



Minimum Viable Product (MVP) Documentation
Black Soldier Fly Meal
for Fish Feed Production
University of Ibadan LL



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1. Overview

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1.1. Abstract

This Minimum Viable Product (MVP) explores the viability of the Black Soldier Fly (BSF) larvae meal as an alternative, high-protein ingredient in aquaculture feed formulation in place of conventional fish meal. The MVP involves the use of locally produced BSF larvae that are reared on organic waste, and processed for inclusion in a base fish feed formulation. The endpoint of the MVP is to prove that feed that is BSF-based leads to similar fish growth rates and health parameters as compared to the usual commercial feed. This resolves the issue of high cost and environmentally demanding current fish feed practices. Our MVP utilized **brewery wastes** to produce BSF thus contributing to the waste-to-protein/wealth model while producing raw materials (BSF-frass) for the production of organic fertilizer. The demonstration can convert waste to protein at scale and create a viable waste-to-protein model that is important to develop circularity and localize resources in the aquaculture sector.

1.2. Photos



Figure 1: Dried BSF larvae and the final, marketable product

1.3. Motivation and challenges tackled

The MVP was motivated to produce BSF meal as a substitute for fish meal in fish diet formulation. Fish is an essential animal protein source, but the cost of fish feed is high due to the high cost of fish meal. Meanwhile, insect protein can substitute fish meal in fish feed at a lower cost, and BSF can be used to degrade organic waste to produce cheap insect protein. The production of BSF meal for inclusion in fish feed is an environmentally friendly approach and the insect consumes agricultural wastes to generate tissue protein, thus mopping up agricultural waste. Furthermore, we were motivated by the fact that there is a need to increase production of the BSF meal as its supply is currently limited. According to a report by SEAFDEC/AQD, feed can account for over 50% of total production costs,

indicating it is an integral part of operational costs. Also, PSEAU reports that in urban West Africa, 50–90 % of many cities' urban waste is from organic sources (kitchen/food waste, etc.). This product therefore provides a double-sided solution to the issue of a) the high feed cost and b) excess unutilized organic wastes. Both of which are highly challenging situations in aquaculture in Africa today.

1.4. Feedback process

The innovator has implemented a BSF production unit of 10m x 10m area in his house. His operation is been technically supported by the staff of the UI Living Lab. Currently, the actor has self-produced about 50kg BSF meal /cycle.

2. Implementation

2.1. MVP Design

System Overview

The implementation of the MVP-BSF meal involves the BSF larvae production, BSF meal processing and meal packaging stages. The stages are described here:

1. **BSF Larvae Production:** This is the system where the BSF larvae are reared and fed with organic wastes. This acts as the sustainable input source for the BSF meal production. The BSF pupae are purchased from a reputable supplier and stocked in a 'reproduction cage' where males and females are conditioned to mate, after which both lovers die. The fertilised eggs are laid inside eggies provided in a mating cage. The laid eggs are scraped and incubated under suitable conditions inside incubation cartons. Hatched larvae are fed with brewery wastes to grow to pupae. The mature pupae are sorted out as a product (BSF), leaving out the waste BSF food and faecal remains as frass (an organic waste). The collected BSF pupae are subjected to processing into BSF meal.
2. **Processing of BSF larvae to BSF meal:** The harvested BSF larvae are oven dried/blanched to remove moisture, and milled.
3. **Packaging:** Processed BSF meals are weighed, then packaged into polyethylene bags for storage and or inclusion in fish feed formulation.

Key Components and Design Decisions

1. **Mating cages:** This is where the entire lifecycle of the BSF is completed. It is a netlike structure that allows for proper aeration while protecting the insects from predators. The INCITIS-Foods UI Living Lab has its mating cages in a screen house that allows for better control over predators, and temperature.
2. **Primary Input:**
 - a) **BSF feed:** Locally sourced organic waste material. The Living Lab utilizes Brewery waste sourced from the Nigerian Breweries to feed the BSF. This waste is used as the substrate/food for the bulk of the BSF's developmental stages. This feed comes in bags and are dispensed to the BSF often in dried form, but are sometimes moistened as the case warrants...
 - b. **Incubation trough:** 60cm x 40 cm plastic carton, black cover cloth, the spoon for mixing, and water
 - c. **Steel tray for sorting of larvae**
 - d. **The weighing scale (sensitive)**

- e. The oven
- f. The mill
- g. The polyethylene bag for packaging

Operational Procedure & Activities

- a) Stocking of BSF Pupae into Mating Cages: Healthy BSF pupae are transferred into mating cages (breeding cages) made of fine mesh that allows ventilation and light penetration. The cages are kept in a warm, well-lit environment (screenhouse) to stimulate adult emergence. Within 3–5 days, the pupae metamorphose into adult flies. Males and females become active, engaging in mating activities.
- b). Breeding, Egg Laying & Harvesting: Adult flies mate within the cages and females lay eggs in specially placed “eggies” made of wooden planks. They are then placed on (not inside) an attractant, a decomposing organic material (poultry waste). The eggies are checked daily for egg clusters, which are collected carefully manually.
- c) Egg Collection & Incubation: Collected eggs are weighed and transferred to small incubation trays containing a starter substrate (moist brewery waste) to facilitate hatching. The incubation period lasts 3–4 days, after which the neonate larvae emerge.
- d) Larval Rearing: Once hatched, the young larvae are gently transferred to larger rearing trays containing organic waste. These trays provide enough space for movement, feeding, and rapid growth. Here, larvae feed on the organic material provided (brewery waste). The substrate provides a nutrient-rich and moist environment (60–70% moisture content), and stirred periodically to prevent anaerobic conditions. Feeding continues for 10–14 days until larvae reach the prepupal stage.
- e) Substrate and Larvae Maintenance: The substrate is stirred regularly for proper aeration, uniform feeding, and temperature control. Moisture levels are monitored daily. Overly dry substrates slow growth, while excess moisture causes suffocation and odour problems. The trays are covered with mesh or fine netting to prevent the entry of predators such as lizards, ants, or rodents. The rearing environment is kept clean and temperature-stable to optimize larval development and survival rates.
- f) Harvesting: When larvae reach the late instar or prepupal stage (around day 18–21), they are separated from the residual substrate. This is done manually by handpicking and using sieves. The harvested larvae are rinsed and prepared for further processing.
- g) Processing: Harvested larvae are oven-dried to reduce moisture to about 10%. Dried larvae are then ground into BSF meal, a high-protein ingredient suitable for fish feed formulations.

2.2. Bill of materials and required tools

Table 1: Bill of materials

Item	Quantity*	Unit cost (Euro)	Total cost
Mating cages	4	43	172.00
Eggies (wooden planks)	20	0.12	2.40
Plastic Crates	10	4.3	43.00
Sieve	20	0.12	2.40
Brewery Waste	20kg	0.26	5.20
Black Breathable Covering Clothes	2yards	1.72	3.44
Oven	1	51.6	51.60
Total			280.04

Table 2: Tools required

Item	Quantity	Unit cost (Euro)	Total cost (Euro)
Thermometer	1	6.02	6.02
Hygrometer	1	6.88	6.88
Larval counter	1	129	129
Sensitive Scale	1	6.02	6.02
Total			147.92

3. Economics

3.1. Business model

The business model aims for marketing the dried larvae to aquaculture feed producers as a substitute for other protein sources. Alternatively, the aquaculture feed production step can be included into the business model, aiming for aquaculture farmers, requiring a bigger investment, but also incorporating the additional value generated in the feed formulating step.

- Sourcing and Procurement of substrate for feeding of BSF larvae
- Breeding of BSF larvae
- Processing of BSF larvae
- Fish/Livestock feed formulation and incorporating BSF meal into fish and animal diets
- Packaging of MVP
- Distribution/Marketing/Sales of MVP

4. Future improvements

4.1. SWOT analysis

STRENGTHS

- Waste-to-Resource Model: The system efficiently converts low-value organic waste into a valuable, high-protein feed source, supporting a circular economy.
- Reduced Environmental Impact: By replacing fishmeal, the MVP lowers the dependence on industrial feed mills and significantly reduces waste volume and associated emissions.
- High Protein/Fat Content: BSF larvae offer an excellent nutritional profile (Crude Protein $\approx$ 40%–50%), making them a top-tier alternative to conventional feed ingredients.

WEAKNESSES

- Frass and Deadflies Management: The process generates a large quantity of frass (larval droppings) and large amounts of chitin (from dead/shed flies), which require further processing or disposal.
- Technical Know-How: Operating the system successfully requires specialized knowledge in insect rearing (e.g., maintaining optimal temperature, humidity, and substrate quality) for consistent production.
- Substrate Variability: The nutritional quality of the final BSF product can be inconsistent depending on the organic waste used for feeding.

OPPORTUNITIES

- **Value-Added Products:** Frass and the chitin-rich dead flies can be further processed into high-value secondary products, such as liquid fertilizer (from frass) and biopesticides (from processed chitin).
- **Easy Market Penetration:** The aquaculture market is actively seeking sustainable feed solutions, creating a large, receptive, and growing market for BSF larvae.
- **Health Benefits:** BSF products often contain antimicrobial compounds (like lauric acid), which can enhance fish health and immunity, acting as a natural functional ingredient.

THREATS

- **Consumer Perception/Bias:** Public discomfort or regulatory caution regarding insect-based feeds may slow full-scale adoption, despite scientific evidence of safety and quality.
- **Predators and Pathogens:** Uncontrolled environmental factors can lead to infestations by pests, mites, or diseases, potentially wiping out entire colonies.
- **Climate Issues (Uncontrolled Environments):** If production is not fully climate-controlled, extreme heat, cold, or humidity can halt the breeding cycle and larval growth, leading to unstable production output.

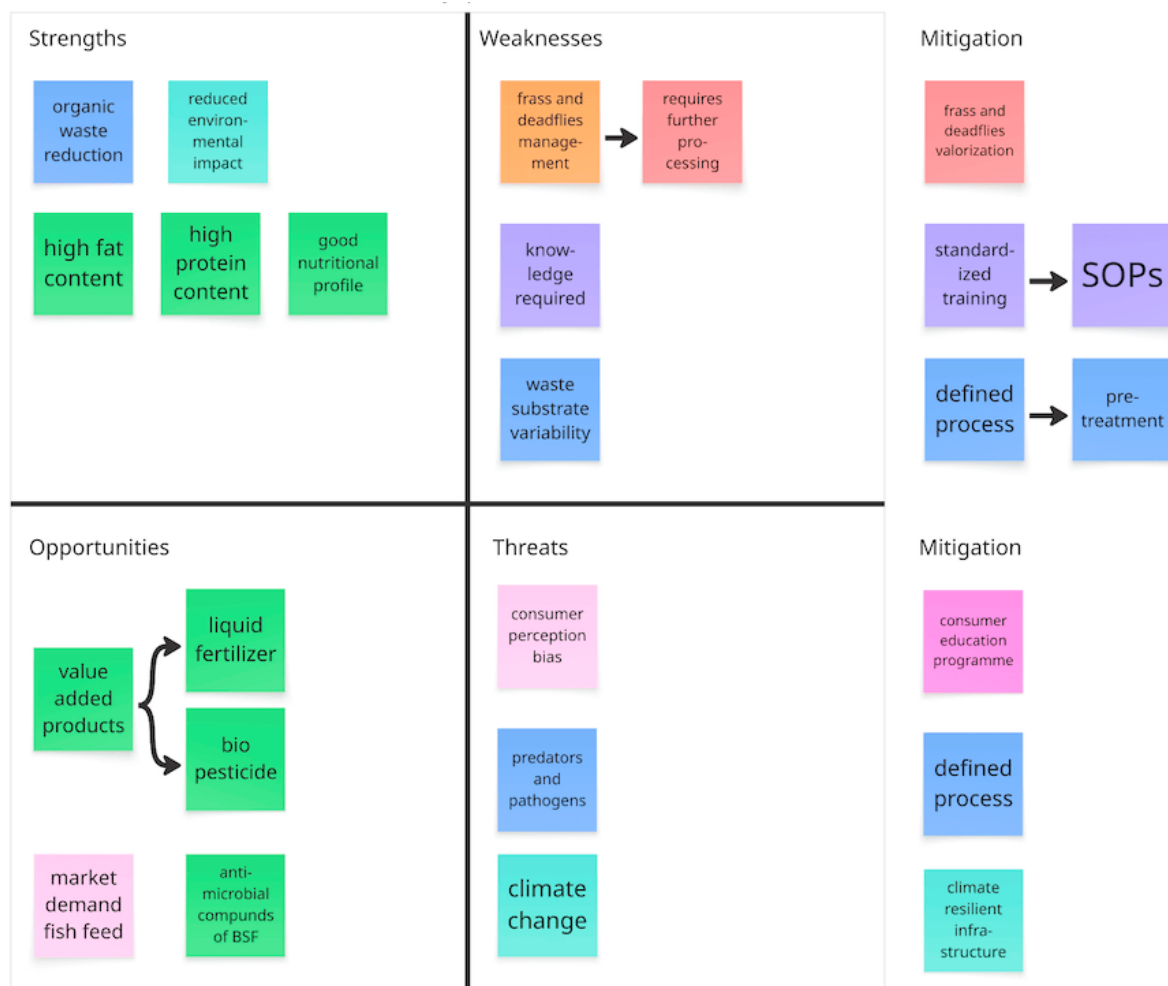


Figure 2: SWOT - UI LL - BSF based fish meal from brewery spelt

4.2. Optimization

Optimization focuses on enhancing the efficiency, consistency, and cost-effectiveness of the MVP:

- Frass and dead flies Valorization: Integrate simple, low-cost processing procedures to turn frass into a liquid fertilizer and to collect or process chitin from dead flies for biopesticide application.
- Standardized Training: Develop a clear, realistic Standard Operating Procedure (SOP) and training program to impart the necessary technical know-how to operators, assuring reliable production quality and consistency.
- Substrate Consistency: Implement a comprehensive process for pre-treating and standardizing the organic waste input to prevent changes in the nutritional composition of the final BSF feed product.

4.3. Threat mitigation

Mitigation focuses on limiting the danger and impact of external threats

- Climate-Resilient Infrastructure: Implement simple, modular insulation and basic automated controls (ventilators) to stabilize the breeding and rearing environment, decreasing the influence of climatic issues and assuring steady year-round production.
- Consumer Education Campaign: Launch a transparent campaign using scientific facts and testimonials to educate farmers and end-consumers about the safety, quality, and environmental benefits of BSF feed, proactively addressing consumer perception/bias.

5. Appendices

5.1. Additional Photographs



Figure 3: Mating Cages



Figure 4: Eggies for egg collection



Figure 5: Growth process of BSF Egg-Pupal stage



Figure 6: Harvested Larvae