Viability of the Black Soldier Fly Larvae pilot of Dhaka's Food System project

Assessment using the Roadmap approach

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Background Dhaka Food Systems project

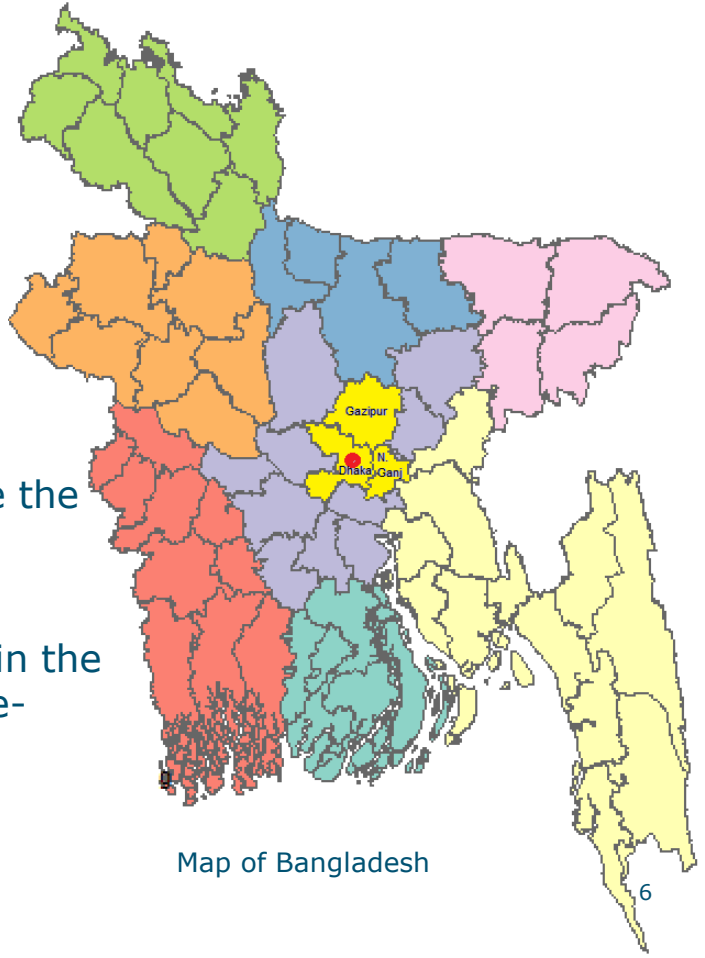
- Rapid urbanization of a growing population has challenged established efforts to ensure access to sufficient, affordable, nutritious, safe and sustainably sourced food.
- The effectiveness and resilience of urban food systems relies strongly on well-functioning food value chains, linking rural production areas to urban consumer markets. Addressing challenges in rural-urban food value chains is an effective entry point to improve urban food system outcomes.
- An integrated food value chain intervention roadmap approach was developed in the Dhaka Food Systems (DFS) project to support stakeholders in the process of selecting, designing and implementing interventions that aim to intervene in food supply chains and enhance the resilience of Dhaka's food system.
    - Link to intervention roadmap approach: https://doi.org/10.18174/632576
    - More information about the DFS project: https://www.wur.nl/en/research-results/research-institutes/centre-for-development-innovation/show-cdi/improving-dhakas-food-system.htm

Assessing the viability of the implemented pilot

- The intervention roadmap approach structures the problem and formulates a strategy to implementing the selected intervention successfully by creating a conducive environment.
- The intervention roadmap approach can be used in any city, region and country, and the roadmap makes the activities, timeline, resources and involved actors visual and replicable.
- The aim of this document is to showcase the activities that were needed to executed the BSF pilot, it assesses the economic viability of the pilot, and it describes the learnings to make the pilot sustainable in the long-term, and scale it towards other cities, regions and countries.
- This document is directly linked to the lessons learned report of the DFS project
    - This document can be found at the DFS project website: https://www.wur.nl/en/research-results/research-institutes/centre-for-development-innovation/show-cdi/improving-dhakas-food-system.htm

Black Soldier Fly (BSF) pilot strategy

- The rapid growing population in Dhaka generates an overwhelming amount of organic waste, and these waste streams are currently not managed properly.
- In combination with an increasing global demand for animal protein, this vast proportion of wastes could be upcycled and be reused by BSFs as protein source in poultry and fish feed.
- The aim of this intervention is to start a pilot to explore the feasibility of setting up BSF production systems in Bangladesh to reduce the amount of side streams.
- The demonstration pilot site of the BSF pilot is located in the Dhaka Metropolitan Area (DMA) (yellow area) at Sher-e-Bangla Agricultural University (SAU) (red dot).



Map of Bangladesh

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Black Soldier Fly (BSF) pilot characteristics

- An operational BSF unit with a maximum production capacity of 1 ton BSF larvae/week was started at Sher-e-Bangla Agricultural University (SAU). The BSF unit was managed manually
- The goal was to process organic waste and produce animal feed by using BSFs
- The BSF unit includes 1) waste seperation unit, 2) larvae rearing unit, 3) mating room, 4) hatching room, 5) larvae processing room and 6) feeding unit (poultry & fish)
- Larvae production was monitored and technical learnings were shared with the public and private sector





The objectives

1. Have a timeline overview of the key activities of the pilot
2. Explore the lessons learned of the pilot and consequent advice for further continuation of the pilot activities without the project's support
3. Explore lessons from literature about similar pilots
4. Draw conclusions about economic viability, sustainability and scaling of the pilot

Methods to achieve the objectives

Interviews with:

- Sher-e-Bangla Agricultural University (SAU) representative
- Poultry association representatives
- Wageningen University & Research (WUR) expert

Conducted in collaboration with and results validated by FAO

Literature study:

- Systematic literature search resulting in 85 studies
- Selection of key search terms: black soldier fly, value chains, waste, valorisation, economic viability, circular, aquaculture, agriculture, organic matter, food loss
- After further selection, lessons incorporated from 6 studies

Results

Overview of pilot activities and roadmap

- The success of implementing a selected intervention greatly depends on the conditions in which the intervention is implemented. It is therefore important to not only select an appropriate intervention, but also describe the necessary supportive actions and boundary conditions to create a conducive environment.
- The selected intervention (BSF production pilot) and supportive actions (all conducted activities to create a conducive environment for its execution and to create sustainability in the long-term) are 'classified' on implementation time, intervention type, intervention level and implementing actor.
    - An overview of the classified intervention and supportive actions is provided in a table (activities)
    - Thereafter the outcomes are visualized in a figure (roadmap)

Overview of pilot activities

* Below activities are not complete in all details, but summarize the key activities

Time	What	Repetition	Har/Org/Sof (a)	Mic/Mes/Mac (b)	Key actor(s)
a	1. Source waste streams; markets/restaurants/resident area	Once	Orgware	Meso	SAU & FAO
b	2. Built a BSF production facility	Daily	Hardware	Micro	SAU
c	3. Buy start material/eggs for BSF production	Daily	Hardware	Meso	SAU
c	4. Waste collection from markets/restaurants/residential area	Daily	Orgware	Meso	SAU & FAO
c	5. Waste seperation, including crushing and drainage	Daily	Orgware	Micro	SAU
c	6. Feeding larvae and flies with the waste streams	Daily	Orgware	Micro	SAU
c	7. Harvest larvae and process for poultry/fish feed	Daily	Orgware	Micro	SAU
c	8. Monitor production; growth, temperature, humidity, etc	Weekly	Orgware	Micro	SAU
d	9. Research excercise about nutrient composition	Once	Orgware	Micro	SAU
e	10. Train industry sector via workshop and demonstration site	Once	Software	Meso	SAU & FAO & industry
e	11. Train industry in Dhaka's 4 city corporations (CC) via worksho	Once	Software	Meso	SAU & FAO & city corporations
f	12. Train poultry farmers; theory and starting material	Once	Software	Meso	SAU & FAO & industry

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a. Hardware, software and orgware: Technology, competences & skills, and organisation
b. Micro, meso and macro level: Individual, group, and community/governmental level

Overview of pilot roadmap

PS = Private sector
GO = Governmental Organisation
NGO = Non-Governmental Organisation

Key lessons learned from the pilot (1)

Technical

- Bangladesh has ideal weather (temperature and humidity) for BSF production throughout most of the year, so no additional inputs, such as heating is needed during most months of the year
- Heavy winds and rainfall, and extreme temperatures, can become a huge problem when the BSF facility is not constructed and adapted for the extreme climate
- BSF productivity increased by using animal feces, animal side streams or starch streams (partly part of kitchen waste) as input source instead of fruit and vegetables streams only. Overal, 6-7 Mton waste is needed to produce 1 Mton of BSF larvea
- The pilot contributed to technical knowledge generation within Bangladesh about BSF production
- More research is needed regarding the safe use of BSF larvae in poultry feed, and therefore, the food safety elements of the final chicken products consumed.

Key lessons learned from the pilot (2)

Economic and market related

- The demonstration site, and workshops and trainings conducted during the BSF pilot, inspired other actors in the food system, mainly industrial feed producers
- The low-input-low-output system used in the pilot creates an economically viable system. Poultry farmers can reduce 30% of the feed cost and it only requires a considerable starting capital to build the BSF production and rearing facility
- Flexible daily purchase price of side streams in the urban setting was 0,50-2,00 $/bag. In the rural areas poultry farmers can use there own local generated (kitchen) waste
- Animal protein side streams to feed BSF larvae are not widely available for BSF production in the urban setting, due to competition with other stakeholders who purchase the side streams. In the rural areas poultry farmers can use their own side streams

Key lessons and advice from literature (1)

Lessons from similar pilots and activities described in literature can help to further optimize the current pilot activities to make them more economic viable and sustainable. These lessons can also provide ideas for continuation and scaling.

- The most significant burden of BSF production for poultry feed is energy use due to larvae processing (drying). The most promising and resilient margins are created when using the larvae as live feed for nearby poultry farms [1,2].
- At present, former foodstuffs containing meat, fish, catering waste and organic household waste are not legal to use as feed for insects in the EU due to food safety legislation. However, the applied EU regulatory framework has been constructed for vertebrates (e.g., fish, poultry, pigs, and cattle) which exclude insects. More research is needed on food safety [3].
- Utilizing insects, such as BSF larvae, for resource recovery is a potentially more cost-efficient use of organic wastes than simply composting alone, which is a fairly low value product [4].

Key lessons and advice from literature (2)

- Unless feedstock for rearing BSF is available on-farm, the profit margins might be limited due to purchase and transportation costs. The combination of insect-based frass organic fertiliser and animal feed provided higher economic benefits [5].
- To date, most manure-valorizing BSF larvae production systems operate at the micro-scale level. However, specific reduction targets for manure-related emissions will likely necessitate large-scale systems at the farm or industrial level [6].

[1] Salomone, R., et al., Environmental impact of food waste bioconversion by insects: Application of Life Cycle Assessment to process using Hermetia illucens. Journal of Cleaner Production, 2017. **140**: p. 890-905.

[2] Suckling, J., et al., Supply chain optimization and analysis of Hermetia illucens (black soldier fly) bioconversion of surplus foodstuffs. Journal of Cleaner Production, 2021. **321**.

[3] Gligorescu, A., et al., Production and optimization of hermetia illucens (L.) larvae reared on food waste and utilized as feed ingredient. Sustainability (Switzerland), 2020. **12**(23): p. 1-14.

[4] Quilliam, R.S., et al., Integrating insect frass biofertilisers into sustainable peri-urban agro-food systems. Journal of Insects as Food and Feed, 2020. **6**(3): p. 315-322.

[5] Beesigamukama, D., et al., Economic and ecological values of frass fertiliser from black soldier fly agro-industrial waste processing. Journal of Insects as Food and Feed, 2022. **8**(3): p. 245-254.

[6] Grassauer, F., J. Ferdous, and N. Pelletier, Manure Valorization Using Black Soldier Fly Larvae: A Review of Current Systems, Production Characteristics, Utilized Feed Substrates, and Bioconversion and Nitrogen Conversion Efficiencies. Sustainability (Switzerland), 2023. **15**(16).

Post-pilot continuation

Key lessons for continuation of the activities

- Focus on 2 different processes instead of one integrated process: 1) producing eggs for new parental material and for sale, and 2) growing larvae from eggs for feed purposes
- Find solution for egg storage during extreme weather circumstances and winter months
- Rear BSF larvae on poultry producer group, village or community level, instead of individual smallholder level
- Set up funds to maintain the demonstration site to be able to provide starting material (BSF eggs or flies) and training to the private sector (large- and small scale) in Bangladesh
- Stimulate the private industry (large- and small scale) in the further uptake of BSF production (e.g. subsidy for building a facility or the starting material)
- Focus on both the larvae production for feed purposes and on the frass (feces of flies and larvae) as organic fertilizer
- Research needed about consequences of microplastics in the diet of the larvae, and other technical, environmental, nutritional (protein and fat content) and food safety elements of BSF potential

Key lessons for scaling current activities to other cities and regions

- Semi-urban areas have more clean waste streams due to more availability of agricultural production sites. Consider to focus on these areas instead of urban settings
- Focus on waste separation in kitchens, markets and households to avoid post-separation
- BSF larvae grew under harsh conditions in the pilot site, while still being economically viable. This indicates that BSF larvae can be grown almost everywhere, but growth, and fat and protein content of the larvae can vary
- More research is needed on economic viability when using automated or environmentally controlled BSF production sites, in case of large-scale facilities
- Social acceptance by consumers of poultry meat and fish and food safety should be researched

Conclusion

- The low-input-low-output BSF production systems is an economic viable opportunity for poultry and fish farmers and large-scale integrated companies to replace part of the current feed inputs.
- The pilot contributed to technical knowledge development, but more research and long-term support is needed for further uptake by the private sector to make it sustainable.
    - Large-scale feed industry: Need technical support for production solutions for during difficult weather circumstances and sourcing material.
    - Small-scale poultry and fish farmers: Important to focus on 2 different processes instead of one integrated process, due to the technical challenges and waste material required.

More information

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