

PROCEDURAL GUIDE



AgriCOOPh



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Organic Waste Bioconversion and the Domestication and Propagation of the Black Soldier Fly

This simple step-by-step guide is meant to show the basic procedures in converting organic waste by the **Black Soldier Fly (BSF)** larvae into residue or frass and larval meal as animal protein and fat source. It will also exhibit the way to achieve the complete life cycle of BSF to ensure its propagation.

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AgriCOOPh VNU Worm Farm, Brgy. Poblacion, El Salvador City, Misamis Oriental;



Vegetable waste comprise part of organic waste that needs to be addressed globally.



The adult Black Soldier Fly, *Hermetia illucens*, Linnaeus 1758.

Economic Significance of BSF

BSF has gained significant attention in organic waste management, specifically, in its bio-conversion of organic waste into valuable products, **frass** as organic fertilizer, and **larval meal** as important sources of proteins and fats for animal feed. The use of this insect provides the following advantages:

- BSF larvae have voracious appetite for organic waste, reducing bacterial growth and odor; the variety of organic waste they process may be highest among flies in short period of time, and making it the best potent recyclers of organic waste, reducing contamination while adding value to waste;
- Emit relatively low greenhouse gases and little ammonia;
- BSF larvae have high feed

conversion efficiency;

- BSF larvae is a useful animal feed source, containing 40% protein and 30% fat for use as energy for adults and has similar amino acid profile as that of the expensive and depleted fish meal; BSF larvae contain natural antibiotics and reduce the concentrations of pathogenic microbes;
- BSF require significantly less water and land area that cattle raising or soybean production;
- They compete and suppress the housefly, a major mediator of disease, by producing an allomone; as adults, BSF has only redundant mouthparts and do not feed and therefore, is not a disease vector;

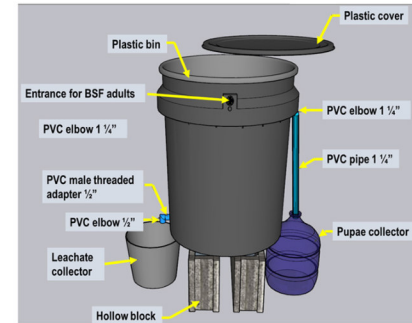
- Fully safe for humans: does not feed on grains, invade human habitats, or carry pests and diseases;
- BSF significantly play a role in circular economy.



BSF Larvae

Business Tagline or Motto

NATURAL COLLECTION OF BSF



An improvised plastic bin is used for daily dumping of kitchen waste but is provided with an inlet for the entrance of BSF adults which are attracted by the rotten smell of the kitchen waste. This utility bin provides households to convert the kitchen waste into fertilizer and animal feed for backyard gardening and animal raising, respectively, while reducing the amount of organic waste to be dumped in the sanitary landfill.

The improvised bin is added with kitchen waste daily but on the 10th day, first sighting of BSF larvae is observed. Thereafter, the larvae continue to feed on the kitchen waste for up to 3 weeks or months. One can observe the larvae when the waste pile is stirred from the bottom with wooden or PVC pipe. As following the reported life cycle of BSF, dark brown larvae or pupa are seen crawling out of the household bin on the 28th day. These



Inside view of the household bin showing the cardboard strips attached to the side of the bin.

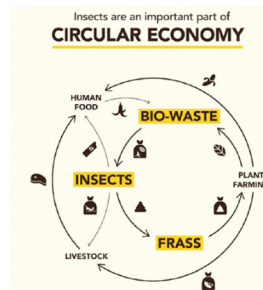


Chickens eagerly await the pupae crawling out of the bin.



A modified PVC pipe inside the bin facilitates the exit of the pupae from the bin.

pupae have already stopped feeding and needs to find a dark place to go into the next phase of its life cycle and to later emerge as an adult. However, since the insect's exoskeleton has not yet hardened, it can still be fed to chickens, pigs, fish, and pets. When fed



From: ESC Project “Have Less, Live More” at Initiative et Développement Citoyen, France



Situated in El Salvador City, Misamis Oriental (inset map), VNU Worm Farm is a small, start-up, low cost company which provide evidence for the proof-of-concept on the bioconversion of organic waste by BSF. In less than 4 months, it completed several life cycles of BSF utilizing vegetable waste from a public market and a fast food restaurant. Frass supported growth of vegetables and BSF larval meal were fed to chickens and pets.

PHILIPPINES
Misamis Oriental





Native of tropical, sub-tropical and temperate regions of the American continent, BSF is now-days present in the rest of the world and has been found in many countries across Europe, Africa, Oceania and Asia. The whole life cycle lasts about 40-50 days.

Distribution and BSF Life Cycle

Adults live for about 8 days to reproduce before dying. Females lay about 500-900 eggs which take about 4 days to hatch. The larval stage, with 5 waste feeding instars, lasts from 13-18 days. At the 6th larval instar, it reaches the pre-pupal stage, and no longer feeding lasting 7-10 days. It enters the pupal stage (resting stage) for at least 8 days. Thereafter, the adults emerge as fly.



Feeding the BSF Larvae

Waste Pre-processing

The waste is processed to reduce its moisture and cut into smaller pieces or shredded to facilitate feeding by the larvae. Furthermore, a 1% solution (1 tablespoon or 10 mL in 1 liter of water) of Effective Microorganisms is sprayed into the surface of the waste to eliminate odor and enhance decomposition. There are several innovative ways of reducing the moisture content such as placing the chopped or shredded waste in an inclined used corrugated sheet for the leachate to flow and collected into a container. Another way is to place the waste in a sack which is then placed in another sack so the leachate can be separated from the waste. In this manner, weights such as big stones can be placed above the waste to press it. Covering the processed waste will allow it to be fermented facilitating the feeding of the BSF larvae.

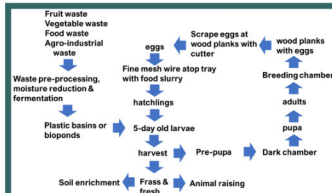
Larval Feeding

About 5 – 7 kilograms of fermented waste is placed in a plastic basin. It might be better to provide a mixture of organic waste (vegetable waste, animal manure, used cooking oil, fish offals, etc.) to provide more quality frass and larval meal in terms of organic matter content, proximate composition, amino acid and highly unsaturated fatty acid profile.

The 5-day old (5 days after hatching) larvae in the slurry (see in the next section on Egg Hatching to Nursery) are added to the organic waste or its mixture. As the larvae are photophobic, they will go to the bottom of the waste or its mixture to proceed its feeding behavior.

Harvesting

The larvae will change its color from beige to dark brown and its this time when they are separated from the frass using a manual sieve. About



Process flow of biowaste conversion & BSF domestication & propagation



BSF larvae feeding on fruit and vegetable waste.



10% or less of the dark larvae placed in a small tray and stacked in the dark room of the breeding cage to continue the propagation as all adults

BSF Farming

Pre-pupa

When the larvae becomes dark brown and light gray in color, it has reached its final larval stage: the pre-pupa. At this stage, the larvae replaces its mouthpart with a hook-shaped structure which it uses to easily move out and away from the food source to a dry, humus-like, shaded and protected environment. Thus, the dark room at the bottom of the breeding cage fully imitates this condition.

If the environmental conditions in the dark room do not change too much in that it remains warm, dry, and shaded, the emergence of adults will begin on the 10th until the 25th day after the pre-pupa are placed in the darkroom.

Adults

Through the light from the breeding cage, the adults will emerge and live for about a week. During this short life, it will search for a partner, copulate and in the case of females, lay eggs. As the adults do not feed, only a source of water or humid condition is required to keep them and the eggs (later) hydrated. Thus the breeding cage is continually misted every morning. Also, natural light and a warm temperature of 25 to 32°C is required at this stage. Flies prefer to copulate in the light of the morning and the females search for an ideal place to lay eggs.

Egg Laying

Females that are ready to lay eggs are attracted by smells from decaying

organic matter. Thus, an attractant is prepared composed of 1 cup of muscovado, 1 cup chicken feed booster, and 2 cups of water and placed in a plastic tray. The mixture is stirred and allowed to ferment before the tray is placed inside the breeding cage. On top of the tray, wooden planks, bound 2 apiece by rubber bands are placed to act as egg collectors or eggies in some manuals as females deposit their eggs in interstices to hide from predation, and close to a potential feed source.

Egg collection

About 5 days after the adults have emerged through a small (3-inch diameter) opening in the dark room towards the netted breeding chamber and illuminated by the natural light, the eggies are checked for the presence of eggs. The eggs appear as yellowish clumps and are scraped gently by a thick paper and transferred to a fine wire mesh atop another tray containing the attractant.

Egg hatching to Nursery

This process is also known as hatching shower as the eggs hatched in 5 days after depositing in the fine wire mesh and the newly hatched larvae or hatchlings drop from the fine wire mesh into the tray with attractant and thus referred to as "showering." The attractant will now serve as the first food for the hatchlings for 5 days.



Wooden rack holds several plastic basins which serves as larval feeding trays.



BSF Breeding cage



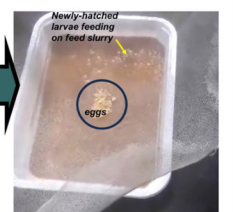
BSF Egg clumps seen in between wooden planks used in egg collection



The BSF larvae undergo several color changes from light brown or beige to dark brown and greyish during its larval development until it emerges as an adult fly.



Scraping eggs with a cutter



Newly-hatched larvae feeding on feed slurry