CLIMATE & CLEAN AIR COALITION TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

PREVENT Waste Alliance

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Is Black Soldier Fly waste-processing a sustainable solution?

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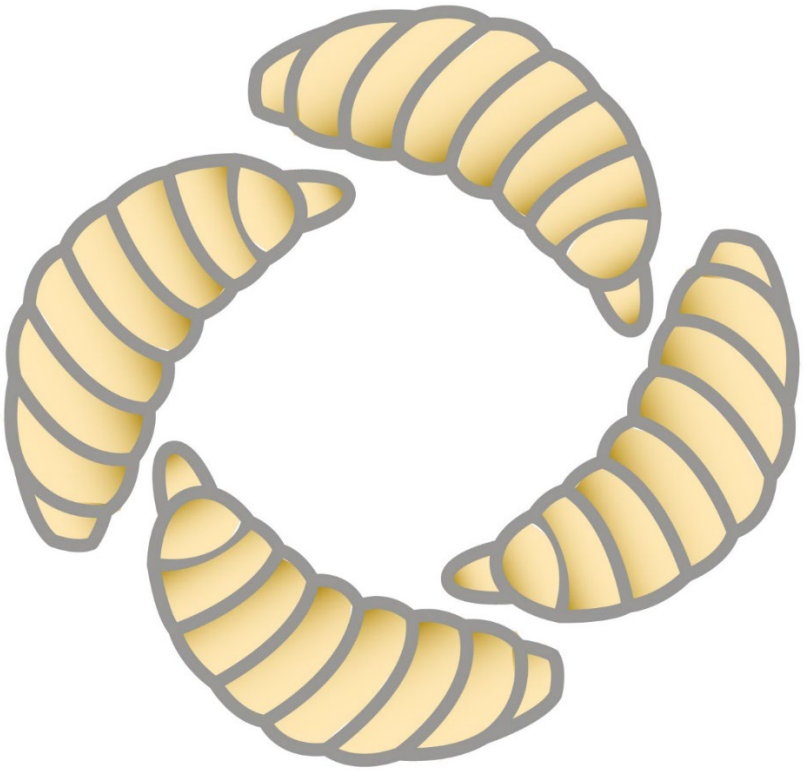
A feasibility assessment approach



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METHODOLOGICAL GUIDANCE

This guide helps with conducting a feasibility study to assess the opportunities and challenges, of BSF waste processing in a selected spatial region based on:

1. Legislation & Institutional barriers and opportunities;
2. Substrate quality, availability and accessibility;
3. Management and operational aspects;
4. Market opportunities and barriers.

It provides guidance and tools to conduct a rapid feasibility assessment, so that challenges and opportunities for waste-based BSF farming, considering different scales and business models, can be evaluated.

The time effort to conduct such a feasibility assessment is estimated to take 10-15 days of FTE (full time equivalent). This implies data collection by utilizing mostly secondary (document) resources as well as interviews with key stakeholders.

Step 0	**Define the spatial region for which the feasibility assessment shall be conducted.** The smaller and more clearly defined the area is, the more accuracy can be obtained in the assessment.

1. Legislation & Institutional barriers and opportunities

Step 1-1	Evaluate existing policies, legislation, by-laws, rules, regulations that affect BSF facilities and operations, either positively or negatively based on ANNEX 1-1

- Identify key interview partners that are familiar with legislation and institutional affecting BSF waste processing either located in the different ministries and or engaged in BSF operations.
- Conduct interviews with selected key informants according to Annex 1-1 questionnaire template
- In each interview ask the current interviewee for names and contact of other possible key informants that might have insight on policies, legislation, by-laws, rules, regulations legislation that affect BSF facilities and operations

Laws and regulations may affect BSF operations and markets. These are typically set and enforced by various regulatory bodies depending on their scope (e.g. food safety, building permits and emissions, veterinary, environment, agriculture and business development authorities).

National laws and regulations will affect BSF operations and markets at country-scale. However the feasibility assessment should also consider specific local governmental rules and regulations.

Farming and Feed: Farming of BSF larvae (and other insects) may fall into the same category of regulations that apply to other farmed animals that are bred for animal or human consumption.

Examples of possible authorities (and possible interview partners) regulating such aspects could be:

- Ministry of Agriculture, Animal Industries, Forestry, and Fisheries
- Food and Drug administration or Food Agency
- Ministry of Environment
- Ministry of Health, Department of Public Health
- Bureau of Standards

Waste management and circularity: Operating BSF as a waste-processing and management approach may further be influenced by legislation specific to waste management.

Examples of possible authorities regulating such aspects could be:

- Local waste management department
- Local government/municipality
- Ministry of Environment
- Ministry of Urban Development and/or Public Works
- Ministry of Energy

Climate Mitigation: Given the potential of BSF-operations to contribute to reducing GHG emissions, policies and legislation relevant to country pledges under the Paris Agreement may also affect BSF feasibility. Examples of possible authorities regulating such aspects could be:

- Ministry of Environment
- Ministry of Energy

Business and Innovation: BSF operations, as an innovative business opportunity, may further be affected by legislation regulating new business areas, markets and overall socio-economic development plans. Examples of possible authorities regulating such aspects could be:

- Ministry of Trade
- Ministry of Science & Technology
- Ministry of Finance
- Ministry of Agriculture
- Local Government
- Ministry of Public Health
- Ministry of Gender Issues

Step 1-2	**Evaluate the "Ease of Doing Business Index".** Explore the topics and respective indicators and the scores given to the country of concern. Enter score of categories into ANNEX 1-2. Comment on how these categories and indicators and respective scores may affect BSF waste processing businesses. Pay special attention to indicators that score low and evaluate how these might affect BSF activities negatively.

The "Ease of Doing Business Index" ranks country economies from 1–190 by aggregating scores on 10 topics, each consisting of several indicators which describe how conducive the regulatory and institutional environment is with regard to starting and operating a local firm. The score and rankings are compiled by the World Bank at https://archive.doingbusiness.org/en/data/doing-business-score?topic=starting-a-business . The topics covered are:

1. Starting a business
2. Dealing with construction permits
3. Getting electricity
4. Registering property
5. Getting credit
6. Protecting minority investors
7. Paying taxes
8. Trading across borders
9. Enforcing contracts
10. Resolving insolvency

2. Substrate quality, availability and accessibility

The rearing substrate is the waste that is used to rear young larvae until they are harvested as grown larvae. Substrates for BSF rearing can include any organic material containing nutrients, such as protein, carbohydrates and fat, which are digestible by BSF larvae. However: i) the country legal framework may restrict the use of some substrates to use as BSF larvae feed; ii) some substrates with low nutrient levels may result in limited larval growth or a need a longer feeding duration which may negatively affect financial feasibility of BSF farming.

BSF larvae have particularly good growth on substrates that are high in digestible nutrients such as protein (>10% dry mass), non-fibrous carbohydrates (e.g., starch and glucose; 20-30% dry mass), fat (10-15% dry mass), and low in indigestible fibers (e.g., hemicellulose, cellulose and lignin) and ash. Often a combination of different substrates may be beneficial to provide a well-balanced diet for the larvae. Nutritional content of the substrate also affects the nutritional composition of the BSF larvae (product).

First main "exclusion criteria" when evaluating possible substrates is to know how legislation affects the possible use of this substrate type. If laws exist that prohibit feeding of certain substrates to larvae, then these should be discarded from the assessment (see section A).

Choice of legally allowed substrates for BSF farming is typically a trade-off between different attributes of the substr ate such as: nutritional quality, safety, purity, amounts available, seasonality, competition of demand, logistical effort of procurement, costs, and environmental benefits.

Table 2-1: Examples of most common waste sources and types of waste used for BSF farming

Sources	*Description*	*Waste types*
Agro-industry		
- Food Processing Industry:	Production of food products from raw agricultural materials. Examples include canning and preserving, , bakeries, candy factories, milling of grains into flour, and cocoa processing, etc.	Organic waste side streams of the production process
- Beverage Industry:	Involves the production of various beverages, including soft drinks, fruit juices, alcoholic beverages, and tea and coffee processing	Fruit and Vegetable Pulp: Brewery Waste (spent grains, etc.): Coffee Grounds: Alcoholic Beverages (distillery residues byproducts such as spent grains, vinasse, or distillery slops): Unused or expired products
- Dairy Industry:	Dairy processing involves the production of milk, cheese, yogurt, butter, and other dairy products.	Milk residues: Unused or expired products: Byproducts from cheese production:

- Sugar Industry:	Sugar mills process sugarcane or sugar beets to produce sugar, molasses, and other byproducts.	Bagasse: Molasses: Filter Cake:
- Vegetable Oil Industry:	Processed oilseeds (soybeans, sunflower seeds, avocado, olive, and palm fruits)	Oilseed Cake/Meal: Other byproducts
- Meat and fish processing industry:	Meat and fish processing plants such as slaughterhouses	Blood Bones: Offal: Rumen content: Feathers and Hair: Fat: Manure: Whole carcasses:
- Biofuel Industry:	Production of biofuels such as biodiesel and bioethanol	Agricultural crop residues like corn or oilseeds
- Floral and Ornamental Plants Industry:	Cultivation and trade of flowers and ornamental plants for decorative purposes and landscaping.	Flowers and ornamental plant residues
Food wholesale and retail		
- Vegetable and Fruit markets	Central wholesale or retail of fruit and vegetables	Expired or spoilt food items, vegetables and fruit
- Supermarkets	Food retail	Expired or spoilt food items, vegetables and fruit
Hotel, restaurant and catering (HORECA) industry		
- Restaurants	Discarded food	Kitchen and food waste
- Hotels	Discarded food	Kitchen and food waste
- Canteens	Discarded food	Kitchen and food waste
Household waste		
- Households	Segregated household organic waste	Kitchen and food waste Garden waste
Agricultural production		
- Crop cultivation		Spoilt crops Crop residues (i.e., bagasse)
- Animal husbandry		Manure: Non-marketable eggs: Male chicks:
- Aquaculture	Residue from farmed fish (feed residues and faeces)	Fish sludge Fish offal
Sanitation		
- Latrines, septic tanks	Excreta emptied from on-site sanitation facilities or container-based toilets	Human excreta and faecal sludge

- Wastewater biosolids	Sludge generated at the wastewater treatment facility	Biosolids
Landscaping and gardening sector		
- Nurseries and garden maintenance		Plant and tree cuttings Leaves Grass

Step 2-1 Identify waste substrates

- Go through the list of most common waste sources and types of waste used for BSF farming (see Table 1).
- Use focus groups, interviews and observations to evaluate which of these substrate exist in your area.
- During each interview, ask for ideas and sources of waste that might be suitable and possible persons to contact for more information.
- Identify key informant sources to obtain information about substrates (in general or for specific substrates.

Step 2-2 Analyse the suitability of the different waste substrates available in the area of concern

- Use ANNEX 2-2 for each substrate to score each attribute based on interview information, focus group, outcomes, reports and/or observations

Two categories of attributes can be distinguished for each substrate type.

Processing Attributes: how does the substrate type affect the operational performance of the facility?

These attributes characterize the quantity and reliability of the substrate generated, how suitable it is in terms of digestibility for BSF larvae and the effect it has on the quality of the end products.

The amounts of a specific substrate type is not assessed as a score but rather as a sum (kg/day) generated from the different locations (sources) in the area of concern. The amount will give indication of the possible operational scale of the BSF waste processing facility (see section C).

Financial Feasibility Attributes: how does the waste affect the logistics, management and finally the financial feasibility of the facility?

Define how complicated and costly it is to access and obtain this type of substrate and to prepare it as a feed for the larvae. This comprises aspects of competition, price, ease of procurement, pre-treatment and environmental benefit compensation.

Attributes should be assessed and scored on a scale of 1-5 (1= worst; 5=best) as described below. The information needed can be obtained through observation, key interviews as well as secondary documents and reports.

For each waste substrate type provide an average score, in other words an average considering different sources (locations) of waste generation. If you notice one or more locations which differ significantly from the average for the same substance type, then compile a separate scoring table for this location and type.

Example 1: in general all layer hen farms in the region generate chicken manure, non-marketable eggs and dead chicken as a potential waste substrate types. Fill out a "average" table for each of these three substrates.

Example 2: If one of the layer hen farms is very different from the other average layer hen farms with regard to chicken manure, then fill out a table for the chicken manure substrate type, specific to this farm.

Table 2-2: Attributes and scoring system for each substrate type.

Processing Attributes	*Description of attribute and scores*
Daily average amount (total of different locations)	*The amount of a specific substrate type is not assessed as a score but rather as a sum (kg/day) generated from the different locations (sources) in the area of concern. The amount gives indication of the possible operational scale of the BSF waste processing facility.*
Seasonal reliability	Score 1: in more than six consecutive months, less than ¼ of the average weekly amount is available Score 2: 4-6 consecutive months, less than ¼ available Score 3: 2-4 consecutive months, less than ¼ available Score 4: 2-8 consecutive weeks, less than ¼ available Score 5: The average weekly amount or more is always available
Nutritional suitability (% DM)	Score 1: unsuitable • Very high in fiber (>50%) • AND very low in protein (<5%) • AND very low in starch and glucose (<5%) Score 3: suitable • medium in fiber (10-20%) • medium in protein (5-10%) • medium in starch and glucose; (5-15%) Score 5: highly suitable: o low in fiber (<10%) o AND high in protein (>15%) dry o AND high in starch and glucose; (20-30%) o AND optimal in fat (10-15%)dry
Water content	Score 1: very high water content (>95%) Score 2: high water content (80–95%) Score 3: very low water content (<50%)

	Score 4: low water content (50–59%) Score 5: ideal water content (60–75%)
Safety (qualitative assessment)	Score 1: very high probability of containing hazards (either mycotoxins, drugs, agri chemicals, pathogens, prions, heavy metals) Score 2: high probability Score 3: medium probability Score 4: low probability Score 5: very low probability of containing hazards
Financial feasibility Attributes	*Description of attribute and scores*
Purity	Score 1: mixed waste (> 40% inorganic and hazardous materials Score 2: 40–50% organic Score 3: 51–70% organic Score 4: 71–90% organic Score 5: Purely organic with less than 1% of other inorganic materials.
Competition of demand	Score 1: >50% demand Score 2: 30–50% demand Score 3: 20–29% Score 4: 10–19% Score 5: there is no demand for this substrate (e.g, <10%) and/or can be monetized
Price	Score 1: substrate is sold at a very high price (price per ton is 2-5x lower than the price of animal feed) Score 2: substrate price is high (price per ton is 5-30x lower than the price of animal feed) Score 3: substrate price is low (price per ton is more than 30x lower than the price of animal feed) Score 4: substrate is free of charge Score 5: paid to take substrate
Securing offtake agreements	Score 1: potential to ensure offtake agreement is very low Score 2: Score 3: potential to ensure offtake agreement is probable Score 4: Score 5: potential to ensure offtake agreement is very high
Ease (costs) of procurement	Score 1: substrate needs to be collected and main sources are dispersed or distant, leading to high costs Score 2: Score 3: substrate needs to be collected but main sources are close and not dispersed, leading to low costs Score 4: Score 5: substrate is delivered

Step 2-3	Evaluate the results of the waste substrate scoring using guidance of ANNEX 2-3
	○ use guidance of ANNEX 2-3 to identify the most promising substrates ○ evaluate mixture of substrates and evaluate their "mixed" scoring

Processing attributes: The sum of scores of all processing attributes will. Highest score of a specific substrate type shows highest suitability in terms of processing aspects.

Financial feasibility attributes: The sum of scores of all financial feasibility attributes will rank the feasibility of using these substrates for a BSF facility.

3. Management and operational aspects

3.1 Climatic suitability

BSF facilities are best suited for climates with average monthly ambient temperatures between 25-30 °C and average relative humidity of 60-90%. Under these climatic conditions, all the stages of the BSF lifecycle thrive with minimal amount of supporting equipment and infrastructure.

In cases where such climatic conditions are not met, they need to be controlled through respective infrastructure and/or climate controlled equipment. This implies a higher capital cost of the building infrastructure as well as higher operational cost for climate control inside the building. Although BSF processing can be conducted in fully closed facilities with full temperature and humidity control, the financial feasibility could become more difficult depending on the energy, substrate costs and product prices.

Table 3-1: Scoring criteria for climate suitability

Qualitative Score	*Average monthly temperature (°C) in at least 8 months of the year*	*Average monthly humidity (%)*	*Measures required*
Suitable	25-30° C and other months 30-35 or 20-25	60-90	Generally no climate and humidity control necessary however in some few instances some passive temperature and humidity control needed (e.g. passive solar heating, shading, ventilation, spray humidifier)
Less suitable	30-35 or 20-25	40-60 or >90	Regular passive and periodically active heating or cooling as well as air humifying or dehumifying
Unsuitable	Above 30 or <20	Below 40	Continuous active heating or cooling air humifying or dehumifying

Step 3-1 Evaluate average monthly ambient temperature and humidity and compare how well fits requirements by BSF larvae (Table 3-1).

- If variations in the area are large, evaluate different locations separately

3.2 Scale and location of possible operations

BSF facilities can be operated at different scales. This is influenced either by a preset decision (e.g on CAPEX capacity, product demand, available land/building), or by the sum of suitable substrate amounts (see section 2). The amounts of suitable substrate to be processed, will give indication of the potential largest scale of one facility or a number of smaller facilities at different locations.

While small scale operations can often be accommodated in empty spaces of existing plots (farms, gardens, small empty plot in neighborhoods, etc.), middle and large facilities will require a designated location (ideally close to a generation source of waste substrate). A small-scale operations processing 1 ton of substrate per day will require about ±250 m^2 while a medium-scale operations processing 5 ton/d requires about ±900 m^2 and a large-scale operations processing 60 ton/d requires about 6,500 m2.

Different scale of operations typically result in different levels of technical and automation requirements as shown below in table 3-2-1.

Table 3-2-1: Scales of operations in BSF waste processing

Scale	*Waste per day (t)*	*Fresh larvae per day (t)*	*Typical products*	*Technology level*
Small	<1	<0.25	Fresh or dried larvae and frass for self-use	Low, DIY
Medium	1-10	0.25-2.5	Dried larvae, larvae meal, BSF larvae oil, frass,	Limited automation
Large	10- >100	2.5->25	Dried larvae, larvae meal, BSF larvae oil, chitin, frass, refined protein, refined lipids, refined frass	High automation

Note: The scale of the BSF does not necessarily give indication of the level of feasibility. Although some experts argue that economies of scale would favour larger facilities, there is no evidence that shows this effect. On the contrary, low labour cost and higher probability to be able to sustain a low technical complexity shows that small to medium scale facilities are more likely to succeed in low and middle income countries.

Step 3-2	Evaluate potential plot availability for BSF operations of different scales (small, medium and large) using ANNEX 3-2

The plot of a designated area for BSF operations should fulfil certain criteria, as listed in table 3-2-2. Ideally such a plot is readily available, close to source of substrate, already have some building that can be used, be cheap, avail of basic service such as water supply, sanitation, power supply and be accessibile through suitable road infrastructure. The plot attributes can be summarized as as shown in Table 3-2-2.

Table 3-2-2: Scoring of plot availability and suitability

Plot attributes	*Description of score*
Plot size availability	Score 1: very few plots of this size are available in this landuse type Score 2: some plots of this size are available in this landuse type Score 3: many plots of this size are available in this landuse type
Buildings on plots for use	Score 1: available plots are mostly barren Score 2: some available plots have unused buildings which can be of use Score 3: many available plots have unused buildings which can be of use
Plot proximity to source of substrate	Score 1: available plot is distant (>60 min travel) from the substrate source Score 2: moderate (30-60min travel) Score 3: close (>30 min travel)
Costs	Score 1: the available plots have a high land acquisition price Score 2: moderate land acquisition prices Score 3: low cost for use of land
Availability of basic services	Score 1: the available plots generally have no access to electricity, water supply or wastewater management Score 2: the available plots generally have partial access to electricity, water supply or wastewater management Score 3: the available plots generally have stable electricity and full access to water supply and wastewater management
Road access	Score 1: the available plots generally are not accessible for cars and trucks Score 2: the available plots generally are accessible by an unpaved road of more than 1km Score 3: the available plots generally are accessible by an unpaved road of less than 1km

3.3 History and experiences with BSF waste processing

Past experiences of local stakeholders with BSF waste processing affects overall acceptance of the technology. Therefore it is important to assess what is happening and has happened in the past regarding BSF waste processing how they performed. If past projects may have failed, it is then crucial to understand what factors have led to the failure in order to take corrective measures (if possible) for future endeavours.

Easily accessible knowledge hubs and knowledge sharing platforms will facilitate the exchange and learning process around BSF operations. Assess and evaluate the presence and proficiency of local skills pertinent to BSF operations. Although skills can be taught through training programmes, having some expert knowledge in the area allows a head-start. Existing and running BSF facilities in the country can also be beneficial as these can be used as demonstration and/or training sites. Assess the willingness of key stakeholders in the BSF domain to share and exchange with knowhow and learnings.

Step 3-3	Evaluate past and existing country experiences with BSF operations (ANNEX 3-3) and evaluate existing exchange and learning platforms on BSF waste processing

4. Market opportunities and barriers

One reason why waste-based BSF farming has emerged is due to its contribution to improved waste management and for its more sustainable and local feed and fertilizer production. However, the market for BSF products is still in its infancy, making it difficult to determine potential market volume and prices for different BSF products as this depends on current products used, customer perception (and their willingness to switch from conventional products to BSF products) and the degree of BSF product refinement. The most common products of BSF farming are:

a. *BSF larvae* that can be used as a component in feeds for farmed animals (e.g., poultry, pigs, fish, wild birds or for pets (e.g., cats, dogs, other zoo animals such as ornamental fish or singing birds).
    - *Live/fresh larvae*: For many animals, insects are part of the natural food supply. Live BSF larvae can be fed live to animals, but live larvae have a short shelf life.
    - *Frozen fresh larvae/larval pulp*: Frozen larvae, whole or after mincing, increases shelf life. This may be desired in the pet food industry where whole fresh larvae or minced larvae are formulated into wet pet food.
    - *Dried larvae:* As animal feeds are often a formulation of several dried feed ingredients, dried whole larvae (that have increased shelf life) can be mixed with other ingredients to produce a feed.
    - *Protein meal:* Larvae can be defatted, to increase shelf life, lower fat content and increase protein content. The defatting process levels the resulting BSF larvae meal composition with feed benchmarks such as soybean meal and fishmeal (i.e., protein content > 50%, < 15% fat) and facilitates its inclusion in animal feeds. In addition, the fat can be marketed and sold separately
    - *Fat:* An efficient defatting process with fat filtration can produce a pure, high-quality fat (i.e., > 99% fat) that is high in antimicrobial lauric acid and a similar composition to coconut fat. It can be used as an ingredient for feed, cosmetics, or biofuel production. If fat is high in omega-3 fatty acids (depends on feedstock) it can be used in high-value markets (e.g., replacement for coconut fat), with higher sales prices.
b. *Frass* is *the* product produced in largest amounts in BSF operations (15-50% of feedstock input at around 50% moisture content) and can be sold for use as
    - soil conditioner or further refined into a fertilizer
    - substrate for biogas and respective fuel production
    - biochar production for carbon sequestration in soils.
    - Fuel briquettes for industrial heat processes

4.1 Customer Perception

As BSF products are typically new in the market, customer perception and their willingness to switch from conventional products to BSF products needs to be evaluated.

Step 4-1	Evaluate perception and acceptance of BSF products based on the questionnaire in ANNEX 4.1:
	○ Regarding BSF-based feed in the poultry, pig, fish, pet food, etc. sector through interviews with farmers and current feed producers/retailers ○ Regarding BSF-based frass in the agricultural, and gardening/landscaping sector through interviews with key stakeholders

4.2 Potential market volume

For the area of concern, evaluate the number and size of the customer base and the amounts of products purchased per sector. This can be assessed using secondary data/reports or interviews with key informants.

Step 4-2	Evaluate size of each sector (poultry, pig, fish, pet food…) according to ANNEX 4.2:
	○ For animal feed ○ For compost

4.3 Market supporting mechanisms

For the area of concern, evaluate if market supporting mechanisms exist and how these can support BSF farming.

Waste management: Waste management services come with a budget, typically in the jurisdiction of local government. Depending on waste sector policies and efforts towards circularity, BSF activities may receive financial support given their endeavour to reduce organic waste to disposal. Exploring if and how local government may support BSF activities, for instance though payment of gate fees, is an important step.

Greenhouse gas mitigation: Countries have pledged their efforts towards greenhouse gas mitigation through Nationally Determined Contributions (NDC). Some countries have pledged an ambitious target and would utilize international market mechanisms or international carbon market to trade (buy and sell) carbon credits or purchasing carbon offsets to fulfil their target. Apart from voluntary carbon market at the international level, there were market mechanisms established under the UNFCCC. BSF activities divert organic waste from disposal site and thus avoid methane. Countries may have a regulated procedure to apply for "CO2 mitigation" crediting which needs to be explored.

Step 4-3:	Evaluate market supporting mechanisms according to ANNEX 4.3:
	○ For waste management ○ For greenhouse gas mitigation

TOOLBOX

ANNEX 1-1 – Existing policies, legislation, by-laws, rules, regulations

Use the questions in the table below either during interviews or in workshops to obtain key information. Once you have identified key relevant policies, legislation, regulations, study these in detail and comment on how they affect BSF-farming.

Interviewee: name, organisation and contact:..... or if an event (add participants list):			
Date:			
Farming, Feed and Fertilizer			
Question	*Policy, Legislation, Article*	*Effect on BSF*	*Comment (e.g enforced?)*
Are any rules in place that regulate on which substrates can be fed to BSF larvae?			
Are any rules in place that regulate which animals (farmed and/or non-farmed) can be fed with insects (e.g. BSF larvae products)?			
Do any rules regulate the harvesting and killing of the larvae?			
Are any specific quality standards for animal feed in place (e.g., nutrient content, concentration of heavy metals, mycotoxins, and indicator microbial organisms)?			
Are any specific quality standards for BSF larvae in place (when used as feed) (e.g., nutrient content, concentration of heavy metals, mycotoxins, and indicator microbial organisms)?			
Are any quality standards for fertilizers in place? (e.g., nutrient content, concentration of heavy metals, mycotoxins, and indicator microbial organisms)?			
Are any specific quality standards for BSF frass in place? (e.g., nutrient content, concentration of heavy metals, mycotoxins, and indicator microbial organisms)?			
Do any rules regulate what processing steps the BSF products (incl frass) must undergo (e.g. certain heat, time, or pressure) before sale and use?			

Do any rules regulate what form (fresh, dried, pellets, meal) the BSF-based products must be in order to be sold for use as feed or fertilizer			
Are there any regulations defining which field of activity BSF-farming is assigned to which affects accessibility to plots of certain land use (commercial zone vs. agricultural zone vs residential area)?			
Waste management, circularity and climate			
Question	*Policy, Legislation, Article*	*Effect on BSF*	*Comment (e.g enforced?)*
Are any rules in place that regulate accessibility to waste by non-governmental institutions (e.g private sector?			
Are policies or regulations in place regarding payments (gate fees) for waste treatment which are also applicable for BSF-waste processing?			
What policies or legislation are in place which support circular economy approaches or regulate waste recycling?			
Do policies, laws or regulations exist that favour access to organic waste (e.g. regulations on organic waste segregation at source, laws and regulatory requirements that restrict the amount of organic waste or food waste that can be disposed of in landfills or incinerators, etc.)			
Are policies, legislation or rules in place that support climate mitigation (CO2 emission reduction)?			
Are policies, legislation or rules in place that govern a procedure to access GHG mitigation credits?			
Business and Innovation			
Question	*Policy, Legislation, Article*	*Effect on BSF*	*Comment (e.g enforced?)*
Do any national or local development plan and priorities exist that favour or hinder BSF activities?			
Do any national or local investment policies favour or hinder BSF activities?			
Do any national or local policies favour and support innovations (e.g. Ministry of Science & technology)?			
Do any national or local policies or regulations favour or hinder BSF activities with regard to taxation (e.g. Ministry of Finance)?			
Do any policies or regulations exist that favour pricing and markets for BSF-based products			

(subsidies on BSF-based feed and organic fertilizers?)			
Do any policies or regulations exist that favour pricing and markets of conventional products (in competition with BSF-based products) (e.g. subsidies on chemical fertilizer, fish meal or other animal feed)?			
Are any law or regulations in place regarding business certification which would apply to BSF facilities (Ministry of Trade, Ministry of Agriculture)?			
Do regulations govern commercialization and licensing of BSF enterprises and products (Local Gov't)?			
Do regulations govern occupational health and safety, that apply to BSF labour force (Ministry of Public Health, Ministry of Gender)?			

ANNEX 1-2 – Ease of doing business

Check score of each category at https://archive.doingbusiness.org/en/data/doing-business-score?topic=starting-a-business , and transfer into the table below. Check subscores of each category and read the info box on its significance. Comment on how thios relates to and affects BSF waste processing businesses.

Category	*Score*	*Comment*
Starting a business		
Dealing with construction permits		
Getting electricity		
Registering property		
Getting credit		
Protecting minority investors		
Paying taxes		
Trading across borders		
Enforcing contracts		
Resolving insolvency		
OVERALL		

ANNEX 2-1 – Identifying waste substrates

Fill out the table below for each potentially available waste substrate in the different sectors. Waste substrate examples are given in Table 2-1. Add additional substrates that may not be mentioned in the list, if required. Use key informants through interviews and workshops to brainstorm on possible waste substrates to include in this list.

Sources and Substrates	*Description of substrate and source*	*Contacts*
Food Processing Industry	....	
Beverage Industry	....	
Dairy Industry	....	
Sugar Industry	....	
Vegetable Oil Industry	....	
Meat and fish processing industry	....	
Biofuel Industry	....	
Floral and Ornamental Plants Industry	....	
Vegetable and Fruit Markets	....	
Supermarkets	....	
Restaurants	....	
Hotels	....	

	.....	
Canteens	....	
Household waste	....	
Crop cultivation waste	....	
Animal husbandry waste	....	
Aquaculture	....	
Latrines, septic tank sludge	....	
Wastewater biosolids	....	
Nurseries and garden maintenance	....	
Other	....	

ANNEX 2-2 – Scoring of waste substrate suitability

Fill out the table below for each substrate type. Use interview information, focus group, outcomes, reports and/or observations for scoring.

Substrate Type	.....	
Location or Average	.....	
Processing Attributes	*Score (1-5)*	*Comment*
Daily average amount (total of different locations)	No score	Add total amount: .....
Seasonal reliability		
Nutritional suitability (% DM)		
Water content		
Safety (qualitative assessment)		
TOTAL (sum of scores)		
Financial feasibility attributes	*Score (1-5)*	*Comment*
Purity		
Competition of demand		
Price		
Securing offtake agreements		
Ease (costs) of procurement		
TOTAL (sum of scores)		

ANNEX 2-3 - Understanding the waste substrate scoring results

Step 1: Rank all substrates by sum of scores of the processing attributes. This indicates which are substrates are most suitable for reliable and good growth of larvae.

Step2: Rank all substrates by sum of scores of financial feasibility attributes. This indicates the substrates that are most beneficial from a business and financial perspective.

Step 3: If for one substrate sum of processing and financial attributes both score high, this indicates that this substrate is very suitable for BSF farming.

Step 4: If for one substrate financial feasibility attributes scores high, but processing attributes scores lower, then consider mixing with another substrates that has scores high in processing attributes. Consider the processing attributes of the mixture and score the mixture. Score all attributes again in a respective table for the substrate mixture.

Substrate or mixture	*Processing attributes*		*Financial attributes*		*Comment*
	Sum	*Rank*	*Sum*	*Rank*	

ANNEX 3-1 – Feasibility based on ambient temperature and humidity

Fill out the table below for each location of concern.

Location:	*Value*	*Score*	*Measures required*
Average monthly temperature (°C) in at least 8 months of the year			
Average monthly humidity (%)			

Location:	*Value*	*Score*	*Measures required*
Average monthly temperature (°C) in at least 8 months of the year			
Average monthly humidity (%)			

Location:	*Value*	*Score*	*Measures required*
Average monthly temperature (°C) in at least 8 months of the year			
Average monthly humidity (%)			

ANNEX 3-2 – Availability and suitability of plot location

Fill out the table below for each envisaged scale of operation.

Small scale plot			
Landuse / Attribute	Densely populated urban/residential area	Industrial/commercial area with other businesses	Rural area or open space in the fringe of a town
Plot size availability			
Buildings on plots for use			
Proximity to source			
Costs (price/m2)			
Availability of services			
Road access			
Comments			

Medium scale plot			
Landuse / Attribute	Densely populated urban/residential area	Industrial/commercial area with other businesses	Rural area or open space in the fringe of a town
Plot size availability			
Buildings on plots for use			
Proximity to source			
Costs (price/m2)			
Availability of services			
Road access			
Comments			

Large scale plot			
Landuse / Attribute	Densely populated urban/residential area	Industrial/commercial area with other businesses	Rural area or open space in the fringe of a town
Plot size availability			
Buildings on plots for use			
Proximity to source			
Costs (price/m2)			
Availability of services			
Road access			
Comments			

ANNEX 3-3 – History and experiences with BSF waste processing

Ask interview participants for their personal experience with BSF. Fill out the table below for each key informant interview or from feedback in events (workshops).

Interviewee: name, organisation and contact:..... or if an event (add participants list):			
Date:			
Question	*Description of attribute*	*Score 1-3 (1=worst, 3=best)*	*Comment*
Average experience	Score 1: Never heard of BSF before this interview/project. Have heard but never seen it with my own eyes Score 2: Have visited a BSF facility/project Score 3: Have been involved in BSF activity		
Impression	Score 1: what I have seen or heard was not convincing (e.g. dirty, inefficient, financially not feasible) Score 2: No judgment possible Score 3: have a good impression from what I have seen		
Knowledge sharing platforms	Score 1: do not exist Score 2: exist but are not active Score 3: exist and are active		
Expert knowledge	Score 1: do not exist Score 2: few experts exist Score 3: many experts exist		
Willingness to share	Score 1: is low Score 2: medium Score 3: high		
Demonstration sites	Score 1: do not exist Score 2: few exist Score 3: many exist		

ANNEX 4-1 – Perception and acceptance of BSF products

Identify interviewees that represent the different farming sectors. Fill out the table below for each interview and for each animal husbandry sector poultry, pig, fish, pet food, etc.

Interviewee: name, organisation and contact:..... or if an event, which sector is represented ? (add participants list):	
Date:	
You are a farmer -- Regarding animal feed	
Which animal husbandry sector do you represent?	
If you are a farmer: what scale of animal husbandry is your farm? (in no. of livestock or amount of produce)	
What do you currently feed?	
Do you make your own feed from different ingredients? If yes why?	
Are you aware that insects (BSF) can be used as feed? If yes, where did you hear about this?	
How do you perceive the value and benefits of insects as feed (when compared to conventional feed)?	
Have you ever used insects in feed? If yes, what is your experience with it?	
Would you be willing to substitute your existing feed with BSF-based feed assuming the same cost and benefits as current? If not, why not?	
How would the product need to look like? Live/fresh larvae: Frozen fresh larvae (whole, larval pulp, pellets): Dried larvae (whole, flakes, pellets): Protein meal (powder, pellets): Fat:	
Would you be willing to substitute your existing feed with BSF-based feed considering a 5% lower cost and same benefits as current?. If not, why not?	
Under which conditions would you be willing pay more for your animal feed which that includes BSF-Products and how much more (%) a) more sustainable or natural product; b) better for animal welfare (e.g. less pecking) c) better feed quality (higher protein content, etc.)	

d) better animal performance (more biomass, more eggs etc.) e) better output quality (better meat, better eggs, etc.).		
You are a farmer, gardener, landscaper -- Regarding frass		
What kind of crops do you farm?		
What scale is your farm (m2 of cultivated land)?		
What do you currently use as soil amendment?		
What do you currently use as fertilizer?		
Are you aware that BSF frass can be used instead of compost for soil and crops?		
How do you perceive the value and benefits of frass (when compared to (when compared to compost)?		
Have you ever used frass?		
Would you be willing to substitute your existing soil amendment or fertilizer with frass assuming the same cost and benefits as current? If not, why not?		
Would you be willing to substitute your existing soil amendment or fertilizer with frass considering a 5% lower cost and same benefits as current? If not, why not?		
Under which conditions would you be willing pay more for frass...and how much more (%)? a) more sustainable or natural product b) better soil fertility c) better crop quality d) better crop yield.		
You are a retailer	Animal feed	Frass
What scale is your retail		
Do you currently sell BSF products? If yes how much (per week) and what products and for which sectors?		
Would you be willing to retail BSF products assuming the same cost and benefits as current conventional products? If not, why not?		
What is your perception regarding acceptance of your customers towards BSF products? Favourable, Rejection; Need proof of benefit, etc.		
Do much BSF products do you think you might be able to sell (per week)?		

ANNEX 4-2 – Market volume

Sector	*Total amounts of "conventional" products sold and price*	*potential sales amount (25% of current products substituted by BSF products*
Poultry Product 1: Product 2: ….		
Pig Product 1: Product 2: ….		
Fish Product 1: Product 2: ….		
Pets Product 1: Product 2: ….		
Ducks Product 1: Product 2: ….		
Compost Product 1: Product 2: ….		
Other Product 1: Product 2:		

ANNEX 4-3 – Market support

Market support mechanisms	*Comment*
Waste management contribution	
• Gate fees paid by local government for waste management services rendered • Gate fees paid by enterprises for managing their waste …other	
Greenhouse gas mitigation	
• Assess country procedures for carbon trading • Assess revenue potential of carbon trading (CO2 eq emission reduction) …other	