

Black Soldier Fly Production

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What is the problem/challenge being solved?

Black Soldier Fly (BSF) cultivation offers an affordable alternative sustainable source of proteins that can be used to replace fish meal and oil in animal feed formulation. Thus, the costs for animal feeds are reduced and organic wastes that are a major environmental threat in urban areas utilized.

What is the solution developed in Living Lab?

Egerton LL has invested in rearing of BSF and using the Black Soldier Fly Larvae in fish feeds formulations. In addition, the frass, a by-product of BSF rearing can be used as organic fertilizer to fertigate vegetables. This circular food system approach reduces organic waste and thus enhances resource efficiency.

Implementation of Black Soldier Fly rearing

Biology of Black Soldier Fly

Black Soldier Fly is an insect, the name comes from the color of the adults which are black with metallic reflections. In contrast with the house fly, BSF is not a pest. It does not bite, sting and is not able to transfer diseases. BSF Life cycle is presented in Figure 1.

Climate factors can affect or interrupt the life cycle; therefore, it has to be observed and adjusted when necessary.

Figure 1. Life cycle of Black Soldier Fly



Preparation of facilities for rearing of BSF

Factors to considered in BSF Facility site selection:

- Availability of sufficient organic wastes for feeding BSFL
- Availability of adequate water for feeding adult flies and personal hygiene
- Away from residential areas due to emanating smell from the waste collected or located downwind near residential areas

- Easily accessible for daily routine operations such as turning of BSFL substrate
- Sufficient lightning, when depending on sunlight consider space with high light duration during the day.
- Sheltering of rearing with proper ventilations to protect from adverse weather changes e.g. rainfall
- For household production consider the backyard of your home.

Facility sections

BSF facility has four recommended sections:

- Larvarium is the section for feeding the BSF larvae.
- Insectarium – a section for breeding the adult flies
- Hatchery – a section for incubating female BSF eggs
- Waste unit – a section for waste processing/screening

Larvarium

Larvarium consists of BSFL feeding containers or trays. These can be commercial trays or trays prepared from locally available materials.



Figure 2. Commercial trays



Figure 3. Locally produced larvae containers using readily available materials. For example: jerricans or barrels cut into halves



Figure 4. Concrete trays were built by local farmers

Requirements for larvarium:

- **Provide darkness/shaded area** as larvae are photophobic (hate light) they burrow in the substrate while feeding.
- **Temperature and relative humidity:** The larvae release heat hence a temperature of about 20°C – 30°C and relative humidity of 60%-70% are optimal.
- **Feeding Containers** should not be too deep, a depth of 5 – 12 cm is appropriate, depending on the nature of the substrate
- **Feeding substrates:** These include various organic wastes that are readily accessible, such as (i) non – ruminant animal manure e.g. chicken poo, pig waste, (ii) municipal organic waste, (iii) cookies and breweries waste, (iv) post-harvest waste, (v) kitchen waste. When choosing a feeding substrate the following factors should be considered: Availability and accessibility, quantity and quality, consistent supply, and transportation distance.
- Younger BSF larval stages (L1 – L2) require finer substrates because they have no chewing parts while older stages (L3 – L5) require coarser/larger particles.
- **Feeding regime:** Introduce the larvae into the feed not the feed into the larvae. The feed substrate needs to be in the container first then add your larvae; they will feed as they burrow to a depth of about 2 cm.

- Larvae eat twice its body mass per day.
- The larvae should be fed depending on the intended purpose: feed, brood colony, frass or even briquettes. For feed (protein) feeding twice its lifespan (weekly) is reducing cost of labor. Frass and brooding colony frequently as you harvest the frass.

Insectarium

Insectarium is a section where adult flies are trapped in love cages to mate and the female lay eggs (Figure 5). Adult flies do not eat.

Figure 5. Love cage is the section where adult flies are trapped to mate and female flies lay eggs.



Requirements for Insectarium

Source of light (direct/artificial light) and flight space

- Adults are photophilic (love light) hence crowd in the direction of light. Locate the love cage in sides that allows optimal sunlight quantity and quality to enhance mating (they mate in light during flight).
- Consider a flight space of 1.5 m when constructing a love cage for male BSF to fly to enhance mating

Temperature and relative humidity

- Provide temperatures between 25°C – 35 °C and relative humidity above 60% to enhance mating and oviposition (egg laying)
- Use a thermo-hygrometer to determine temperature and humidity

Attract substrates

- Introduce a decomposing matter (smelly, fermenting substrate) i.e. tropical fruits wastes, waste breweries, manure to attract and induce mated females to lay eggs
- To collect maximum eggs, cover the attractant container with a netting material to enable the females to lay eggs in the eggies crevices.

Water Points

- Introduce drinking water points using spongy or cloth materials to prevent them from drowning
- Sprinkling water also provides adequate humidity and prevents adult dehydration

- Glucose/sugar can be added to provide energy for the mating adults and increases their lifespan up to 10-12 days

Egg laying material ("eggies")

- Female adults lay eggs in small, dry spaces; one can use corrugated plastics/cartons or tied pieces of wood.

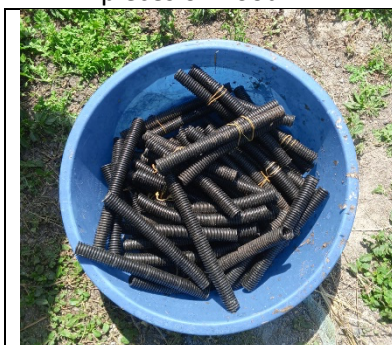


Figure 6. Corrugated plastic eggies



Figure 7. Carton eggies.



Figure 8. Wooden eggies.

Perching and mating site

- Use potted plants, sponge surface or hard ground surface majorly for male adults to rest as females are always found round oviposition areas
- Mating start in the air (1.5 m) and is completed on perching sites/leafy plants

Hatchery

This is a section of hatching eggs. The requirements are;

- Optimal temperatures of 27°C – 30°C and relative humidity of about 50% - 60%
- Complete darkness; neonates are photophobic
- Highly nutritious substrate (higher carbohydrates) should be preferred as a hatching substrate i.e. fine potato waste, maize germ chick mash.
- Special feeding containers; consider small size containers to help maintain moisture in the substrate

Waste Unit

This is a section for receiving waste, screening and processing (Grinding, mixing etc.). Waste is stored in containers (Small scale farmers)

Routine practices in BSF facilities

Hygiene – Cleaning up is done daily to reduce odor and keep away predators

Temperature and Humidity regulation – During the day open the ventilations when it's hot and close them during the night being cold to help maintain the optimum temperatures. Record daily temperature and humidity at least 3 times a day.

Feeding – Providing adult flies with water (sprinkling on the nets) daily. Feeding larvae, consider your feeding regime.

Harvesting – Harvest eggs at least after every 3 days. Harvest larvae when still cream/beige in color (14 days). Harvest frass once the substrate is fine and dry.

Post harvest practices

Larvae

- Blanching – immersing in hot water for about 2-5 minutes to kill the larvae
- Drying – This could be done under direct sunlight, greenhouses or oven
- Feeding – The larval stage (dried) can be used to feed poultry, pigs and fish directly as protein supplement at a quantified ratio recommended by a food nutritionist
- Value addition – The larvae can be used in feed formulations to make pellets for livestock as a protein/amino acids source

Frass

- Further compost using additional organic nutrient rich components (N:P: K) to get balanced nutrient composition

Predator, disease and precautions

- Predators – Spiders, Rats and mice, Ants, Snakes, Lizards, Frogs

Precautions against predators

- ✓ Physical barriers – elevated stands from the floor. In each leg of the stand put in a plastic container place in a second one filled with water optionally add chilly/pepper or salt to the water
- ✓ Clear the bushes/thickets around your rearing unit because they could be hiding places for predators
- ✓ Predators like ants are very innovative ensure there is no crack or anything that can incline them to get into your rearing unit

Diseases; little diseases have been reported to attack BSFL. Observe and take pictures of what you feel could be a disease infection. Share with experts/research institutes around you.

Data Recording

This depends on how a farmer intends to keep his/her records there is no criteria of how to do it. Ensure all activities are recorded and traceable. Label the crates/trays or love cages, and fill in data sheets.



Figure 9. Labelling of crates

Table 1. Example of data recording sheet for larvarium.

Farmers/ Attendant name					
F/Tray no.	Date: Larvae introduction Date: Quantity of larvae in gram	Date: 1 st Feeding Quantity in kilograms	Date: 2 nd Feeding Quantity in kilograms	Date: Wet Larvae Harvesting Quantity in kilograms	Remarks & observations
1.	15/08/2023 100 g	15/08/2023 5 kg	22/08/2023 3 kg	30/08/2023 2 kg	Good biomass
2.					
3.					
Etc.					

How to start the production

- ✓ Obtain knowledge on BSF production from expert institutions or persons through training
- ✓ Ensure you have the right structures (be innovative)
- ✓ Obtain your brooding stock (eggs, larvae or pupae)
- ✓ Maintain the first cycle
- ✓ Monitor your cycle and enjoy the adventure!

Table 2. Trouble shooting

Problem/Question	Possible cause	Suggested solutions
Hatching substrate forming molds Reduced hatching rates	Too high humidity Low/high temperatures	Maintain humidity at 50% - 60% Maintain temperatures between 27°C – 30°C
Upper food substrate not consumed by the larvae	Too much light	Turn the substrate Reduce light intensity in the larvarium
Bottom food substrate not consumed by the larvae	Too deep feeding container	Get a container of 5 – 12 cm depending on the feed substrate Larvae burrow up to 2 cm to feed
Larvae crawling out the feed tray Larvae death	Substrate too hot/too wet Too high temperatures in the larvarium	Maintain humidity at 50% - 60% Maintain temperatures between 27°C – 30°C
Stunted larval growth	Poor feed substrate choice Underfeeding	Prefer a well-balanced feed substrate
Smelly substrate when larvae is feeding	Formation of anaerobic zones	Turn the substrate for aeration Provide enough quantity of feed; avoid overfeeding
Ants in the feeding trays/love cages	Cracks Inclined materials e.g. grass Type of feed substrate e.g. kitchen waste	Take precautions i.e. use of water traps at the legs of the stand Maintain hygiene
Reduced brood stock	Parasitoids Poor feeding	Use an optical net to prevent entry of parasitoids Good hygiene and screening of waste Proper feeding
Adults flies not mating	Unfavorable temperatures Not enough flight space Not enough resting surface Low light intensity	Maintain temperatures between 26-35°C Provide flight space of about 1.5 m Provide potted plants for resting Ensure enough light (direct sunlight)
Females not laying eggs	Poor quality of attractant Low humidity around the oviposition area Poor choice of eggies	Use fermenting tropical fruits/chicken poo as attractant High humidity around the oviposition area Wooden eggies/box eggies with small, dry crevices
Many dead flies in the love cage	High temperatures	Maintain temperatures at optimum level
Small size of flies	Poor feeding at the larval stages	Provide well balanced feed substrate