BUGS Africa
Implementation report for Ethiopia

PREVENT
Waste Alliance

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Executive Summary

This **implementation** report evaluates the potential of Black Soldier Fly (BSF) technology in Ethiopia, specifically in the regions of Addis Ababa and Butajira, which were identified as key areas for deployment during a stakeholder workshop in March 2024. The primary goal of the project is to tackle organic waste management challenges while advancing sustainable agriculture and food security. By converting organic waste into valuable products such as animal feed and soil amendments, BSF technology addresses waste disposal issues and promotes environmental sustainability. The expected outcomes of the project include improved waste management practices, increased agricultural productivity, and economic growth in these regions.

The assessment revealed that BSF technology holds significant potential for managing organic waste in Ethiopia, particularly in Addis Ababa and Butajira, where substantial amounts of waste are generated. This aligns with the country's national waste reduction goals and presents an opportunity to transform waste into valuable economic resources. However, a key challenge is the lack of specific regulatory standards for BSF-based products, such as insect-based animal feed and fertilisers. This regulatory gap could hinder the widespread adoption of BSF technology, highlighting the need for clear guidelines and standards. While there is promising market demand for BSF products in Ethiopia's animal feed and fertiliser sectors, raising awareness among farmers and retailers is crucial, as many remain unfamiliar with the benefits of BSF technology.

Regarding infrastructure and climate suitability, Ethiopia's environment is generally favourable for BSF farming. However, some regions may require additional investment in infrastructure to support waste sorting and temperature control for optimal BSF production. Locating BSF facilities near industrial zones and peri-urban areas could help mitigate challenges related to land availability and waste transportation. From an environmental standpoint, BSF technology has the potential to significantly contribute to Ethiopia's climate goals by reducing greenhouse gas emissions and diverting organic waste from landfills. Moreover, BSF operations could benefit from carbon financing initiatives, further enhancing their environmental and economic impact.

The report also highlights several challenges encountered during the implementation process, including the absence of regulatory frameworks for BSF products, limited awareness of BSF technology, and infrastructure constraints. To successfully scale BSF technology, the report recommends developing clear regulatory standards for BSF products, establishing demonstration sites to increase awareness and acceptance, and fostering partnerships with local industries to ensure a reliable supply of organic waste for BSF farming. Additionally, investments in localised infrastructure for waste sorting and temperature control are crucial for optimizing BSF operations.

While challenges exist, the implementation of BSF technology in Ethiopia offers a valuable opportunity to address waste management issues and promote sustainable agricultural practices. By closing regulatory gaps, raising awareness, and investing in the necessary infrastructure, BSF technology can be scaled effectively, generating significant environmental, economic, and social benefits for Ethiopia. The report suggests piloting BSF at a site close to Addis Ababa due to its urban proximity and continuous waste availability.

1 Introduction

The Black Soldier Fly (BSF) technology has attracted considerable attention for its innovative and sustainable approach to addressing significant challenges in organic waste management, animal feed production, and organic fertiliser manufacturing. By cultivating BSF larvae (Hermetia illucens), this technology provides an efficient method to convert organic waste into valuable products such as protein-rich animal feed, biofuel, and organic fertilisers. Its potential to tackle issues related to food security, waste management, and environmental sustainability makes it a promising solution applicable to both developed and developing economies.

In sub-Saharan Africa, where waste management systems are often inadequate and the agricultural sector struggles to secure affordable and sustainable animal feed, BSF technology offers a compelling opportunity. Ethiopia is heavily dependent on agriculture[1], with over 60% of its population engaged in agriculture. While Ethiopia has one of the largest livestock populations in Africa, especially poultry and cattle, the generated yields per animal are among the lowest. The currently low utilisation of feed resources makes feed one of the major constraints to the Ethiopian Livestock sector[2].

At the same time, the lion's share of municipal solid waste generated in Ethiopian cities is organic waste. This organic waste is mostly mismanaged and hence remains underutilised[3]. BSF farming, in this context, provides a dual benefit: addressing waste management issues while producing affordable animal feed and organic fertiliser, thereby supporting Ethiopia's broader environmental and economic goals.

Funded by the PREVENT Waste Alliance and Climate and Clean Air Coalition (CCAC), this project aims to promote BSF technology initiatives in Ethiopia. It focuses on enhancing waste treatment processes and advancing the circular economy. The initiative aims to evaluate and implement a sustainable BSF technology model tailored to Ethiopia's specific needs and objectives. The approach includes comprehensive assessments of critical factors such as regulatory obstacles, substrate availability, and market potential. The initial project phase has included detailed feasibility studies and stakeholder workshops, identifying essential elements for successful implementation. This report builds upon these findings, outlining the subsequent steps required to scale up BSF farming in Ethiopia, ensuring alignment with national policies, local requirements, and broader sustainability targets.

[1] World Bank Group Data (2025) https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=ET-UG
[2] Gelayenew et al. (2016). https://globaljournals.org/GJSFR_Volume16/2-Assessment-of-Livestock-Feed.pdf
Southwestern Ethiopia; FAO (n.d.). https://openknowledge.fao.org/server/api/core/bitstreams/499edead-e9ee-4234-bac0-8e4b161d0ee4/content/x5548e03.htm
[3] Lenhart, M., et al. (2022). https://www.dbfz.de/fileadmin/user_upload/Referenzen/DBFZ_Reports/DBFZ_Report_45.pdf

2 Background info about the country

Ethiopia's economy is predominantly based on agriculture, which contributes about 34 % to the country's GDP and employs over 60 % of the population. Despite its agricultural potential, Ethiopia continues to face food security challenges due to low productivity. This is largely attributed to a heavy dependence on rain-fed agriculture, lack of modern agricultural inputs and declining soil fertility. The soil degradation is driven by several factors, including: nutrient depletion from continuous intensive cropping without sufficient replenishment of soil nutrients (mainly nitrogen (N) and phosphorus (P)); soil erosion especially in the highlands, which removes the fertile topsoil; soil acidity, particularly in the highlands, which hampers nutrient availability and crop growth; and overgrazing, which reduces the production, productivity and quality of agricultural produces. Additionally, the rising costs of agro-chemicals and limited access to modern farming techniques, like irrigation infrastructure, constrain productivity.

Ethiopia is one of the top livestock potential countries, with in total over 130 million cattle, sheep, goats, camels, and poultry distributed throughout the country. Of Ethiopia's overall greenhouse gas (GHG) emissions, livestock accounts for about 21 %[4]. Nitrous Oxide (N_2O) from waste management and fertiliser use in pasture and feed crop production, and Methane (CH_4) from enteric fermentation during digestion in ruminants (cattle, sheep, and goats) are the main sources of the domestic GHG emissions.

Data on waste generation in Ethiopia are scattered. For Municipal Solid Waste (MSW), an average of available figures from different years was estimated to be 0.383kg/person/day. Thereby, the values differ across regions and among cities of different size. For example, it was estimated that in Debre-Brhan, inhabitants produce 0.55 kg/capita/day in 2018. In smaller towns, like Meristo, the value was estimated to be 0.18 kg/capita/day in 2020[5].

The composition of MSW in Ethiopia is primarily based on food waste, which accounts for nearly 40 % of all MSW produced. This is followed by dust, ash and sand, making up 26 %, and yard waste, constituting 16 % of the overall MSW. Other types of waste, such as paper and plastic, each account for less than 10 %. Metal, textiles, and rubber take on no significant share of Ethiopia's MSW[6].

Despite the significant efforts to promote recycling and resource recovery, the efficiency of sustainable waste management and waste valorisation is still low. Overall, 73 % of the domestic MSW is compostable, 12 % recyclable. However, only one third of the MSW is collected properly, whereas the rest is dumped illegally[7]. Identifying and adopting appropriate and affordable waste management technologies to maximise and diversify waste valorisation options is a priority intervention in the recently launched Addis Ababa City Solid Waste Management Masterplan (2024-2043).

Leveraging on Ethiopia's high but under-utilised agro-waste generated in rural areas and food waste generation in urban areas, the growing demand for affordable agrochemicals and animal feed opens opportunities for solutions like the BSF approach as a sustainable alternative. The fly can convert organic waste like food scraps and manure into high-quality protein for livestock and organic fertiliser. This will not only significantly reduce waste disposal but also boost business models for the BSF value chain. It can create jobs, additional livelihoods and income generation, enhance food security through animal feed production, and increase fertiliser availability from local sources. Furthermore, BSF can decrease the environmental burden of organic waste disposal through innovative waste-to-resource conversion and thus contributing to GHG emission targets.

Introducing BSF technologies would align with Ethiopia's broader development goals. Utilising BSF contributes to climate change mitigation and adaptation efforts by building resilient and enhanced livestock productivity, while reducing methane emissions from the livestock sector through improved feed management. It also contributes to rural development by creating alternative livelihoods and food security. For example, BSF technology could support the Climate-Resilient Green Economy strategy[8], which aims at achieving economic prosperity without increasing GHG emissions and unsustainable use of natural resources. Another example is the Livestock Master Plan[9], which aims to boost the productivity of key livestock value chains.

Several line ministries are relevant for the implementation of BSF technology, including the Ministry of Agriculture, Ministry of Planning and Development, Ministry of Skills and Labour as well as the Addis Solid Waste Management and Cleansing Agency. These stakeholders play an important role in promoting sustainable agricultural practices and food security, supporting agricultural innovation and research, and enhancing workforce skills, entrepreneurship and employment options, among others. This is an opportunity to co-design multisectoral collaborative approach to scaling BSF technology, leveraging the strength and expertise of different sectors.

Additional to governmental stakeholders, promising initiatives on the BSF value chain and by product valorisation are run by actors from academia and the private sector. For example, trials are run by Addis Ababa University, the International Centre of Insect Physiology and Ecology (ICIPE), and small and medium-sized enterprises (SMEs) such as Melkam Integrated Farms, Eden Garden Farms, Thermo House plc. However, there are no tested viable business models in place yet. This is mainly due to a lack of sufficient regulatory frameworks for BSF production and utilization. Currently, "The Dried Insect product as source of Protein for Animal feed" Specification[10] is used as a legal framework. Additionally, high input costs for feed and equipment hamper the development of suitable business cases. Moreover, it would be crucial to address possible public opposition and misunderstandings about BSF manufacturing to guarantee larger acceptability and success in the sector.

[4] derived from Federal Democratic Republic of Ethiopia (2024): https://unfccc.int/sites/default/files/resource/Ethiopia_First%20BUR.pdf
[5] Kahsay Gebrekidan, T., et al. (2024). https://www.researchgate.net/publication/385178275_Municipal_solid_waste_management_in_Ethiopia_Physical_and_chemical_compositions_and_generation_rate_Systematic_review
[6] Kahsay Gebrekidan, T., et al. (2024). https://www.researchgate.net/publication/385178275_Municipal_solid_waste_management_in_Ethiopia_Physical_and_chemical_compositions_and_generation_rate_Systematic_review
[7] Kahsay Gebrekidan, T., et al. (2024). https://www.researchgate.net/publication/385178275_Municipal_solid_waste_management_in_Ethiopia_Physical_and_chemical_compositions_and_generation_rate_Systematic_review
[8] FAO (2011). https://www.fao.org/faolex/results/details/en/c/LEX-FAOC186137/
[9] FAO (2015). https://www.fao.org/faolex/results/details/en/c/LEX-FAOC191493/
[10] IES (2021). https://www.gov.ethiostandards.org/sites/default/files/2023-02/production%20and%20handling%20guidline-16012023%20%281%29.pdf

3 Project activities

This report is based on extensive stakeholder consultation and a feasibility assessment for BSF. Workshops were held to conduct a policy analysis with relevant representatives from academia, research, national government and policy developers, entrepreneurs and development partners. Additionally, interviews were held. The following sections elaborate on the methodology.

3.1 Inception workshops

An inception workshop was held on 24th March 2024 in Addis Ababa, Ethiopia. It served as a platform to create awareness and promote BSF utilisation in Ethiopia. The workshop brought together relevant stakeholders from academia, researchers, national government representatives, policy developers, entrepreneurs, and development partners. Together, they conducted an analysis of Ethiopia's strengths, weaknesses, opportunities, and threats (SWOT) regarding BSF technology to deliberate on the potential opportunities and identify solutions to associated barriers.

3.2 Interviews

The project team in Ethiopia, in close consultation with the participants of the inception workshops, conducted follow-ups and one-on-one consultations. Based on this, the project team identified two potential areas that would in principle be suitable for the application of BSF technology and should therefore be examined more closely as part of an assessment.

The stakeholder interviews were based on a template covering qualitative and quantitative criteria like enabling legislation and institutional barriers and opportunities; substrate quality; availability, and accessibility; management and operational aspects and market barriers and opportunities.

The assessment for choosing these locations for BSF production was based on the feasibility assessment guidance tool developed under task 2.1 of this project. This considered several aspects, such as availability of space to set up BSF facilities, with favourable climate, economic and spatial conditions as well as the possibility to ensure optimal conditions for breeding, rearing, and harvesting. Another important criterion was that the companies already took a proactive initiative to pilot the BSF production, despite potential reservations in society against using insect feeding. Two sites, Melkam Integrated Farms and Soil in Butajira and More Plc in Addis Ababa were eventually chosen as locations. In-depth interviews were conducted on those identified two sites (see details on the sites below). The table below provides a brief overview of the stakeholders consulted and the derived outcomes of the interviews.

Stakeholder	Characterization and key takeaways
Ministry of Agriculture	MoA is exploring different options to improve entrepreneurship in the agriculture sector especially in rural areas. Hence BSF could be one solution.
Ethiopian Animal Feed Industry Association	They have 89 members who are producing animal feed for commercial purposes. They have the potential and expressed interest to create awareness to facilitate training for interested members on BSF feed preparation, feed safety, and quality issues.
Ethiopian Aquaculture Association	The aquaculture sector is in its infant stage hence, collaborating the few commercial fish farm owners to try BSF can address the biggest operation cost which is feedstock.
Addis Ababa University Center for Environmental Science	The center has built a pilot BSF facility and extracted and prototyped five by-products from the BSF including frass, animal feed, protein powder, fat for cosmetics and keratin to produce alternative materials to conventional plastics.
International Center for Insect Physiology and Ecology	This center has supported in drafting policy frameworks for insect utilisation and conducted research and development.

3.3 Feasibility assessment for BSF

For the feasibility assessment regarding BSF technology, a procedure was developed by Eawag in collaboration with Eclose. The methodology is based on a combination of the study of secondary resources but also primary data collection through interviews with key stakeholders. An assessment manual was developed to conduct the feasibility study basically 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.

4 Results

4.1 Identified locations

As suitable locations for further assessment, the following two locations were identified:

Melkam Integrated Farms is located close to Butajira: Butajira is a rural town in the East Gurage Zone (~35,000 inhabitants), located around 135 km away from Addis Ababa. The area has close links to the surrounding agriculture, its own market, and an established organic horticulture in avocados, oranges, papaya, and mangoes. The farms utilise different alternatives for agrochemicals like composting using vermicompost, azolla biofertiliser and frass from BSF. Butajira benefits from low-cost or free substrate sources, like brewery and potato peel waste. However, competition for agricultural by-products (already used for other purposes such as composting) and limited infrastructure (water, electricity) pose challenges for BSF development.

Soil and More Plc located in Addis Ababa: the capital city of Ethiopia (~4 million inhabitants) and a major economic hub with a diverse range of economic sectors. As a major urban centre, Addis Ababa generates a significant amount of organic waste but lacks a culture of source separation, resulting in the contamination of substrates. Furthermore, additional costs for sorting and transport might impact feasibility. Compared to a rural town, however, land availability is lower and higher land prices are to be expected.

Despite these challenges, the proximity to waste sources and the potential to access segregated organic waste in the future offers opportunities. The project team selected the Bole Arabsa site, which is also the future site for establishing a Centre of Excellence for Circular Economy to demonstrate best practices that optimize waste valorisation like BSF utilisation, among others.

Regarding climate conditions, Butajira has a slight climatic advantage over Addis Ababa due to its higher average temperatures. However, both locations will require investments in climate control infrastructure to ensure the viability of BSF production, particularly for reproduction processes.

While both locations face challenges, Addis Ababa appears more promising for large-scale operations due to its higher waste availability and urban proximity. Butajira is better suited for small-scale or pilot projects but faces infrastructure and substrate competition issues that may limit scaling.

4.2 Summary: results of the assessment

The outcomes of the assessment highlighted the potential opportunities and bottlenecks for adopting and utilising the BSF technology in Ethiopia, especially in the regions of Butajira and Addis Ababa. The assessment evaluated the feasibility of BSF technology based on local waste substrates, regulatory frameworks, operational considerations, and market demand for BSF products.

The findings of the workshops showed that Ethiopia holds great opportunities for the development of BSF value chains. For example, opportunities could be the potential increase in the export of BSF products, job creation, food security, and income generation. The workshops highlighted the need to build on the existing knowledge and research on entomological features and benefits of BSF utilisation within the country. Additionally, it identified the need to, in parallel, facilitate technology and knowledge transfer from countries with advanced BSF utilisation both in Africa and globally. The main findings are summarised in the following.

Potential for BSF in waste management: Using abundant organic waste substrate available in Ethiopia from both rural and urban locations such as agro-processing facilities, agro-waste, vegetable market waste and retail organic residues (restaurants, shops, hotels) is an opportunity. It is estimated that the available waste stream is more than 2,600 tons per day, of which around 65 % is of organic nature. The current costs of obtaining the waste are low and affordable labour and skilled manpower for managing BSF facilities, production and utilisation is also available. BSF technology offers a promising solution for organic waste management in Ethiopia, especially in regions with high organic waste production like Addis Ababa and Butajira. This would also align with the country's goals for sustainable waste processing and reduction of landfill dependency. The Addis Ababa City Solid Waste

Management Master Plan (2024 – 2043) sets scenarios which consider the waste minimisation/prevention at the source, conversion of organic and recycling of plastic waste. The scenarios aim to achieve by 2043 the following targets of waste management for the total amount of MSW generated:

- sent to landfill: 32.74 %,
- composted: 28.18 %,
- thermally converted: 16.6 %
- recycled: 14.33 %,
- anaerobically digested: 5.28 %,
- reused: 2.87 %

Regulatory gaps and opportunities: Ethiopia currently lacks comprehensive regulations specifically for insect-based products, including BSF. As identified due to the in-depth policy analysis during the inception workshop, the country has limited specific policy and regulatory guidance on the commercial production and use of BSF biomass, particularly for feed and fertiliser applications. There is a lack of clear standards and quality control measures for BSF-based products to ensure food and feed safety.

However, the government's ongoing initiatives in waste management and environmental sustainability could pave the way for regulatory development to support BSF. Stakeholders also emphasised that opportunities arise due to the support from the Ethiopian government to increase incentives to campaign and promote initiatives like BSF technology application.

Market viability, skills development and challenges: In the workshops, stakeholders identified the opportunity that the increasing cost of agro-chemical fertilisers might make biofertilisers from BSF a more easily accessible and in comparison, more affordable alternative. Similarly, the stakeholders found that the cost of conventional animal feed based on soya (i.e., for poultry and aquaculture) is increasing. Substituting soya beans, which have been facing rising costs, with BSF can be cheaper for affordable animal feed and organic fertiliser.

However, while there is interest in BSF products as alternatives to conventional feed and fertilisers, awareness and acceptance remain low. Workshop participants explained that Ethiopia is a rather conservative society when it comes to agriculture practices. Accordingly, there is no insect rearing and feeding culture in Ethiopia for humans or animals. Hence, there is a need to create sufficient awareness of the topic within both the communities and among businesses. This can also contribute to overcoming barriers like competition with existing waste valorisation interventions. Factors such as cultural attitudes and the need for product validation are crucial for market penetration.

Stakeholder have further emphasised that there is also a need for capacity building for proper waste management in terms of waste segregation skills. Furthermore, they pointed out that enabling incentives are needed to develop targeted financial incentives, technical assistance, and capacity-building initiatives to support the emergence of a thriving BSF industry in Ethiopia.

Climatic suitability and infrastructure: As identified in the workshops, a major opportunity for BSF cultivation in Ethiopia is the country's favourable climatic conditions (i.e., regarding light and temperature etc.). BSF facilities can operate effectively in Ethiopia's climate, particularly with minor adjustments in areas like temperature and humidity control, which could influence operational costs.

Regarding the availability of infrastructure, participants in the workshops identified that the presence of several agro-processing industrial zones, like Bulbula and Yirgalem Agro Industry Parks, offers potential for establishing high-quality and continuous waste collection systems. However, especially urban regions face challenges related to land availability and infrastructure costs. Stakeholders pointed out that there is a need for the improvement of infrastructure for collection and transporting to ensure the availability of sufficient quality waste substrate that feeds into the BSF processing facilities.

Another important threat, identified by the participants of the workshops and subsequent discussions with different stakeholders was the need to take precautionary measures, such as contained rearing space, when introducing a BSF facility in the ecosystem to avoid possible adverse impacts on the biodiversity.

Economic and environmental impact: Regarding economic impacts, workshop participants mentioned that cost saving could be realised by reducing spending on imported fertiliser. There is however a clear need for increased investment in research, development, and demonstration projects to showcase the technical and economic viability of BSF farming in the Ethiopian context. Current trials are conducted with limited resources from either bilateral funds or private funds.

Regarding environmental impacts, BSF technology could help Ethiopia achieve climate goals by reducing GHG emissions from organic waste and enabling participation in carbon markets. Additionally, BSF production could support local job creation and promote circular economy practices.

In summary, it can be said that Ethiopia holds great opportunities to integrate BSF utilisation into existing waste management and agricultural development programs, leveraging synergies and promoting circular economy approaches. However, to support BSF's integration and its scaling, the report suggests further pilot projects, awareness campaigns, and potential public-private partnerships to improve waste segregation, establish supportive policies, and encourage local entrepreneurship in BSF-related industries.

5 Estimation of GHG emissions reduction

One key advantage of BSF larvae is their efficiency in quickly consuming and converting organic waste, preventing it from ending up in landfills. In landfills, organic waste decomposes.

Anaerobically, releasing methane (CH_4), a powerful greenhouse gas. In the wet tropics, each ton of food waste sent to a landfill generates methane emissions equivalent to approximately 930 kg of CO_2 (Scharff et. al, 2023, The impact of landfill management approaches on methane emissions). In contrast, BSF technology emits only 50 to 300 kg of CO_2 equivalent per ton of organic waste treated[11, 12], varying with the degree of technology and the origin of the energy used in the facility (Mertenat et. al, 2019, Black Soldier Fly biowaste treatment-Assessment of global warming potential; Spykeman et. al, 2021, A modular environmental and economic assessment applied to the production of Hermetia illucens larvae as a protein source for food and feed). Based on demographic data and scientific publications, the table below shows the GHG reduction potential if all organic waste in the Butajira and Addis Ababa regions is treated with BSF instead of being left to decompose uncontrolled in the street or at the landfill site.

In Butajira, a rural town, waste generation is about 0.3 kg/person/day and the organic share is around 65 %. The 35,000 inhabitants of Butajira thus generate about 3,800 tons of overall waste per year. In Addis Ababa the annual waste generation is much higher, approximately 1.2 million tons, while the organic fraction is 55% on average.

	Total amount of waste generated/year	Organic fraction	GHG emission reduction potential
Butajira	3,800 tons	65 %	1,900 tons CO2eq/year
Addis Ababa	1,200,000 tons	55 %	500,000 tons CO2eq/year

6 Recommendations for larger BSF roll out in the country

Based on the above findings, the following recommendations were formulated:

- Recognition of the BSF approach as a viable/standard option for organic waste management in national policies, setting framework conditions including the definition of standards for BSF breeding, rearing and harvesting.

- Conduct a comprehensive feasibility study encompassing technical, economic, environmental, and social aspects. **This detailed feasibility study should analyse:**
    - Optimal BSF species: Identify the most suitable BSF species for the local climate and available feedstock.
    - Characterise the available organic waste streams (e.g., municipal solid waste, agricultural residues regarding quantity, quality, and seasonality. Assess potential contamination risks (heavy metals, pesticides).
    - Evaluate different BSF rearing systems (e.g., vertical farming, open trays) considering scalability, cost effectiveness, and environmental impact.

[11] Mertenat et al. (2019): https://www.sciencedirect.com/science/article/abs/pii/S0956053X19301564?via%3Dihub
[12] Spykerman et al. (2021): (2024). https://doi.org/10.1016/j.scitotenv.2021.148217

- Map the entire BSF value chain, from waste collection to product distribution, to identify potential bottlenecks and opportunities for optimization in the fields of logistics, waste acquisition and its quality, storage, BSF products distribution channels.
- Climate Analysis: Precise temperature, humidity, and rainfall data for the site throughout the year to confirm its suitability for BSF rearing.

- Pilot the BSF Project, preferably at Bole Arabsa site in Addis Ababa due to its waste stream availability and location to gather practical data on production yields, operating costs, and market acceptance that will inform the design and scale-up of the commercial facility.

- **Infrastructure Development:** Develop necessary infrastructure at the Bole Arabsa site, including:
  - Dedicated BSF rearing units: Design climate-controlled rearing units optimised for BSF lifecycle stages.
  - Waste pre-processing facilities: Establish facilities for sorting, shredding before feeding to BSF.
  - Larvae harvesting and processing equipment: Invest in efficient and hygienic equipment for harvesting, separating, and processing BSF larvae.
  - Frass and chitin processing facilities: Develop facilities for processing and packaging BSF frass as fertiliser and exploring chitin extraction technologies.

- **Collaboration and Knowledge Sharing:** Foster collaboration with research institutions, international experts, and other BSF producers to share knowledge, best practices, and technological advancements. Leverage the Circular Economy Center of Excellence as a hub for knowledge dissemination and networking.

- **Support capacity building and market development:** Organise tailored training programmes for stakeholders, such as potential BSF producers, people working in agri- and aquaculture, people working in waste management. Secure thereby the consideration of vulnerable groups, like women and youth.

I. Barriers to Consider:

- Securing adequate funding for capital investments (infrastructure, equipment) and operational expenses can be challenging.

- Address the shortage of technical skilled labour in BSF farming and processing to facilitate efficient operations.

- Create viable markets for BSF products by overcoming consumer perceptions and establishment of distribution channels.

- Secure social acceptance by continuously addressing any remaining cultural taboos related to insect farming through community engagement and education programmes.

II. Opportunities to Explore:

- **Circular Economy Integration:** Integrate the BSF facility into the broader local circular economy ecosystem at Bole Arabsa and in Butajira, creating synergies with other waste management and resource recovery initiatives.

- **Local Value Creation:** Prioritize local sourcing of materials and equipment and create employment opportunities for the local community.

- **Public-Private Partnerships:** Foster collaboration between government agencies, private companies, and research institutions to leverage and develop resources and expertise.

- **Innovation and Research:** Invest in research and development to optimise BSF production technologies, develop new product applications, and improve the sustainability of the entire value chain.

- **Integration with Existing Waste Management Systems:** Integrate the BSF facility with the existing solid waste management system at Bole Arabsa to create a closed-loop system for organic waste recycling.

- **Access to waste:** As a rural town with strong agricultural ties, Melkam integrated farms located in Butajira benefits from low-cost or free substrate sources like brewery and potato peel waste. However, competition for agricultural by-products (already used for other purposes) and limited infrastructure (water, electricity) pose challenges.

- **Favourable climate:** Butajira has a slight climatic advantage over Addis Ababa due to its higher average temperatures.

By addressing these recommendations, barriers, and opportunities, the BSF project at Bole Arabsa can contribute significantly to sustainable waste management, economic development, and the growth of the circular economy in Ethiopia.

6.1 Suggested business models

Accelerating the development of the BSF value chain in Ethiopia can be mainly achieved via two business strategies, i.e. the 'out grower's scheme' and a 'business to business' approach. Their hypothetical application is explained in the following:

- Model one- Out grower's scheme: A partnership between a medium enterprise as a contractor and smallholder farmers (the "out growers"). The contractor provides BSF eggs, technical trainings and equipment and the out growers provide the larvae to be processed as feed or to make other by products.

- Model two- Business to Business (B2B): schemes that can offer premium incentives to encourage bulk purchases of BSF by products or long-term contracts for exports markets.

The two models consider mainly affordability of investment cost, initial investment needs on technology, follow-up operational cost and upscale capacity, with positive cost benefit analysis. The proposed models focus on downstream, middle and upstream value chains to boost profit margin of the business entities by diversifying their income source from multiple revenue streams. Overall feasibility of BSF farm setting is measured on the balance of market demand and supply of consumer needs and market trends.

7 Next steps with the CCAC part of the project

In the coming months, the CCAC-funded project component will progress with key activities aimed at embedding BSF technology into national and local waste management strategies. A comprehensive implementation guide will be developed to support public actors, including policymakers and development agencies, by providing policy recommendations, business models, and training materials to integrate BSF into climate and waste strategies. A social media campaign will raise awareness of BSF's role in enhancing NDCs by diverting waste from landfills, reducing GHG emissions, and creating valuable byproducts.

Capacity-building efforts will continue with national workshops introducing government officials and stakeholders to the BSF training kit. To strengthen local implementation, an online hub will be established to facilitate knowledge exchange among BSF operators, offering a platform for discussions, resources, and expert advice. Face-to-face training workshops will provide hands-on guidance, covering BSF facility design, operational procedures, and GHG savings calculations.

To ensure long-term sustainability, the project will assist governments in developing large-scale BSF project proposals and connecting with funding opportunities. Lessons learned will be compiled and shared across Sub-Saharan Africa to support replication, with an updated implementation guide and workshops targeting ministries, municipalities, and development agencies. The project will conclude with a publicly available final report, summarising outcomes and paving the way for future initiatives to expand BSF technology as a tool for sustainable waste management and climate action.

8 Links to other BUGS Documents

- **BUGS Project Factsheet**
  https://prevent-waste.net/wp-content/uploads/2025/07/FactSheet_BSF_2025-06.pdf

- **Country Factsheet Ethiopia**
  https://prevent-waste.net/wp-content/uploads/2025/08/factsheet-BUGS-Ethiopia_2025.pdf

- **Feasibility Guide Ethiopia**
  https://prevent-waste.net/wp-content/uploads/2025/07/Ethiopia-Guide-for-assessing-the-feasibility-for-BSF.pdf

- **Assessment Report Ethiopia**
  https://prevent-waste.net/wp-content/uploads/2025/07/2025-01-10-Assessment-report-Ethiopia.pdf

- **PREVENT Project BUGS Website** (including documents on Uganda and Côte d'Ivoire)
  https://prevent-waste.net/projekte/bugs-project-biomass-utilization-by-insects-for-green-solutions-in-africa-through-black-soldier-fly-technology/

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