Centre for insect Research & Development

BSF FARMING TRAINING MANUAL

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BSF TRAINING MANUAL

Forward

Owing to the growing global demands for cheaper alternative protein for poultry, pigs and aquaculture, there has been a significant shift in focus to insects as alternative protein source. Insects are efficient utilizers of space, water and labour, and generate high value protein needed in human and animal nutrition.

This training manual focuses on basic rearing tips for the black soldier fly larvae (BSFL). It has inbuilt lessons from many years of practical trials by Dr. Deborah Ruth Amulen & the team at the Centre for Insect Research and Development (CIRD). CIRD's core aim is to promote simplified cost-effective backyard rearing models for black soldier fly larvae. At CIRD we also do believe significant employment and business opportunities can be created from industrialized black soldier fly/larvae farming. Hence we strive to provide quality BSF rearing materials to support sustainable BSF farming as a business.

ABOUT THE AUTHOR

Dr Deborah Ruth Amulen (PhD) holds a PhD in Applied Biological Sciences from Ghent University Belgium. She has extensive post-doctoral training from Michigan State University (USA) on Utilization of black soldier fly larvae for rural development. She is also a lecturer at Makerere University, Department of Livestock & Industrial Resources, College of Veterinary Medicine, Animal Resources and Biosecurity (COVAB).

Dr Amulen has more than 15 years of experience working with beneficial insects such as honeybees & black soldier fly. First as a scientist and secondly as an investor. She and a fellow scientist registered Center for Insect Research and Development (CIRD) where some dreams such as commercialization of research ideas and trials of innovations before community scale up are made possible.

Dr Deborah is very passionate about transforming communities through commercialization of beneficial insects. She has bold ideas of developing high value products from beneficial insects. For this to be possible, she strongly believes communities must be part of the broad vision. One step of achieving this vision is the development of simplified training manual to provide knowledge required for improved adoption of BSF rearing as a source of protein for formulating animal feeds.
At CIRD we are also committed to building a sustainable BSF value chain through various support services and innovations.

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MODULE ONE

What is Black soldier (BSF) fly

Learning Outcome: At the end of this session, participants should be able to explain the importance of commercial BSF larvae rearing for economic development.
The aim is to increase awareness and adoption of BSF farming

The black soldier fly (BSF), scientifically known as ***Hermetia Illucens*** is a naturally occurring fly in the environment especially in the tropics like Uganda. This fly is not currently known to transmit any diseases to humans and animals. It's larvae (maggots) is rich in protein therefore it can be fed to fish, pigs and poultry. Ugandan farmers should consider adopting farming of this useful insect because of many factors listed below.

The Role of Commercial Black Soldier Fly Farming in Rural & Urban Development in Africa

Cheap alternative Protein Source

BSF larvae feeds on organic waste to generate nutritious protein that can be fed to pigs, fish, chicken and pets (dogs & cats). currently, poultry and pig farming is limited by the high costs of feeds. Many farmers are increasingly abandoning their enterprises due to these expensive feeds. In Uganda, the current price of 1kg of silver (mukene) is approximately 4,736 to 5,624 Ugandan shillings (1.28 to1.52) USD,) yet a Kg of BSF Larvae ranges between 1,850 to 3,182 Ugandan shillings (0.5 to 0.86 USD). Fish meal is one of the key ingredients in animal feeds and because of high competetition between humans and animals for the fish, it is increasingly challenging to obtain this ingredient. Therefore, BSF larvae are a suitable alternative since animals (chicken, pigs & fish) naturally consume these larvae. Besides in Uganda, there is high acceptability by farmers to use larvae for animal feeding.

Low-cost business to start

Farming of Black soldier larvae is affordable. A farmer needs to have access to organic waste, have BSF farming skill, starting stock and space where to rear the insects. In Uganda, there are emerging farms selling eggs, pupae and neonates. A farmer also needs access to the BSF net for adult cage rearing and containers for larvae rearing. Trainings of BSF farming are readily available, Center for Insect Research and Development (CIRD) is one of such training centers.

BSF fly farming helps manage environmental organic waste

The larvae (maggots) of the black soldier fly are known to have high affinity for organic waste and have since been promoted as a suitable organic waste recycling method. The use of BSFL in organic waste recycling offers far more enriching benefits instead of dumping this waste in landfills or incinerating.

The outcome of the BSFL recycling process yields protein, fertilizers and other by products of BSFL which can be sold like oils. The BSFL (larva) consume all types of organic waste ranging from rotting crops, fruit waste, sweet potatoes and restaurant food. It is also known to consume chicken and pig manure. In commercial BSFL recycling, the farmer has to ensure there is a balanced ratio of the different types of nutrients in the organic waste for the best growth results of the maggot.

BSFL farming technology uses less water

Water for agriculture is an increasingly scarce resource. Farmers are encouraged to adopt farming practices that utilize less water while yielding high outputs. The business of rearing BSFL (Maggot) utilizes less water. For example the at CIRD we use approximately 0.5 litres of water to produce 1kg of Black soldier fly larvae compared to 2,300 litres of water required for soyabean. That means you need 4600 times more water to produce 1kg of soya compared to a kg of BSF.

BSF fly farming generates diverse products of economic value

The black soldier farming value chain generates numerous economic benefits. By adopting black soldier fly farming, a farmer can generate many products such as protein, chitin, organic fertilizers and numerous biotechnological applications.

Protein: BSF larvae can be promoted as an alternative protein source to replace fish meal (mukene) in the formulation of animal feed diets. Currently, livestock and fish farmers face a key challenge of high costs of animal feeds. The most expensive ingredient is protein. We therefore promote maggots as a cheap alternative protein to help farmers cut costs of production.

Organic fertilizer:

The waste material left after BSF larvae has recycled waste is considered very useful organic fertilizer. BSF ferterlizer is cheaper than commercial feterlizers. Currently at CIRD we sell organic fertilizer at 500 Ugsh per kg. Other BSF companies sell it at 900 per kg. The market price for commercial feterlizers is 3,900 Ugsh per kg. Meaning BSF ferterlizer is 7.8 times cheaper than commercial ferterlizer.

Oil and Chitin: The oil extracted from BSF larva is reported to be as good as coconut oil. It can be used to make skin care products such as lotions and soap. Chitin can also be extracted from pupae shells and dead flies; this compound can be used as medicine. Chitin is reported to have immunological effects and its beneficial in the treat- ment of lung diseases like asthma.

Biotechnological applications of BSF:

Due to the increasing antimicrobial drug resistance (AMR), new medicines for livestock and humans need to be developed. Antimicrobial peptides can be extracted from BSF larvae. Besides there is grey literature indicating that organic fertilizers from BSF have nematocidal properties. Meaning the fertilizer can be used for pest control in crop farms.

SESSION TWO

The Biology and Rearing of Black Soldier Fly Larvae

LEARNING OUTCOME: After training, participants are expected to understand how to rear maggots and adult pupae. Know the age at which to harvest the larvae for feeds and how to rear pupae (breeding stock).

The duration of the lifecycle of this fly influenced by:

There are four stages of the black soldier fly, that is the eggs, larvae, pupae and adult (Figure 1). To be able to farm the larvae a farmer needs to understand what to do at every stage of the life cycle. Typically, it takes an average of 40 days or more to complete the BSF fly life cycle from egg to egg. At our CIRD farm we take an average of five (5 weeks) to have adult flies from egg. This duration can be extended to six weeks if the temperature is very cold (below 25°C) and larvae also die if the temperatures are higher than 30°C.

Figure 1: Graphical illustration of BSF fly life cycle.

Factors that influence the duration of the BSF fly lifecycle

Temperature

Normally the favourable condition is between 26-30°C. If temperatures are lower, it will slow the lifecycle. Very high temperatures reduce the lifespan of adult flies. In the larva rearing room, high temperature may reduce the moisture content in the substrate, so the farmer or person managing the unit must constantly check on the moisture content of substrate to avoid desiccation.

Humidity

The favourable humidity is 60-70% to allow feeds to be moist enough to be consumed. However, very wet food delays larval growth and also makes a lot of the larvae crawl outside the rearing container as they avoid excessively moist conditions. Very dry environments may lead to quick drying of organic substrate, the farmer can constantly moisten the feed.

Quality of feed

A very good substrate with balanced protein and carbohydrate content increases the growth rate of the larvae. In our experience the BSF larval stage can be reduced by 3 days if the quality of feed is good. An example of a balanced feed is a mixture of restaurant food waste & brewers waste (1:2). Farmers are encouraged to experiment their own feed formula using available wastes in their locality.

Stage one:

The black soldier fly (BSF)

The BSF fly is black in colour with white legs. The body of this fly is narrow and about 2 cm long. The adult fly has no developed mouth parts so does not feed at adult age but survives on the fat reserves built up during the larva stage. These flies do not sting and they do not vector any diseases. They only live for an average of 7-14 days. During their lifetime, they only drink water, which a farmer can add glucose or sugar. The black soldier fly (BSF) can be found in garbage places, it survives on organic wastes, females lay between 500-900 eggs in clusters (figure 2).

Figure 2: The black soldier fly

What are the needs of the black soldier fly?

The love nest- a net;

For commercial rearing, the black soldier fly needs to be caged using nets. The size and choice of net depends on the scale of production. Do not recycle insect treated nets as this will kill your adult flies. Ensure the cage is spacious to accommodate the BSF fly behaviour of mating, since they tend to have copulation in flights.

Light intensity:

The adult flies need a lot of light. A strong daylight with temperature between 25°C to 35°C encourages mating. In cases where flies are housed, and less light is available, use artificial light-LED lights >6000K are recommended. In Uganda, the building can be modified (utilise solar) to provide suitable light. Light is important for mating; absence of light your flies will not lay eggs.

Water:

Adult flies need water to increase their lifespan. Absence of water reduces the lifespan from 7-14 days to only 6 days. Always check the nets to ensure there is water for the insects and use a clean cloth or cotton wool for providing water to the insects (Figure 3).

TIP: Feeding adults with sugar water and milk increases egg laying & hatchability and lengthens their lifespan 3 times in males and 2 times in the female flies. Fertility of the fly is also influenced by the nutritional content of the available substrate at larval stages. Diet rich in protein produces adult flies with high egg laying abilities.

FIGURE 3: EXAMPLE OF HOW WATER CAN BE PROVIDED. THERE ARE DIFFERENT METHODS, ONE CAN EVEN USE THE CLOTH.

Tips for quality assurance of the water

Ensure the water is free from chemical contaminants
Water should be clean,
Use clean cotton wool or cloth for water feeding
Ensure there are no moulds in the water
Change the cotton wool every two days as you harvest eggs

Resting places:

The BSF flies mate while in the resting places. The farmer needs to provide plants or places for resting and mating to occur. Remember; the primary goal of adult flies after hatching is mating and egg laying. You can set up your flies in small or large rearing cages as shown in figure 4.

Tips for the nets:

use nets that are not treated with insecticide

wash the net once its dirty to increase light intensity into the net and avoid moulds.

A Small Net | **B** Large Net | **C** Medium Net

Figure 4: Examples of BSF fly rearing nets that can be used.

Stage Two:
BSF Egg harvesting, management and care

The process of egg collection requires the farmer to take note of the following; type of material, method of egg collection, attractant.

a) Egg collection material:

One can use timber, paper or plastics. Most farmers use timber because it is durable. Ensure that the timber does not repel insects or have insecticidal properties (Figure 5).

Figure 5: bsf fly egg laying nest set up inside
The net and picture of eggs in the timber

B) The Attractant

This is very important in triggering egg laying. The BSF fly naturally likes to lay eggs near smelly/ rotting organic matter. To ensure that the eggs are laid in the right places, the farmer has to create these conditions inside the bsf net. The attractant can be any organic matter, but what works best for us is a mixture chicken manure, rotting banana and pig manure.

The same concept can be used by the farmer when attracting flies from the wild environment in cases where access to a commercial BSF larvae or pupae supplier for starting stock is limited.
Note: Frequently change the attractant to increase chances of flies laying at your egg collection sites. At CIRD we change it every two days.

c) Egg Collection

Routine egg collection is essential depending on how flies are laying. One can collect eggs at an interval of two days or three days. Ensure that you do not leave the eggs to dry. For the case of farmers in very hot weather, please ensure you frequently harvest your eggs.

Egg Collection Methods

1. Scrapping:

One of the egg collection methods is scrapping it from the timber, then weigh and set it up in the substrate. The advantage of this method is that the weight of the eggs collected can be determined (Figure 6). However, when scrapping, a lot of caution should be taken into consideration to avoid damaging the eggs.

2. Non-scrapping method:

Weigh the timber before placing in adult fly cages for egg collection and weigh them after egg collection to get the grams of eggs collected. Then, collect the timbers and place them on top of the hatching media.

Figure 6: Egg collection by scrapping from timber.
Weighing of eggs after scrapping

Tips for ensuring safe and quality egg colletion

1. Ensure you collect eggs at the cooler time of the day to avoid drying
2. Ensure the eggs are covered quickly after collection to prevent drying
3. Ensure your hands and egg collections tools are clean to avoid contaminating the eggs
4. Avoid exposing the eggs to a lot of water / moisture as it reduces hatch ability.

How to prepare egg hatching media or substrate?

Eggs are delicate and sensitive to a lot of water, moulds and heat. Hatchability of eggs can be influenced by the following factors;

A) Quality of organic substrate or hatching media used

B)Moisture of the substrate or hatching media

C) Temperature

D) Presence and abscence of moulds- media with moulds will reduce hatchability

Hatching media or Organic substrate:

Maize bran has proved to be a good hatching media. Chicken feed can also be used but moisture must be routinely adjusted as it tends to dry very fast. Also, chicken feed tends to mould a lot hence affecting egg hachability. Make sure the moisture content of the hatching media is between 60 -70%. Remember presence of fungus in feed will reduce the hatchability of the eggs.

Egg Placement on Substrate

A) Ensure that you do not soak the eggs in the substrate, a lot of water tends to make some eggs rot.

B Eggs need to be in a moist place near the substrate, so that neonates that hatch do not dry up.

C) Upon hatching, transfer the neonates to nutritious feed like chicken mash for one day or two to increase the size before transferring into rearing organic substrate.

TIP: When purchasing maize bran, ensure its less salty, has no moulds and is fresh.

Egg Incubation

Once the eggs have been collected and safely placed onto the prepared hatching media, they are then placed in an incubation box for 3 to 4 days. In our local conditions we use a box to help regulate the temperature. Optimum temperature for good egg hatching is between 26 to 30°C. At CIRD we place the containers with larva/neonates in a box for temperature control. The farmer should monitor the eggs while in incubation, always add moisture if the hatching media is drying up.

Stage Three:
How to raise BSF larvae for animal feed

Day four of the larva:

When larvae have hatched, they are called neonates. Experience has shown that transferring tiny neonates directly into rearing organic substrate leads to higher number of deaths. So we encourage the farmer to add a high nutrient rich diet such as a small portion of commercial feed to increase the length and weight of the larvae to the size of rice.

Day five of larvae:

Transfer the larvae that is the size of rice to the main rearing organic substrate. When distributing the larvae, ensure its poured on top of the organic substrate and not under. Let the larvae crawl by themselves to the bottom of the container.

Feed management:

During the period of larval growth, there are two feeding methods. One is called batch feeding; under this method all feed is given at once until the larvae reaches harvesting stage. Second feeding method is continuous feeding. Under continuous feeding method, the feed is added in small quantities as the larvae consumes until harvesting at day 7 to 14. The feeding ratio will vary depending on the type of organic substrate used. A nutrient rich organic waste may require less quantity to produce a Kg of fresh larvae compared to low nutrient organic substrate that will require more Kgs of waste to produce a Kg of fresh larvae. At CIRD 2.3kgs of waste produces at least 1kg of fresh BSFL.

TIP: Every farmer intending to start has varying access to organic waste (substrate), we suggest that the farmer profiles available waste and then be helped to determine the useful combination that can achieve significant results.

TIP: Moisture content of the substrate is very important and will decline as the larva grows. The favourable mousture content is 60-70%. To know that your larvae is consuming the organic waste, the rearing containers shall be warm and when you touch the substrate it will be hot. Sometimes this temperature rises up to 50°C. Do not panic when this occurs since it is normal. The high temperature also enhances excess water in the substrate evaporates. In the end you have dry and easy to harvest larvae

How to harvest BSF Larvae for Animal Feeds

Once the larvae have attained maturity normally between day 7 to 14. The farmer has two options for harvesting. One approach is by sieving physically or mechanically depending on the scale of investment, the second approach is get a tapline, pour the larvae under the sun, they will separate from the waste and you harvest. The second approach takes a much longer time.

How to select the right stage of larvae to harvest –

use the date to predict the age. Meaning every rearing container needs to be numbered and tracked. Secondly, harvest larvae with yellowish colour at the tips as shown in the picture below. The larvae at this stage has the highest crude protein levels (Figure 7). If the farmer waits and harvests when the colour is darker (pupae) the crude protein levels are lower. Most of the protein has been mobilized to make pupae

Figure 7: How to harvest BSF larvae for livestock feed and the right stage of BSF larvae to harvest for livestock feed (fish, chicken and pig).

Drying of BSF Larvae

Once larvae are separated then it needs to be killed before they can be dried. The key caution is; do not over heat the larvae as this will destroy the protein. Heat between 30 to 40°C is good (Figure 8)

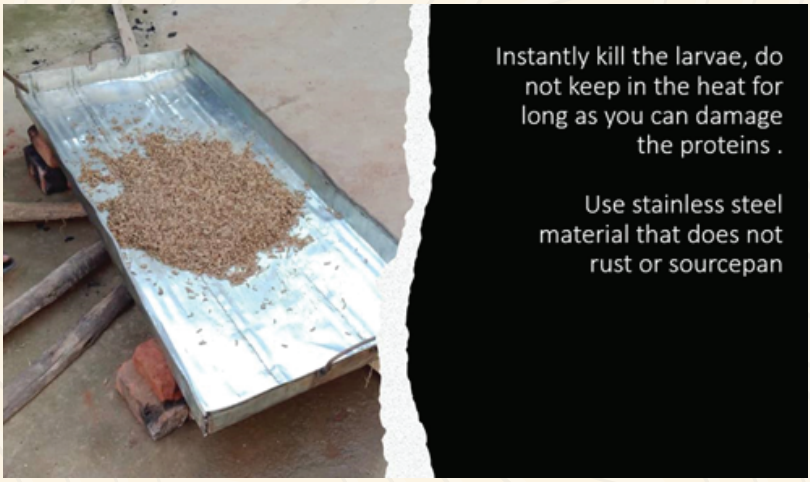

Figure 8: The process of drying BSF Larvae

BSFL drying Method 1:

Use Taplin to dry under sunlight (Figure 9 A)

At CIRD, we have tried using direct sunlight in a taplin. The advantage is that it is a cheap method. The disadvantages of this method are many, these include;

1. This method takes long (an average of 5days)
2. The larvae are eaten by wild birds during drying
3. Houseflies easily lay on the larvae creating a foul smell that is challenging to manage.
4. This method is also labour intensive since the workers have to keep removing the larvae in the evening and bringing back to dry during day.

BSFL drying Method 2:

Create a solar dryer with iron sheet and solar paper (Figure 9 B)

This method has worked efficiently for small to medium scale drying of BSF larvae. This is less labour intensive. The larvae dry within two days and is much cleaner. The larvae are also protected from predator birds and the smell is well managed due to constant aeration of the larvae (Figure 9).

Other drying methods:

The farmer can use vaccum dryers, freeze dryers and temperature regulated ovens. But these are expensive mthods in cost of installation and electricity.

A B

Figure 9: Example of two drying methods for BSFL. On the left, the use of taplin and on the right the use of a simple solar drying system (use solar paper or transparent iron sheets).

Storage of dried larvae

The dried larvae can be stored in sacs as shown in the picture below figure 10;

Figure 10: Storage of BSFL in sacs

Factors to ensure during storage of BSFL

1. Ensure that the bags are raised from the ground or placed on wood
2. The storage area should not be dump (this facilitates mould formation)
3. The larvae that is stored for longer periods is attacked by beetles and other pests. It should periodically be brought out for drying.

Stage FOUR:
Raising larvae for pupae, Pupa care and Hatching management

Pupae care is a very important aspect of BSF breeding.

To ensure that you have parent stock, 30% of the trays with BSF larvae between day 7-14 are kept. For example, if you have 10 trays of BSF larvae, keep three trays for adult stock.

After harvesting the BSF larvae that is to be fed to chicken, poultry and fish, continue feeding BSF larvae meant for pupae for another two weeks. By day 21-25, the larvae would have stopped feeding and begin turning into pupae. Stop feeding them and start creating dry conditions as this stage does not need a wet area. To create a dry environment, we use maize bran if the feed is very wet. In the rearing trays, pupae that has stopped feeding will now move to the top. The farm workers can collect it and transfer to a dry container.

Pupae care and management

Pupae needs a warm place temperature between 26 to 30°C. Pupae should be kept in a dry place.

Ensure that all your larvae are well fed, so that hatchability is increased. The common mistake farmers make is to stop feeding larvae at day 14 and expect it to change t pupae. Such larvae may turn to pupae, but it will not hatch.

To synchronize pupae hatching, place them in a sac to create dark conditions and place in a warm place. At CIRD we have created an incubation box for this purpose.

To quality assure if your pupae will hatch, a gentle press method is used. If the inside is hard then the larvae deposited enough food

reserves and as such it will hatch. But if the pupae are soft or flat, the feeding was not sufficient thus the chance of the pupae hatching into a fly is low.

After one week when the pupae have stopped moving, its then transferred into the net. The flies will then continue hatching.
The key activity for the farmer is daily turning of pupae to allow flies at the bottom of container to get out.

the farmer should protect pupae from water. Any contact will water will make the pupae rot (Figure 11)

Figure 11: Harvesting of Pupae is similar to the method used to harvest fresh larvae

SESSION THREE

What Inputs are Needed to Start Commercial Bsf Farming

Learning outcome: At the end of the training, participants are expected to have knowledge of the minimum required equipment and where to find them. Participants should also have knowledge on how to set up either a small to medium scale BSF rearing facility.

When choosing which equipment and unit structure the farmer must consider the following;

Scale of production: if it's a small backyard unit, the structure can be very simple and cheap to set up. As the farmer scales up, some aspects of mechanization must be considered. For example, breaking down the particle size of waste becomes expensive and needs a machine.

Income levels: BSF larvae rearing inputs are relatively cheap. So, for start-ups, do not look for the most executive equipment. for example consider using jerricans as rearing trays which costs between 4,500 to 7,000 Ug shillings each instead of commercial insect rearing trays that cost 40,000 Ug shillings each.

Disability proof: When working with special needs persons, consider light weight equipment, easy access structures and semi-automation to ease their operations.

For ease of planning, we shall organize inputs based on the different sections in commercial BSF larvae rearing which includes.

1.Organic waste management: This is the heart of BSF farming business. Ensure you have the source of organic waste identified and supply should be reliable. In some cases, you have to plan for logistics such as transportation and sorting of the waste. Ensure you have diverse nutritious waste for the BSF larvae.

2.Adult fly rearing cage: farmers are using different materials that is from from nets to mesh for the adult fly cage. What is important is to use material that is easy to clean, allows enough light intensity and can last long.

3.Egg collection and hatching material: a farmer can use from paper, timber to plastics. Depending on what is convinient for them interms of cost and ease of use.

4.Larvae rearing containers and shelves

5.Pupae care section

6.By products- organic manure management;

in large operations there should be space allocated for waste sorting and processing.

Equipment for organic / substrate management

In the rearing of BSF larva or maggots, prepare storage conditions for the waste. If it is food waste, ensure you cover it to prevent houseflies from laying in it first. There are several ways in which wastes can be stored. Airtight buckets or if using sacks (kaveera) ensure it is tied to prevent access by houseflies. Once you allow houseflies to lay on the substrate, they produce a bad odour that may inconvenience both workers and neighbours. Example of containers that can be used to store waste are shown below (Figure 12)

Figure 12: Storage methods for organic waste to prevent from houseflies and rotting

Equipment for adult flies

For adult fly management the equipment needed are;
The nets
The attractant containers
Water source containers
Resting places for flies (plants)

Equipment for egg collection

The equipment needed for this section are;
The scrapping material (cutters)
Egg collection timbers
Tissue paper or Saviets for incubation
Hatching media (maize bran, brewers waste etc)
Containers for hatching
Incubation box for heat generation

Equipment for larvae rearing

The equipment and materials needed for this section are;
Rearing containers or jerricans
Shade or stands to place the containers
Gloves
Weighing scales for food measures or larvae
Cleaning brushes or brooms
Plythene bags for storage of dry larvae
Sieving containers for fresh larvae harvesting
Frying pan for instant killing of BSFL

SESSION FOUR

Challenges of bsf larva rearing and how to manage

Rats & **predators**- They consume the larvae in storage and containers. We have controlled rats by having cats and also maintaining the BSF unit / farm clean.

Red ants- Like to damage pupae, larvae and flies. Ensure the farm is hygienic and if its persistent use ash to control. Do not use insecticides.

Snakes-Ensure the place is hygienic and if in the community ensure the larva rearing room is clean.

Lizards- They eat the larvae. Control them by enclosing and cleaning the larvae room.

Birds – Eat larvae if in an open area. Drying in an enclosure will be appropriate.

Waste mobilization-is another challenge in African setting because waste is not sorted and is always dumped in landfills. Ensure you have built a network of waste supply. This team shall support in waste sorting, transportation and aggregation. Organic waste needs to be a mixture for improved quality. For example, feeding on only fruit waste is not sufficient, the BSF needs a combination of waste

Temperature fluctuations in large rearing facilities without incubators is a big challenge. We have adapted by creating incubation boxes for delicate stages like eggs and pupae. For neonates/young larvae, we also cover their containers during cold weather with blankets to warm up.

Also ensure the larvae has quality organic waste and at the right moisture content (60-70%). The larvae will generate heat as they consume the waste hence generating warmth. The challenge comes when the feed consumption is low due to poor quality and high moisture in feed, which must be solved.

SESSION FIVE

Personnel safety at a bsf farm

Learning Outcome: At the end of this session, the trainee shall know how to keep themselves safe while working in a BSF farm.

Why you should consider personel safety

Whereas the black soldier fly is known not to vector any diseases for man there is need for farm workers to protect themselves while working in the BSF farm. During rearing of larvae, the employees use organic waste which exposes them to different kinds of materials. The different stages of caution at the BSF farm include;

A) **During the cleaning of the BSF Unit;**
The BSF farm should be constructed in such a way that it's easy to clean. The floor is already prone to red ants and this can damage pupae and larvae. Therefore, regular cleaning is highly recommended. The farm workers are also recommended to wear masks and protect themselves from the dust during cleaning.

B) **Cleaning of BSF larva rearing containers:**
workers are advised to wear gloves during this process so as to protect themselves. Frass may contain some bad chemicals whose residues if they remain under finger nails get exposed to the worker hence poisoning.

C) **Organic waste handling on farm;**
When food and brewers waste are being loaded, the floor of the unit gets slippery. We advise workers to always wear gumboots to protect them from injuring their toes after a toe knock. Gumboots also protect workers from slipping off a slippery floor of which this may cause fractures
.

D) **During larval feeding;**
When feeding larvae on a daily basis, workers may inhale the unusual scent from organic waste. It's advisable to wear face masks at this point in time. Workers are also advised to wear gloves when serving the brewers waste and food waste to the larvae because the organic waste usually contains sharp materials like needles, razorblades which may in other words injure the individuals during work. Overalls and overcoats are also to be used when feeding larvae so as to prevent direct contact between the skins of individuals and organic waste.

E) **Pupae and larvae harvesting;**
When pupae are ready for harvest, waste materials should be carefully separated from it.
These waste materials include Polyethen bags, plastics, bones, razorblades and needles among others. The latter can injure an individual hence a deterioration in one's health. Below is a picture showing some of the waste materials/ objects sorted from pupae figure 13.

Figure 13: Example of materials and sharp objects one finds in organic waste; especially food waste from restaurants.

F) **Handling of plastic waste;**

After waste sorting, the waste materials are packed in sacks and transported by waste disposal company to a plastic recycling site. It is advisable that inorganic waste be separated from the organic waste. Waste materials like plastics should be taken back to the plastic companies for recycling.

Why personnel protection is important

Personal protection and safety is paramount in the BSF unit. It is so important because it safeguards the workers from direct exposure to harmful materials which may affect their health negatively

Types of personal protective gears in the BSF unit and their uses.

There are a number of personal protective gears which are required in the BSF unit. Personal protective gears at CIRD BSF unit include face masks, gumboots, overalls and overcoats, gloves, and helmets.

i. Face masks; They offer protection from inhalation of dust and gas emissions like ammonia, methane and carbondioxide. They also protect workers from inhaling other airborne germs.

ii. Gumboots; They are worn when loading foodwaste and brewers waste, when cleaning the BSF unit. They have treads underneath for friction hence this prevents an individual from slipping and tripping off a slippery floor.

iii. Overalls and Overcoats; These are made of tough material and are won on top of personal clothes. They protect workers against direct contact with harmful materials which may land onto their skins.

iv. Gloves; Gloves prevent direct contact between the hands of a worker and contaminated water at the BSF unit. Gloves also offer protection from sharp objects which may be contained in the organic waste during larvae feeding.

v. Helmets; During work, workers are advised to wear helmets so as to protect their heads from injuries and damage to the skull.

SESSION SIX

Environmental safety and management of A BSF farm enterprise

Learning outcome: At the end of this session, trainees should know the environmental safety practices for a BSF farm enterprise.

Due to the rising impacts of climate change, environmental pollution should be regulated as much as possible. Poorly managed waste can result into air pollution through greenhouse gas emissions. In BSF farming we need to ensure that we do not add to the environmental pollution baggage.

Why a BSF farm should have an environmental Monitoring Plan

It helps the farm to identify risks of their operations to the environment and develop mitigation plans which they can apply to track the impacts.

There are different types of waste generated from a BSF farm;

Organic fertilizer; this is what is left over after the rearing process of larvae and pupa. This can be cleaned, packaged properly and sold as Fertilizer.

B) **Shells;**

This is organic waste from a BSF farm. When flies molt from pupae, shells are left. These are thereafter they are ground and added into ferterlizer. Where the technology allows chitin can be extracted and utilized as medicine.

C) **Inorganic waste;**

Inorganic waste generated on a BSF farm include;

Plastic bags/polythenes; These bags are used for packing foodwaste. When food inside them is used up, the bags are folded and packed in sacks to be taken back and disposed at the main dumping site.

Sharp materials like needles, razorblades.

They come along with foodwaste. Maximum care is required when

serving food to the BSF larvae and when sorting pupae because these sharp materials can injure an individual.

Bones; Bones also make up part of the waste materials contained in the foodwaste.

How to safely dispose different types of waste.

Both the organic and inorganic waste types should be safely disposed off.

Organic waste;

Organic waste such as shells and moulded lumps of brewers' waste should be properly packed in sacks and disposed off at the main garbage site. Manure should be well sieved using a sieving basket and well packed in sacks to be applied in gardens as fertilizers.
Frass should be allowed to sip through a well-constructed effluent drainage system as a way of discharging/ properly disposing it.

Inorganic waste;

Inorganic waste materials like foodwaste sacks/ bags, Polyethen bags should also be well packed in sacks and taken to the main dumping site.
Inorganic materials like needles, razorblades and plastics should be taken to scrap companies so that they can be recycled.

Monitoring plan for sustainable environmental safety

In every organized setting, there are guidelines which govern it. Below are some of the guidelines needed for sustainable environmental safety on a BSF farm;

A) Regular cleaning of the BSF farm.
B) Wearing protective gears when at work.
C) Proper waste disposal.
D) Proper ventilation of the BSF structures and renovation of the damaged structures.
F) Pouring water on the floor of the BSF rearing unit to increase humidity.
G) Proper odor management through use of Indigenous Micro Organisms.
H) Stocking adequate cleaning materials such as liquid soap, scrubbing brush and rubber squeezers.
I) Carrying out routine environmental inspection.

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