Simplified Black Soldier Fly Approach (SIMBA)

REPRODUCTION UNIT

STANDARD OPERATING PROCEDURE

ECLOSE
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aquatic research

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SCOPE

Standard operating procedures (SOPs) in BSF farming play a critical role in ensuring the success, safety, and scalability which connects to effective reproduction in the BSF life cycle, as well as consistent output and quality of larvae, frass, and by-products. SOPs help standardize tasks (and their timing at different stages of the process). This SOP focuses on the reproduction unit.

The larvae of the Black Soldier Fly (BSF) can be used for the treatment of the organic fraction of solid wastes. The larvae convert the nutrients contained in the waste into marketable products, such as the grown larvae themselves for use as animal feed, and the leftovers of the process (called frass) for use as soil amendment.

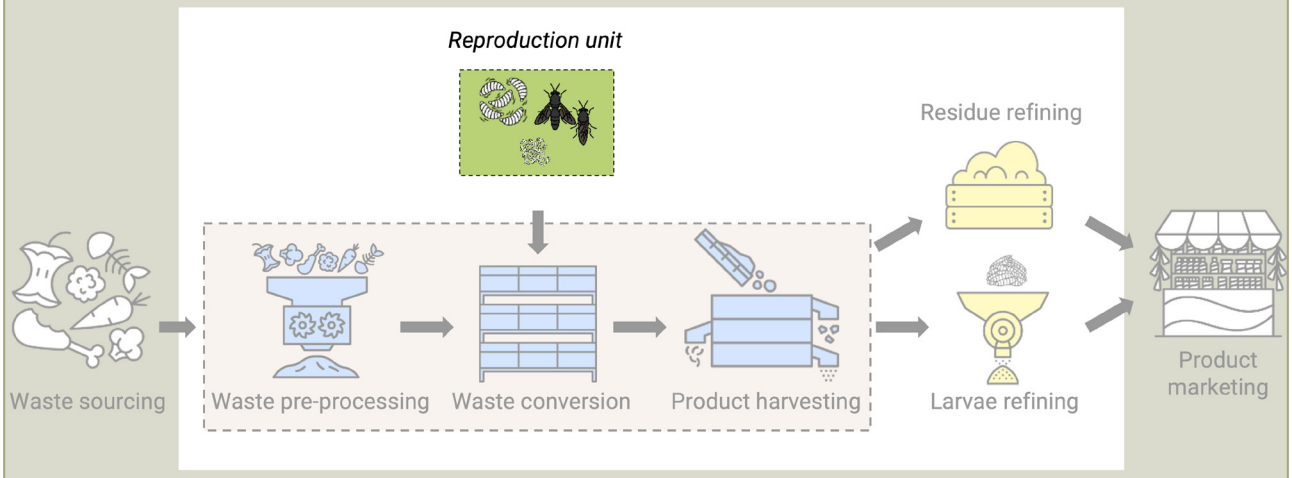
Running a professional BSF waste processing farm at medium to large scale requires many tasks at different stages of the process, carried out on a daily basis. However, such a farm can also be operated part-time at smaller scale, requiring just a few hours per week on selected days. We call this SIMBA: a SIMplified BSF Approach.

A simplified BSF approach (SIMBA) can be suitable for:

- A first step entry into BSF waste processing, conducted as a part time side activity to explore and learn more about the practical aspects of BSF reproduction or use this as demonstration of BSF waste processing.
- An established small farm that wants to produce BSF larvae as feed for their chicken, pigs and/or fish but has limited human resources and can allocate only a few hours per week to BSF activities.
- A research centre that would like to operate a small-scale reproduction unit to then use flies, larvae, or frass for research, or for training and demonstration purposes.

In this manual, we focus only on the reproduction unit of such a simplified approach. The reproduction unit has the purpose to create optimal conditions to maintain the lifecycle including: BSF pupation, mating, laying of eggs, hatching and first days of larvae feeding while keeping the labour effort as low as possible. This reproduction unit SOP complements another SOP, the grow-out unit SOP, which instead focuses on growth of the larvae and organic waste reduction.

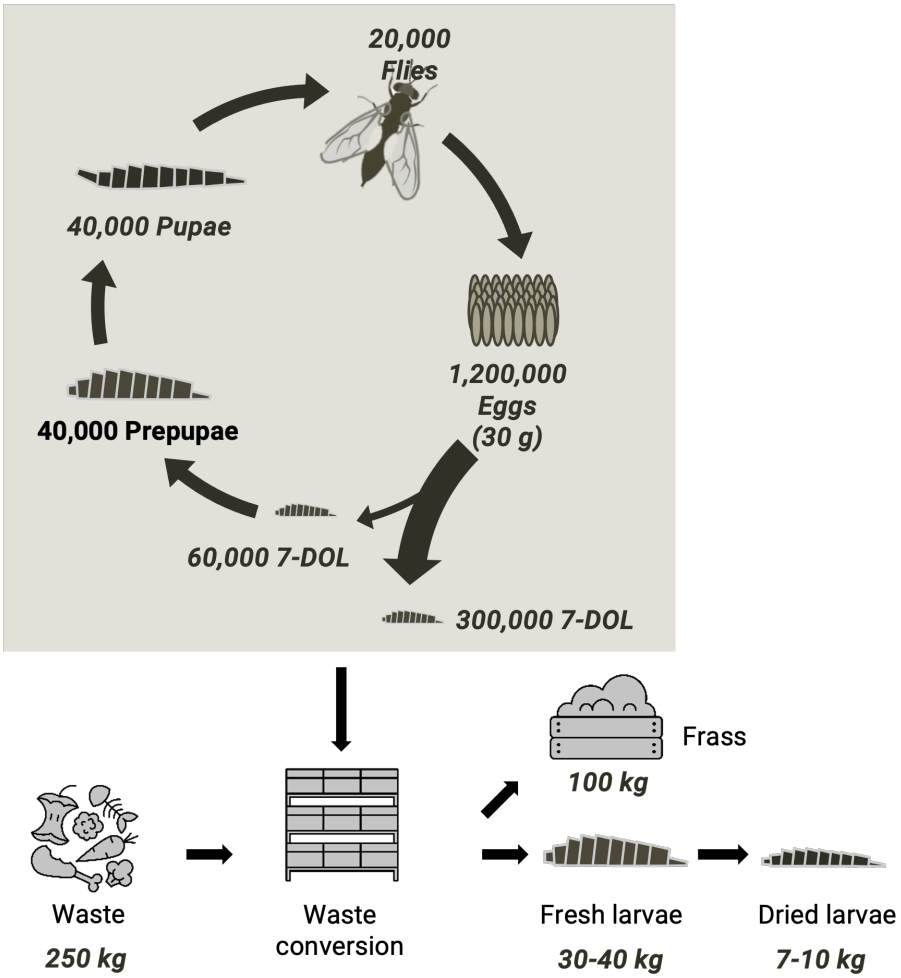
Figure 1: Schematic of elements of a BSF facility with a focus on the reproduction unit.



This standard operating procedure (SOP) is a description of tasks conducted at the reproduction unit of a SIMBA BSF facility, operated with a labour input of only a few hours on two days per week.

This manual follows a two-day weekly schedule (e.g., Monday/Thursday, Tuesday/Friday, or Wednesday/Saturday). Since a week has seven days, the gap between the first and second workday (e.g., Monday to Thursday) is shorter than the gap between the second day and the first workday of the following week (e.g., Thursday to Monday). To balance this, work on the first scheduled day should be done in the morning (before lunch), and work on the second scheduled day should be done in the afternoon (after lunch). **A facility using this schedule can produce enough larvae to process about 250 kg of organic waste per week. This process generates 30-40 kg of fresh larvae during the waste conversion process, which corresponds to 7-10 kg of dried larvae** (Figure 2). If you are considering a larger scale BSF approach (>1 ton per day) than proposed here, we suggest consulting the Step-by-Step Guide, published by Eawag. It is freely available at www.sandec.ch/bsf-knowhow. However, a larger scale BSF approach will then also require more working hours per week.

Figure 2: Performance indicators (per week) for a reproduction unit operated according to SIMBA



Two annexes accompany this document:

- **Annex (A)** is an alphabetical list with a description of equipment items, describing their possible composition and key functionalities as well as providing pictures of examples.
- **Annex (B)** is a "Task and Schedule Checklist", describing the tasks and highlighting when these tasks need to be done in the weekly work-schedule.

ESSENTIAL OPERATION REQUIREMENTS

Operating a BSF reproduction unit serves the purpose of generating enough larvae, pre-pupae, pupae, flies, eggs and neonates to maintain the reproduction cycle and have a reliable number of young larvae available for outgrowing on the selected organic waste substrate.

Preconditions for operating a simplified reproduction unit are:

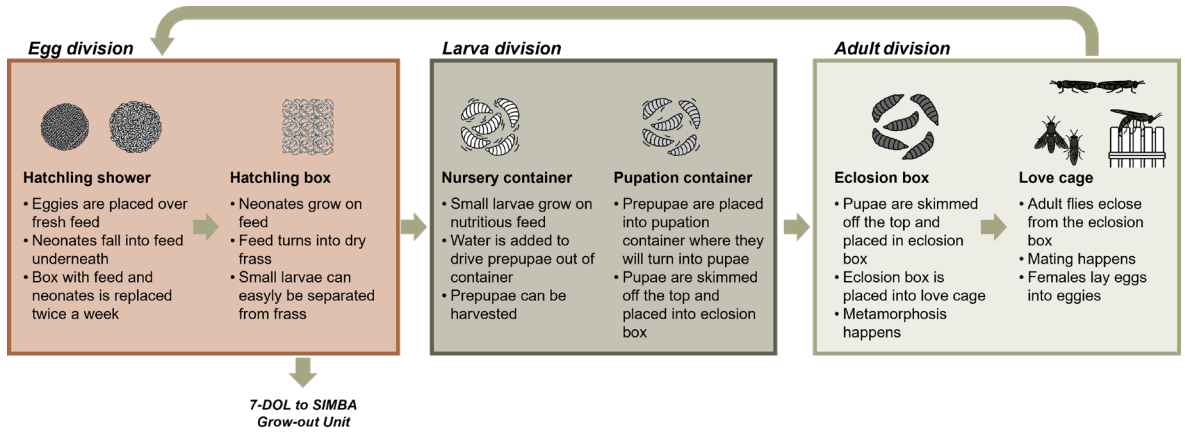
- **Dedicated space:** A dedicated area is required to accommodate the different life stages of the black soldier fly. Female adult flies can easily be distracted by the smell of larvae, so keeping the two life stages (larvae and adult fly) apart is ideal.
    - It is preferable to have separate physical spaces (buildings or rooms) for the larval and adult stages. This can be a simple roofed structure or a greenhouse. Main requirements are a roof to protect from sun and rain and that love cages can be placed in a bright but shaded space.
    - Each room should have a minimum space of approximately 15 m2. So, in total you will require about 30 m2 of roofed space.
- **Suitable climate:** Ideally, the average daily temperature does vary within the range of 25 to 32°C. Below 25° C, the operation may slow down but larvae and flies will still survive. If temperatures stay above 32° for a longer period, it will be essential to provide enough moisture in the cages and containers to prevent the BSF from overheating and/or drying out. A relative air humidity of 60-80% allows for optimal performance of the reproduction process.
- **Seasonal changes:** There will be changes in environmental conditions throughout the year. The water content in mixtures for substrates, water applied in the love cages and exposure of cages to natural light might have to be adapted to that.
- **Responsible manager:** A person in charge of the reproduction unit, overseeing that tasks are completed, ensuring that the equipment is well-maintained, and the necessary consumable materials are available. This person must have a good overall understanding of BSF reproduction, and act as the point of contact for the operator(s) responsible for completing the tasks.
- **Committed operator(s):** An operator needs to allocate about 2-3 hours, twice a week (total 4-6 hours per week) to operate the reproduction unit. The operator follows a strict protocol. Understanding the complete life cycle and necessities of BSF in their different life stages is beneficial not a requirement. However, the operator needs to be attentive and provide feedback on observations to the responsible manager.
- **Established monitoring system:** Implementing a monitoring system is crucial to track key performance indicators such as the number of larvae, pupae, and 7-day-old larvae (7-DOL). The reproduction manager should diligently analyse these numbers to evaluate the colony's performance. In case of any significant deviations, the reproduction manager should investigate the cause and take appropriate action. Depending on the environment in which SIMBA is implemented, the monitoring system can include less or more performance indicators.

The operation in the reproduction facility can be divided into three divisions (Figure 3):

Egg division: eggs hatch and neonates get their first meal.
Larva division: small larvae grow until ready for pupation.
Adult division: adults eclose from the pupae, mate, and lay eggs

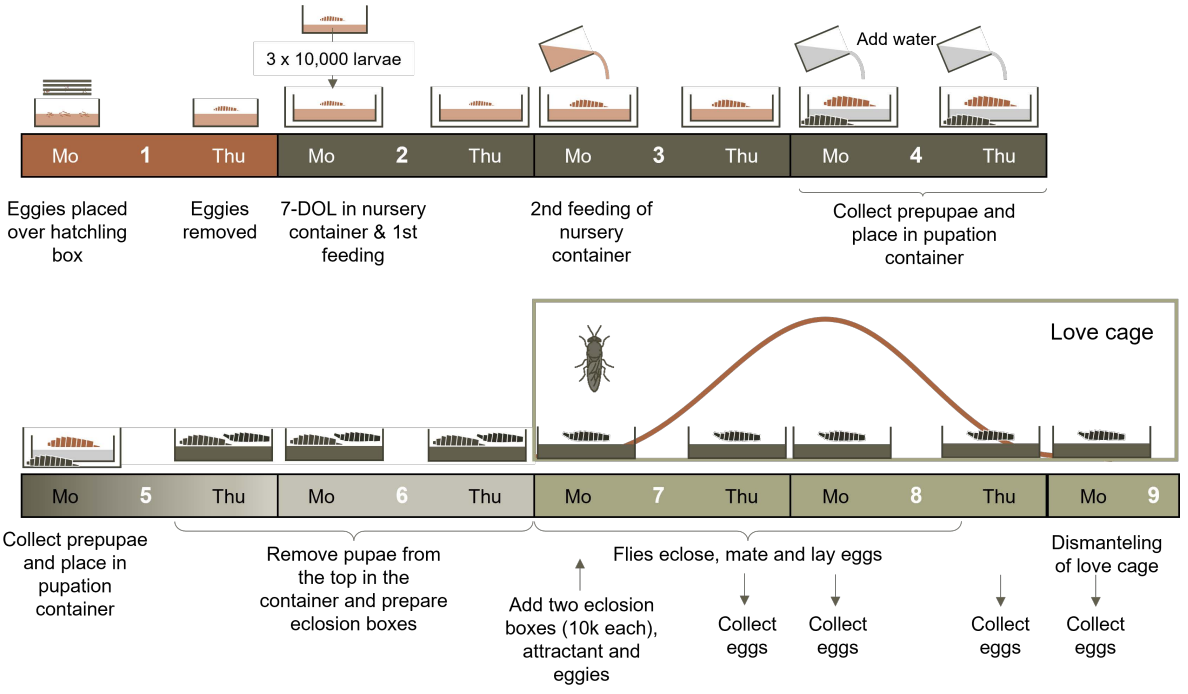
The specific terminology of equipment is explained in the respective activity descriptions.

Figure 3: The individual divisions of a black soldier fly reproduction unit



The whole reproduction cycle takes about 8 weeks (Figure 4). When run at full capacity, this standard operations procedure of a simplified reproduction unit foresees to have **four love cages standing at all times.**

Figure 4: It takes 8 weeks to fulfil a whole cycle when using the SIMBA approach.



In the following section of this manual the principles of each division and the associated tasks and activities to be carried out are described. Each piece of equipment mentioned is highlighted in the text and listed in alphabetical order in Annex A, where the main functional characteristics of each equipment item is described.

ACTIVITIES IN A BSF REPRODUCTION UNIT

EGG DIVISION

Eggs are collected regularly from the love cages. Female flies lay them into so-called eggies which are placed inside the "love cages". Love cages are nets where adult flies are contained and where they mate and lay eggs into the eggies. Once removed from the love cage, the 24 eggies are placed divided over two nursery hatchling boxes with each 1.5 kg feed (moisture content: 70%). Label the hatchling box with today's date.

Figure 5: Date sticker indicating the date this component (e.g. love cage or hatchling box) has been set up

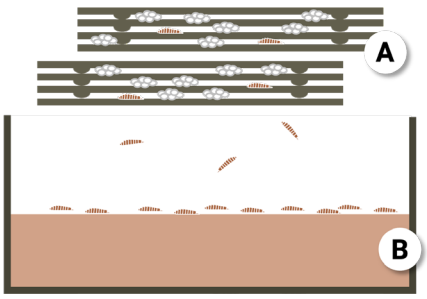
The feed provided should be of a good and constant quality, such as rice/maize/wheat bran, spent grain, soybean processing residue or chicken feed. To reduce moisture and discourage house flies from laying eggs, sprinkle a thin layer of wheat bran on the hatchling feed before placing the eggies on top. The eggs will hatch over a period of several days (e.g., Monday to Thursday) and the neonates (newly hatched larvae) will fall from the eggies into the hatchling box below. This system is known as the hatchling shower (Figure 6).

After 3-4 days (typically by the next working day) the eggies are removed from the hatchling shower. This means that all larvae in the same hatchling box are now between one and four days old. The hatchling box is then left for another 3-4 days (until the next working day) without any eggies above, allowing the larvae to continue growing. After this period, the larvae are now considered seven-day-old-larvae (7-DOL) and are harvested from the hatchling box. The residue in this hatchling box should now be quite dry.

After the eggies are removed, they can be taken apart and cleaned with water. It is important not to use soap for cleaning, as this could remove or mask the natural remaining scent of the eggs that lingers and helps attract flies to lay eggs in the future when the eggies are re-used.

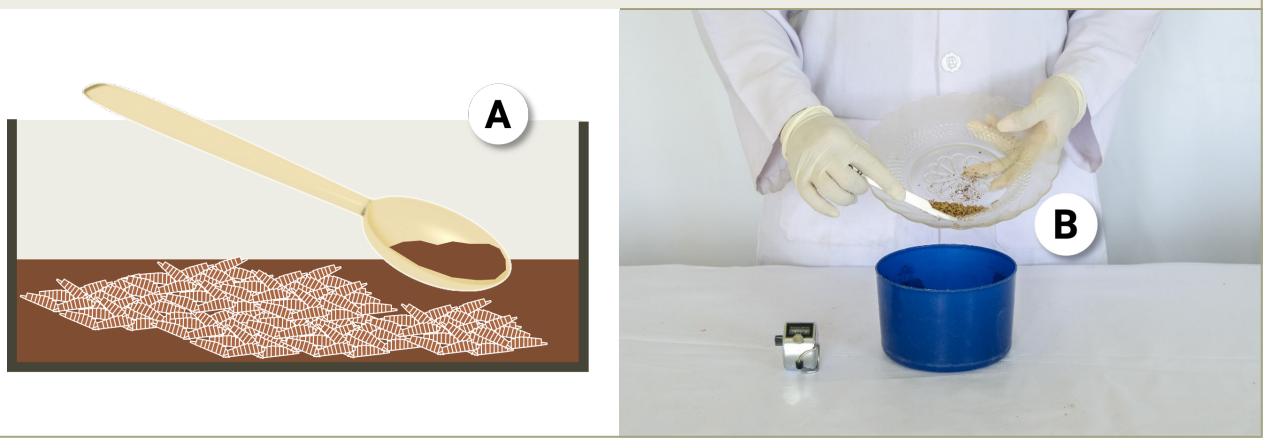
When operating a reproduction facility for research purposes: Eggs should be gently scraped off each eggie after removing them from the love cages. The pure egg mass can be weighed before hanging it in strainers over the hatchling boxes. In addition, for research purposes it is also advantageous if the larvae are all of the same age. Therefore, it is recommended to replace the hatchling box every 12 or 24 hours with a new hatchling box during the first 3-4 days.

Figure 6: The hatchling shower includes a hatchling box with feed inside and the eggies on top. Eggies with eggs in the crevices (A). Hatchling box: container with feed (70% water). Neonates fall into box and start to feed (B)



Harvesting the 7-DOL: The now seven-day old larvae are harvested from the hatchling boxes. Tapping on the wall of the box will create vibrations and larvae will aggregate together away from the residue. Use a spoon to remove and discard as much residue as possible from the surface in the hatchling boxes (Figure 7A).

*Figure 7: From the hatchling boxes, 30,000 7-DOL are separated. Remove residue/frass from hatchling box **A**; Counting sample. **B**.*



Once you have removed as much of the residue as possible (without removing any larvae), mix the remaining larval mass with a spoon thoroughly (there will still be some residue in the mixture) and take a random scoop with a spoon and weigh about two grams of this mixture. Alternatively, you can take a plastic bottle cap (or any other convenient unit) as a measure. Count the number of larvae contained in the two grams or the scoop/bottle cap. Do this by using a plate and tweezers where you push each larva over the edge of the plate into a bowl underneath while counting them (Figure 7B). To reduce the risk of miscounting, set aside a counting aid (piece of wood, screw, stone) for every 50 or 100 larvae counted. At the end, count the pieces put aside. Alternatively, do the push-over-the-edge method, spread larvae out on a plate and count quickly with a click counter (Figure 8). Repeat the process of scooping out 2 grams and counting the larvae collected in the sample for three times.

Figure 8: Counting of 7-DOL: distribute 7-DOL evenly in two rows. Count each row by pointing to each larvae and clicking on counter. Once counted, remove counted larvae and repeat procedure with two new rows.

Based on your weighing and counting results, the formulas below can be used to calculate number of larvae or grams needed.

7-DOL per gram	$\frac{7\text{-}DOL}{g} = \frac{Number\ of\ larvae\ counted}{Sample\ size\ (in\ gram)}$

Do this calculation for your three scoops and then average the result to obtain the parameter "average 7-DOL per gram (or bottle cap) of mixture".

Since the size of the 7-DOL as well as the purity of the sample can vary from week to week, it is necessary to repeat this count and calculation every time you are harvesting 7-DOL.

To breed enough pupae and finally adult flies for larval production, we will need 30,000 -7-DOL larvae, which will grow into flies over the next weeks. Using the formula below, calculate how many grams or bottle caps of the mixture you will need so that you have 30,000 7-DOL for that working day. Weigh this amount and temporarily store this amount of mixture in a small cup.

Grams of mixture required to obtain 30,000 7-DOL	$gram\ of\ mixture = \frac{30{,}000}{\text{average 7DOL per gram of mixture}}$
Number of bottle caps full of larvae to obtain 30,000 7-DOL	$\#\ of\ bottle\ caps\ of\ mixture = \frac{30{,}000}{\text{average 7DOL per cap}}$

LARVA DIVISION

To produce enough flies that will ultimately lay the desired number of eggs, each working day you will need 20,000 prepupae which eventually reach the pupal stage. Assuming a mortality of about 30%, this means you will need to prepare 30,000 7-DOLfor your reproduction cycle. These 7-DOL will be divided into three nursery containers (surface of ±1500 cm2), each containing 10,000 larvae, and each container will be fed two times over the period of a week. After the 7-DOL have eaten and grown for about 14 days, they are ready for pupation and will transform into prepupae. When they become prepupae they will start looking for a dry place to pupate. Adding water to the nursery container creates a moist environment, that motivates the prepupae to leave the nursery container. Meanwhile the remaining larvae, which are not yet prepupae, will continue to feed inside the nursery container until they are also prepupae and ready to leave the nursery container.

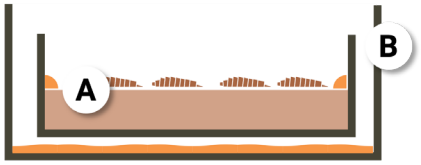
There are two main approaches to achieve the required number of prepupae:

- **Approach A:** Rearing a fixed number of larvae inside the reproduction unit from 7-DOL until prepupae.
- **Approach B:** Harvest the desired number of larvae from the biowaste treatment/ grow-out units and provide them with a last small feeding until they transform into prepupae.

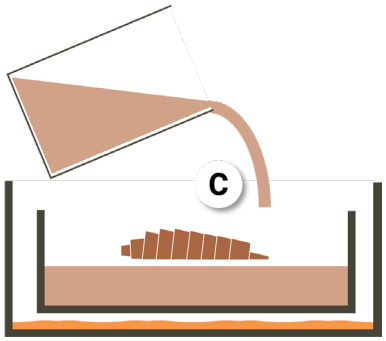
Approach A: Larvae rearing in the reproduction unit

In this standard method, larvae are raised inside the reproduction unit, mostly on a diet with pre-defined ingredients (e.g., maize bran, chicken feed), similar to the diet of the hatchling boxes. Organic waste can however also be use

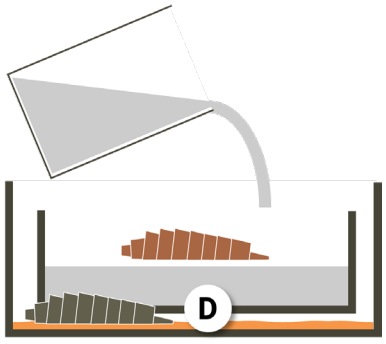
First feed:
Prepare three nursery containers and add the first feeding (5 kg of prepared feed, 70% H2O) to each container. Add a few spoons of dry material (e.g. wheat bran, sawdust) at the edges of the nursery container (orange) to hinder crawl out of larvae. Now add 10,000 7-DOL to each container (A). Place the nursery container into a larger box – we call this the collection container (surface of 2400 cm2) – which should also contain a layer of dry material (B). Put the collection container and its nursery container on a shelf and label it with today's date.



Second feed:
One week later, provide the second feeding of 7 kg (70% H2O) to each nursery container.



Prepupae collection:
One week later, prepupae will begin to leave the nursery container and accumulate in the collection container. At this point, add 1 litre of water to the nursery container to motivate the other prepupae to leave. After a further 3 or 4 days (next working day), collect the prepupae which have already left the nursery container (D) and add another 1kg of water to encourage the remaining prepupae to leave. After another 3-4 days (next workday), you can harvest the last prepupae and remove the nursery container at the same time.



Approach B: Larvae rearing in the reproduction unit

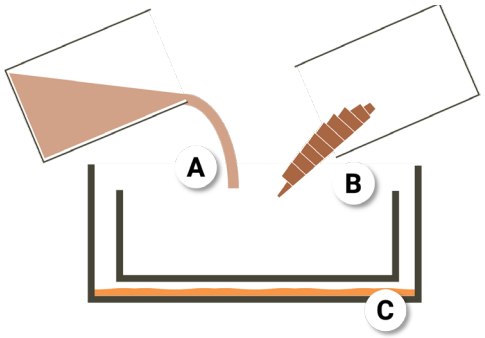
In facilities where BSF larvae are also used for waste treatment at the same location, the larvae needed for the reproduction cycle can also be obtained from the larvae harvested from the grow-out unit. The harvested larvae then only need to be further fed until they reach the last larval stage, the prepupal stage. This method eliminates the need for a full larval rearing process within the reproduction unit. However, it is important to ensure that the waste is nutritious enough to maintain a strong and health population and stable lifecycle.

A separate document "Simplified Black Soldier Fly Approach (SIMBA) – Grow-out Unit: Standard Operations Procedure" is available to learn more about how to prepare the substrate from the biowaste, how to feed the larvae and how to separate the larvae from the frass.

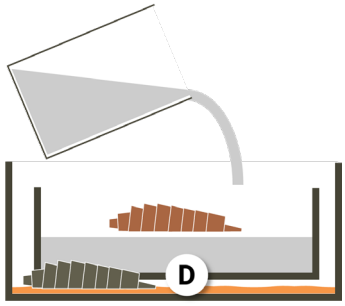
The individual steps of this scenario are described in the task list under L-3B and L-4B.

All collected prepupae from the collection container, collected in a single working day, are placed in a pupation container where they can turn into pupae as quickly as possible. Eclosion – the emergence of the adult fly from the pupa - happens 2-3 weeks after.

First feed:
Prepare three nursery containers and add the first feeding (3 kg of biowaste, 70% H2O) to each one (A). Now add 10,000 17-DOL larvae to each nursery container (B). Place the nursery container into a larger box – we call this the collection container – which should also contain a layer of sawdust or another non-food dry material (C). Put the collection container and its nursery container on a shelf and label it with today's date.



Prepupae collection:
Next working day, prepupae will begin to leave the nursery container and accumulate in the collection container. At this point, add 1 litre of water to the nursery container to motivate the other prepupae to leave. After a further 3 or 4 days (next working day), collect the prepupae which have already left the nursery container (D) and add another 1L of water to encourage the remaining prepupae to leave. After another 3-4 days, you can harvest the last prepupae and remove the nursery container at the same time.

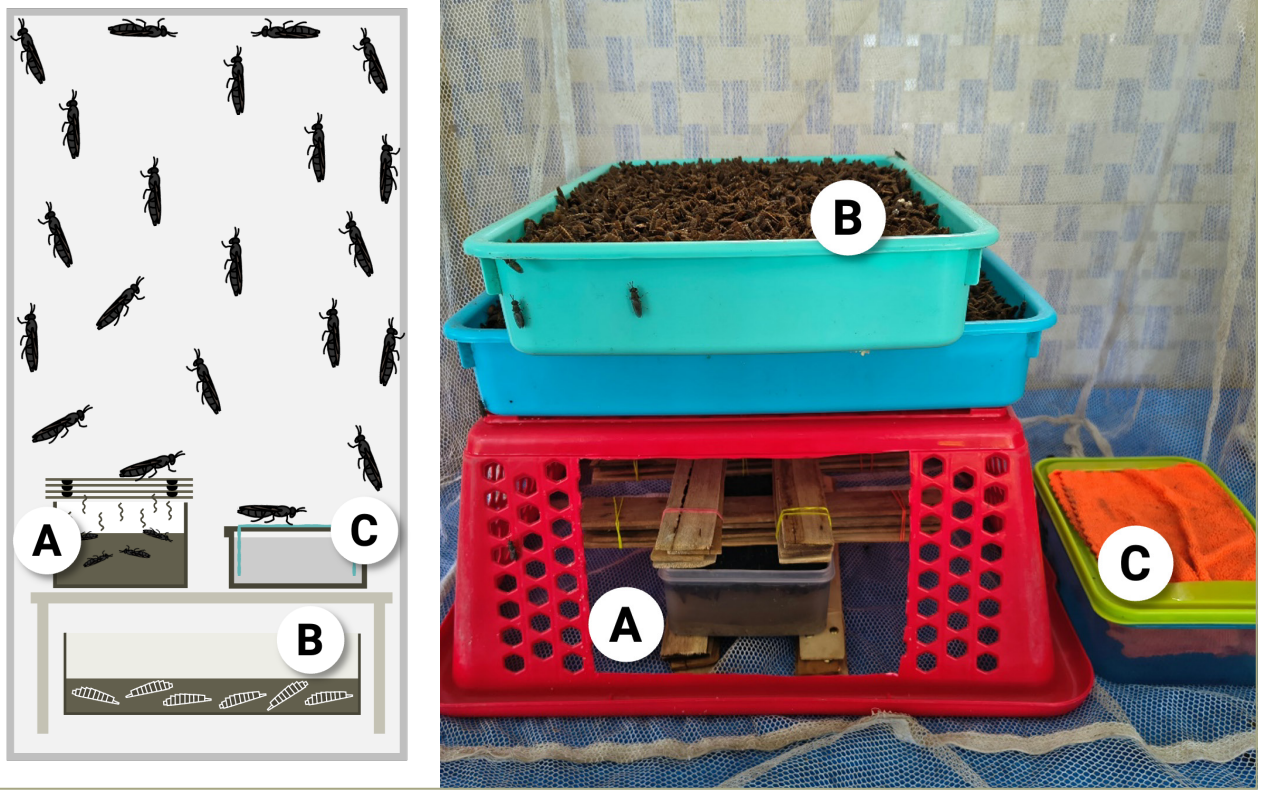


Setup of the pupation container: Add all the harvested prepupae from the collection containers to the newly prepared pupation container, label it with today's date and place it on a shelf/rack. On the next working day, prepare a new container and add the prepupae collected on that day to the new pupation container. The pupation container does not need to contain any material to aid or support the pupation process as long as it is in a dark place. If natural light reaches the tray, a layer of sawdust or any other similar dry non-food material can be added to provide darkness for the prepupae. Ensure that the sawdust or any other similar dry non-food material does not contain any harmful/toxic substances that may harm the pupae or negatively affect pupation.

ADULT UNIT

The love cage provides all the infrastructure to satisfy the adult flies' needs: light, water, space and a place to deposit eggs. Inside the love cage, add one water container, six eggies and one attractant container and two eclosion boxes (Figure 8). Below, the items which will be added inside the love cage are described.

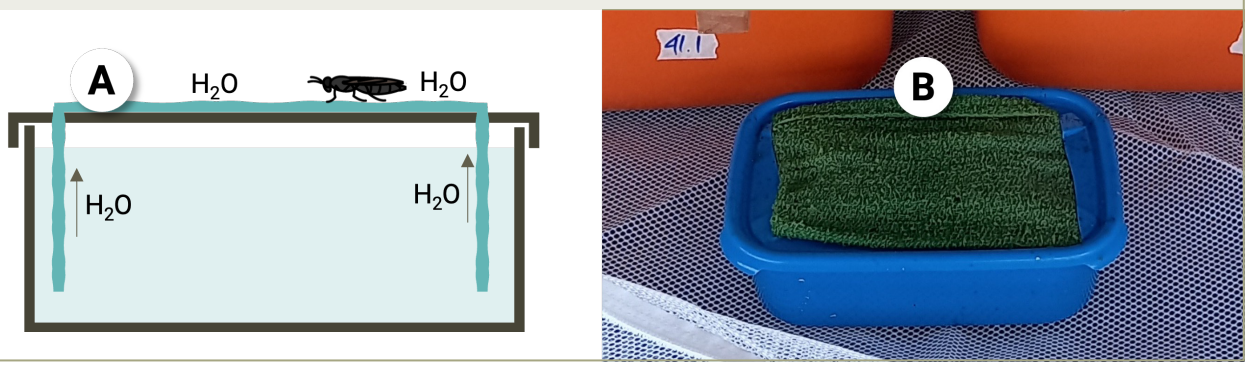
*Figure 9: Set-up of the love cage: Attractant container with eggies on top and bottom **(A)** are placed below the eclosion boxes **(B)**. Also, a water container **(C)** is included in the setup of the love cage*



Eclosion boxes: You will need a total of 20,000 pupae to produce sufficient flies to inhabit the love cage. Start by taking the oldest pupation container to skim off pupae from the top to transfer them into an eclosion box. As with harvesting 7-DOL, tapping on the wall of the pupation container will create vibrations. The mobile prepupae will aggregate and push the immobile pupae up to the top of the pupation container. This makes it easy to then remove these pupae. Repeat this process for the newer pupation containers. Remove and count 2 batches of 10,000 pupae you have just skimmed off the pupation container. If you do not reach a total of 20,000 pupae, add additional prepupae from the oldest pupation container until you have reached 20,000. Place each batch of 10,000 in a separate eclosion box. Place the two eclosion boxes (totalling 20,000 pupae) into one love cage.

Water container: A water container in the love cage (Figure 9 – C) provides the flies with water. But it is important to avoid open water surfaces to avoid flies drowning. Fill the water container with water and cover the container with a lid. The lid should contain two slits. Pass a cotton cloth over the lid and through both slits whereby the ends of the cotton cloth should be in the water below. The cotton cloth will take up water from the container through capillary forces and thus provides a constantly wet cotton surface on top of the lid for the flies to drink. Check regularly for the water level in the water container and make sure the cotton cloth is in contact with the water.

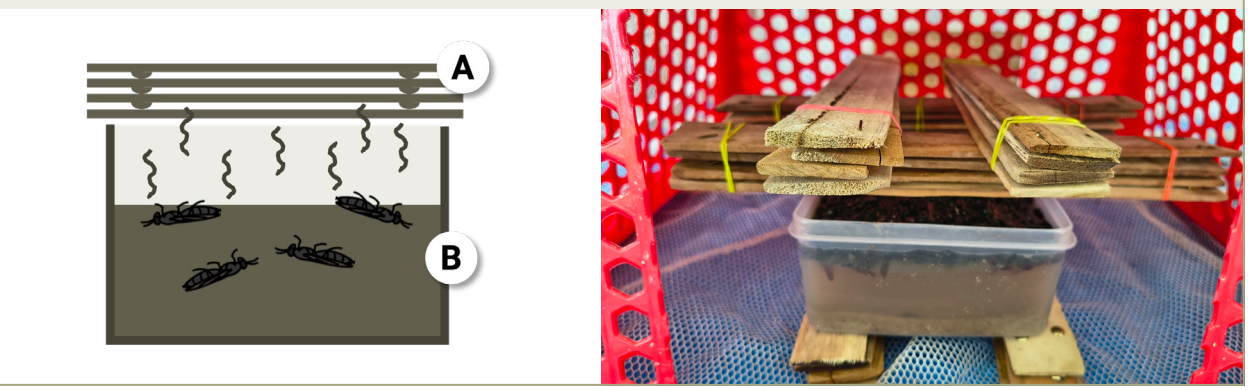
Figure 10: Set-up of the water container in the love cage: ***A:*** *Cloth takes up water from the container, providing a wet surface as a drinking source for the adult flies ;* ***B:*** *Slits are cut into the lid of the container and cloth is inserted so that it is in contact with the water*



Attractant: An attractant container which contains attractant must also be added to the love cage. This "attractant" is a mixture of materials which mimics decomposing organic matter. By its smell it attracts the females to lay eggs close by (Figure 11). An example of an attractant could consist of 2 tablespoons of dead flies, 2 tablespoons of residue from the oldest nursery container mixed with 2 tablespoons of chicken feed and water to produce a slurry. Check the attractant regularly and add water to the attractant if it should have turned dry.

Eggies placement and harvest: You also need to add eggies into the love cage. Eggies is a material and structure that satisfies the flies' preferences to lay eggs (Figure 11). Once female flies have laid their eggs into the eggies, the eggies must be removed before the eggs hatch. Eggs will hatch about three to four days after they have been laid by the female flies. The eggs should not hatch in the love cage. That is why the eggies must be removed from the love cage at least twice a week. When removing an eggie it must be replaced with an empty eggie.

Figure 11: Set-up of the eggies and the attractant: ***A:*** *Eggie: Stacked wood sheets separated from each other by push pins;* ***B:*** *Attractant: container with a watery mixture of residue, dead flies, and feed.*



Setup the love cage: For a successful reproduction, the flies require natural light. In most cases, it is sufficient to keep the love cage under a semi-transparent roof, close to the open sky, on a sturdy surface which can hold all the items placed inside the love cage. To setup the love cage, start by hanging up a clean cage on the love cage table. Then place two eggies on the bottom, add the attractant container on top and add 4 eggies on top of the attractant container. Add a cover, like the pink frame in Figure 9, over the attractant container. Then add the eclosion boxes and water containers on top of the cover. Add a sticker, indicating the actual date to the love cage.

Dismantle the love cage: After 2 weeks, remove all items from the love cage and dismantle the love cage. By now flies should have eclosed from most pupae, have finished mating, laid eggs, and most have died. Wash the love cage with water and soap to avoid bacterial and fungal growth on the net.

ANNEX

ANNEX A: Alphabetical list with a description of equipment items

Attractant container

This is a small container (30x20x10 cm) in which a mixture of rotting fruits, dead flies and feed is placed. It functions as an attractant for flies who want to deposit their eggs. It is typically placed under the eggies in a love cage to guide the flies to the right place for egg laying.

Click counter

A device which can be used to keep track of how many larvae have been counted. You can find these in office tools suppliers.

Collection container

Container in which the prepupae are collected after they have crawled out of the nursery container. The collection container is slightly larger than the nursery container. You can also place several nursery containers in one collection container if the latter is large enough.

Eclosion box

Small box (30x20 cm) where the (pre)pupae are stored for as long as they are in the love cages. Each box holds 10'000 (pre)pupae which are mostly stiff and immobile. Flies will eclose from the pupae during the 2 weeks. No additional material is needed for the eclosion box.

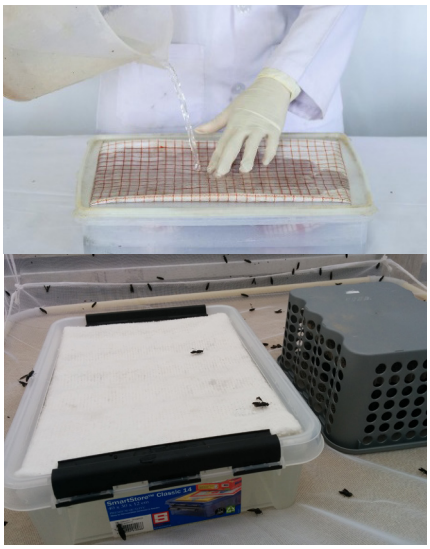
Eggies

Untreated wooden sheets with pushpins to create spacing and rubber bands to hold together a set of 6 sheets of wood with pushpins make one eggie. Six eggies are required per love cage. A minimum of 36 eggies are required for SIMBA: 6 x (4 love cages + hatchling shower + replacing/cleaning)

Feed

This is the mixture of nutritious substances which will allow the BSF to grow during its larval stage. In most cases, a nutritious but constant substrate (e.g. pig manure, rice/ wheat/corn bran or restaurant waste) can be used.

Hatchling shower	The system which allows for a continuous "shower" of neonates hatching from BSF eggs and falling onto a substrate on which they immediately start feeding. Normally this is a rack with bars on which eggies can be placed over the hatchling box.	
Hatchling box	The tray in which the larvae grow for the first 7 days. The hatchling box is filled with feed and neonates will fall onto the feed from the hatchling shower. Space requirements are 200 7-DOL/cm2. For the operation we thus need two boxes à 2400 cm2 (e.g. 60x40 cm) every week.	
Love cage	A net which can be washed regularly. That means, it should not be permanently attached to a frame but can be removed easily. It holds the eclosion box, the water container, the attractant and eggies, and of course the flies. The material should be netting, sewable and machine washable and should not be treated with insecticide. For SIMBA, the dimensions should be between around 75x75x150cm (WxDxH). Five love cages are needed at the site. Four in operation and one being washed.	
Masking tape and pen	Label components (e.g. love cage or hatchling box) with a date sticker so that you always have an overview of the current operation. This can be done either using the standard date format (e.g., 28.7.25) or, to make calculation easier, using a date code: calendar week + xth day of the week (e.g., 31.1 = thirty-first week of the year on Monday).	
Nursery container	Container in which larvae grow on substrate, transform into prepupae and crawl out off. We assume a larval density of about 4 larvae/cm2. If you work with 10,000 larvae like suggested in this guide, you will need a container with a surface of 2,400 cm2 (e.g. 60x40cm). A minimum of 30 nursery containers are needed for the basic operation of SIMBA.	

Plates	This item is used to count the 5-7 day old larvae in order to be able to portion them. A ceramic plate works best. 1 plate is enough for the counting work	
Plastic bottle cap	Used to portion the larvae in preparation for counting. Three full bottle caps should be counted once per month to average the quantity of larvae in one bottle cap. This average amount per bottle cap can be used to calculate how many bottle caps are required for a nursery container or grow-out container. Any bottle cap from a 1-2 Liter plastic bottle will work.	
Pupation container	Tray in which the harvested prepupae are placed. Trays are around 60x40 cm. A minimum of 8 pupation containers are required for the operation	
Reproduction unit	Two adjacent roofed areas where you can maintain a relatively constant temperature of 25-32 °C and a relative air humidity of 50-60%. For ideal sunlight, transparent roofs can be used. Each room should have a minimum space of approximately 15 m2. So in total you will require about 30 m2 of roofed space for the reproduction unit.	
Strainer	Metal strainer as container for collected eggs, scraped off eggies. Such strainers are hung over the hatchling boxes.	
Water container and cotton cloth	A container (e.g., 20x10x7 cm) which is filled with water. A cloth is placed in the container to distribute the water and to prevent the flies from drowning	

ANNEX B: List of tasks and time schedule

Print this table and laminate. Fields with an X mean the task is not required on this day.
Mark (✓) each empty field when the task has been completed with a whiteboard marker.
Remove all marks after the two weeks have ended and reuse the sheet for the next two weeks.

Week of year		...		...	
#	**Day (Mon- 1; Tue- 2; We – 3; Thu– 4; Fri - 5; Sat - 6; Sun - 7)**	**1**	**4**	**1**	**4**
General tasks					
G-1	**Clean all materials** • Clean all the material used in the process • Ensure all the materials have their fixed spot in the room				
G-2	**Clean all working surfaces** • Clean working surfaces with detergent and water • Wipe working surfaces with ethanol				
G-3	**Clean floors /weekly)** • Sweep and then wipe floor with detergent and water	**X**		**X**	
G-4	**Waste management (weekly)** • Empty all trash bins	**X**		**X**	
G-5	**Wash towels and working cloths (every 2 weeks)**	**X**		**X**	
Adult division					
A-1	**Remove old love cage** • Remove eggies from the love cage (see E-1). • Remove all the items from the love cage (water container, shade box, attractant, eclosion boxes, dead flies and date sticker). • Clean all items and dry them so they can be used for the setup of the new love cage (see A-3). • Remove the love cage and clean the surface where the love cage was standing. Clean the love cage and hang it up on the same place again.				
A-2	**Prepare and fill eclosion box** • Take the oldest pupation containers and remove the top layers of pupae from each. • Prepare two batches of 10,000 pupae and add each batch of 10,000 to one eclosion box. Always empty the oldest pupation containers first before starting to remove (pre)pupae from newer pupation containers to reach the desired total of 20,000 pupae.				
A-3	**Set up new love cage** • Prepare an attractant container with attractant (dead flies, residue from nursery container, water) and a water container covered with a wet cloth and place them near the cage. • Place the attractant container in the cage with two clean eggies under it and four eggies over the container. • Add a shade lid? over the attractant container and eggies. • Add the two eclosion boxes each containing 10,000 pupae for a total of 20,000 pupae in one cage. • Add the water container. • Close the love cage and add a sticker with the date of today under the cage.				
Egg division					
E-1	**Handle eggies** • Remove eggies from each love cage. • Add six new eggies to each love cage, except for the cage to be removed today. • Remove old eggies from the hatching containers. • Clean the removed eggies and dry them on a rack. Only use water to clean the eggies.				
E-2	**Prepare hatching containers** • Take three hatching shower crates (60x40 cm) or basins and ensure they are clean. • Prepare 6kg hatchling feed by mixing 1.8kg of dry rice bran with 4.2kg water. • Add 3kg of the mixture to each crate.				
E-3	**Set up hatchling shower** • Take all eggies (24), collected from the love cages today, and separate them into 2 groups of 12 eggies with a combined similar amount of eggs (inspect visually). • Add each group of 12 eggies over a hatching shower crate (60x40 cm)				

Week of year		...		...	
#	Day (Mon- 1; Tue- 2; We – 3; Thu– 4; Fri - 5; Sat - 6; Sun - 7)	1	4	1	4
Larva division					
L-1	**Preparing larvae for counting** • Take the hatchling box that was prepared one week ago • Scoop off as much frass without removing larvae. • Tap on the container with a spoon/stick several times to prompt movement of the larvae. They will huddle together and allow you to remove more frass • Scoop off frass again after 2-3 minutes. If necessary, repeat this procedure until most frass is removed.				
L-2	**Counting larvae** • Determine weight of content (larvae-frass residue) of hatchling box after most frass has been removed • Stir this content thoroughly • Quickly take two samples of 0.5-2g or by volume using a bottle cap • Note down exact (net)weight of samples • Count all larvae in these two samples (see counting methods) • Based on this (average) results, calculate the number of larvae in the hatchling box and record this				
L-3A	**Approach A: Set up nursery container** • Prepare 3 batches of 10,000 larvae and 3 nursery containers • Put the first feeding (5 kg) into a container. Add 50g rice bran around the borders and in the center. Repeat for the other container • Add the three batches of 10,000 larvae on top of the rice bran in the center of each of the three containers • Label containers with a sticker of today's date • Place each nursery containers into a collection container which contains a handful of dry material (sawdust)				
L-3B	**Approach B: Set up nursery container** • Prepare 3 nursery containers • Put the first feeding (3 kg) into each container. Add 50g wheat bran around the borders. • Distribute 30,000 grown larvae obtained from the grow-out unit evenly over each container (10,000 per container) in the middle of the feed. • Label containers with a sticker of today's date. • Place the nursery containers into larger boxes (collection containers) which contains a handful of dry material (for example sawdust)				
L-4A	**Approach A: Feeding nursery containers** • Add second feeding (7 kg) to the nursery containers that were prepared one week ago • Add 1kg of water to the nursery containers that were prepared two weeks ago and the one before that				
L-4B	**Approach B: Feeding nursery containers** • Add 1kg of water to the nursery containers that were prepared the working day before (3 or 4 days)				
L-5	**Collection of prepupae** • Collect pre-pupae from all collection containers that are at least two weeks old • Sieve the harvest with a 4-mm-sieve • Weigh the collected prepupae and note down in log sheet • Collect two 40g grab samples from all collected prepupae, count and determine the number of prepupae per gram of sample. • Calculate the total number of prepupae collected based on grab samples and note this value. • Put all prepupae together in a pupation container and label it with today's date				
L-6	**Dismantle nursery container** • Empty the content of the nursery container that was prepared 2.5 weeks ago (5 working days) into the grow-out unit • Put container aside for cleaning				

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This document provides “Standard Operating Procedures (SOPs)” in BSF farming. SOPs play a critical role in ensuring the success, safety, and scalability which connects to effective reproduction in the BSF life cycle, as well as consistent output and quality of larvae, frass, and by-products. SOPs help standardize tasks (and their timing at different stages of the process). This SOP focuses on the reproduction unit.

Visit to learn more about the Black Soldier Fly (BSF) biowaste processing