BSF producers, per month**

	Farmer 1	Farmer 2	Farmer 3	Farmer 4	Farmer 5	Farmer 6	Average
Eggs	20-53 gr	No	?	?	No	No	5 gr
5-DOL	625-1,320 gr	?	?	?	?	No	160 gr
Wet larvae	15 kg	20 kg	50-70 kg Av 60 kg	300 kg	?	90 kg	80 kg*
Dry larvae	30 kg	No	No	yes	30 kg	No	10 kg*
Frass	27-43 kg 30 kg	?	40 kg	10 kg	?	30 kg	18.3 kg*

\* In the calculations other averages are used. See assumptions

**Table 28. Sales and prices estimates of BSF products**

BSF product	per cent sold	Price range	Price taken for calculations
Eggs	Commercial: 33-60 per cent. Av: 50 per cent Small-scale: 5 per cent	1,200-1,500 UGX per gr start-up 2,500-10,000 UGX per gr normal	4,000 UGX per gr (1.07 USD)
5-DOL	Commercial: 30 per cent Small-scale: 5 per cent	20,000 UGX per kg (starter kit)	20,000 UGX per kg (5.37 USD)

BSF product	per cent sold	Price range	Price taken for calculations
Wet larvae	Commercial: 36-70 per cent. Av: 50 per cent Small-scale: 5 per cent	2,000-3,500 UGX per kg	2,750 UGX per kg (0.74 USD)
Dry larvae	Commercial: 0 per cent Small-scale: 5 per cent	4,000-4,500 UGX per kg	4,250 UGX per kg (1.14 USD)
Frass	Commercial: 100 per cent Small-scale 5 per cent	980-1,200 UGX per kg	1,100 UGX per kg (0.30 USD)

### Assumptions and remarks

- When a production range was given in the interview, the average is used.
- A study of Abro et al (2022) showed a much lower yearly average BSF production: 4 kg of wet larvae for small-scale farmers, 25 kg for mid-scale farmers and 27 kg for large-scale farmers. For the commercial BSF producers the consultants have chosen to keep the data collected during the fieldwork for the production and sales calculations. The commercial BSF producers do record keeping and having seen the production facilities, the production data they gave in the interviews seem correct. For the small-scale BSF producers, the consultants have chosen to calculate the wet larvae and dry larvae based on the sales of the eggs and 5-DOL of the commercial farmers.
  - Wet larvae: commercial farmers sell 2.6 kg of eggs per month (50 per cent of 5.2 kgs) and 1.5 tons of 5-DOL (30 per cent of 5.1 tons). 2.6 kg of eggs produces app. 5 tons of wet larvae (1 gr of eggs become 2-3 kg wet larvae, we used 2 kg) and 1.5 tons 5-DOL app. 6 tons of wet larvae (1 kg of 5-DOL grow 5 kgs of wet larvae, we used 4 kg). In addition, farmers who do full-cycle BSF produce (based on our data collection) 5 gr of eggs per month. That is 10 kgs of wet larvae per month times 500 farmers is 5 tons per month. That means that all small-scale farmers jointly produce about 16 tons of wet larvae per month, of which 1 ton is used to dry (see below).
  - Dry larvae: there are not that many small-scale farmers that dry BSF. The consultant team has therefore estimated that 1 ton of wet larvae with an average moisture content of 60 per cent is dried. This will become 400 kgs of dry larvae.
  - Frass: the average larvae-frass ratio is 1:1.2. The consultants lowered this to 1:1 because BSF production is often not optimized. Hence that means that jointly, small-scale farmers produce 16 tons of frass per month
- For the production data of BSF eggs and 5-DOL of small-scale farmers, the consultant team has chosen to use the average of the data collected during interviews and multiply this by the estimated number of 500 small-scale BSF producers.
  - BSF eggs: average production is 5 gr times 500 producers is 2.5 kgs.

- 5-DOL: average production is 160 gr times 500 producers is 800 kgs or 0.8 tons.
- The percentage of commercial BSF products sold was calculated based on data collected in interviews with commercial BSF producers.
- The only commercial BSF producer that produced dry larvae is bulking them, so sales are 0 per cent.
- The percentage of the BSF products sold by small-scale farmers is based on an assumption of the consultant team. Small-scale BSF producers sell little of their BSF produce, therefore, the consultants took an average of 5 per cent for all BSF products.
- The price range was made based on data on data collected in interviews with BSF producers.
- The exchange rate to calculate the price to USD is 1 UGX = 0,00027 USD (August 22, 20223).

## 8. Notes

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