



Making Funny Money Through Maggot Farming

Compiled by V. Marufu

Zimbabwe Organic & Natural Food Association

+263 779 438 025. +263 779 020 480

zonfa@powerconnect.co.zw



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Thank you for showing interest in maggot farming which is a highly lucrative business if taken seriously. Agriprotein, South Africa, is a good example of an organisation producing Maggots for the Stock feed industry on a large scale. Basically it's all about taking substrates that attract flies and feeding them to the flies and within a week they will have turned into maggots which will then be harvested and processed.

(Z.O.N.F.A) was formed with the sole purpose of promoting, supporting and helping to establish Africa's Farmer's Markets, providing services and educational assistance to urban small holder farmers, rural small holder farmers and wild collectors while providing economic bridges between rural and urban communities.

We also do manufacture value addition agri-machines such as the driers that you would require to dry the maggots, pulveriser to turn maggots into powder, pellet making machines e.tc.

If need be, we can also can work with you from your project's conception to completion on a consultative basis.

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Definition of Maggot Farming

- A maggot is the larva of a fly (order Diptera); it is applied in particular to the larvae of Brachycera flies, such as houseflies, cheese flies, and blowflies, rather than larvae of the Nematocera, such as mosquitoes and Crane flies.
- Maggot farming is the act of growing maggots for the industry. It is distinct from vermicomposting as there is no separate composting process going on, and maggots are used which are distinct from worms (they also consume only flesh, not plant-based material).

Maggot Farming: background and rationale

Background

- Growing human population increases demand for food especially animal source foods
- By 2030, over 9 billion people along with billions of animals raised annually will need to be fed
- Production of stock feed ingredients will have to be intensified to meet the stock feed demands
- Land limitations on intensive cropping and fishing
- Water pollution from intensive farming and overgrazing leads to climate change
- One way of addressing food and feed security is through insect farming

Why Insects

- Insects are ubiquitous with high growth rates and highly reproductive rates
- Low environmental footprint over their life's entire life cycle
- Low production of GHG e.g. pigs produce 10 times more GHG than mealworms per kg
- High feed conversion rates e.g. insects require 2kg of feed to produce 1kg of insect mass compared to 8kg required by cattle to produce 1kg increase in body weight
- Reared on bio-waste such as waste food, human waste, compost, poultry manure etc. and transform these to high protein feed that can be used for livestock
- Less water dependent than conventional livestock
- Less land dependent than conventional livestock
- Highly nutritious
- Nutritional content depends on life stage and substrate used to rear larvae
- Low risk of transmitting zoonotic diseases

Nutrient composition

Nutrient	Maggots	Soyameal	Fishmeal
Dry Matter	90.20		89.86
Crude Protein	63.99	44.6	70.65
Crude Fibre	1.56	6.5	1.03
Fat	20.61	2.75	7.89
NFE	5.62	34.3	1.38
Energy	2114.88		2021.14

Amino acids

Amino acid	Maggot	Soymeal	Fish meal
Arginine	3.63	3.67	5.8
Histidine	1.98	1.15	2.6
Isoleucine	1.46	1.76	4.68
Leucine	2.90	3.26	7.62
Lysine	5.22	2.54	7.75
Methionine	2.34	0.70	2.95
Phenylalanine	3.57	2.31	3.98
Threonine	2.27	1.76	4.35
Tryptophan	3.17	0.10	1.20
Valine	2.92	1.09	5.29
Total	29.46	18.34	

Animal Feed

- Rising feed costs have made farmers look to unusual sources of protein – and you can't get more unusual than maggots
- Proteins fed to livestock are typically soya-based.
- Insect proteins can be produced fairly easily in mass production and you can use organic waste to grow your insects on



Who has done it before?

- **AgriProtein.**
- The Vancouver-based **Enterra Feed Corporation** production of black soldier fly larvae products.
- **EnviroFlight**, based in Ohio in the US, also produces feed for farmed fish made from black soldier fly larvae.
- **Protix Biosystems** in the Netherlands selling larvae lipids for use in animal feed, and protein to pet food manufacturers.
- **Ynsect** hopes to be farming mealworms and black soldier flies near Paris on a large scale by 2016.
- **Small Scale Farmers** in Benin, Zimbabwe and some part of Africa, Asia and Europe

Why Should One Venture into the Maggot Farming Business?

In Benin, Father Godfrey Nzamujo secured a piece of land in the peri-urban area of Porto Novo. The integrated farm he established is amongst the best I have seen. He had his own slaughterhouse, and all the offal was used to feed the flies and turn their eggs into maggots, which he then fed to quails. He had an abundant supply of quail eggs, some of which were destined for export to Paris. For Father Nzamujo, this was a nice additional earning. He indicated that 90% of the cost of quail farming is the feed. Since he uses his own maggots as feed, it costs him much less to raise them, allowing him to be a competitive seller on the global market.



Songhai maggot farm in Porto Novo , Benin © 2006 , ZERI

Maggots are very disgusting and the sight of them could easily make one vomit, but to a chicken or fish, for example, maggots are a juicy treat. Apart from the good taste, maggots are very nutritious and rich in proteins, a vital element in every animal feed. Proteins are important because they are a critical component in developing muscles in these animals which eventually become the meat that we humans eat.

Interestingly, maggots are hardly, if ever, used in animal feeds that are used by livestock farmers around the world. For decades, proteins in animal feed have come from two main sources: Soybeans and Fishmeal.

- Now, as long as you have organic waste, maggots can literally be “farmed” in your backyard
- Maggots can process offal and then be used as feed for livestock
- They have higher levels of protein than the usual soy based feed. Maggots contain up to 60% protein & 25% of fats compared the 35% of protein of the much heralded soy based feed
- With maggot farming you can produce the same amount of protein in 10 days as a pig does in 6 months from a stack of five bins of maggots
- Maggots are now being used to process human waste and can also be processed into sources of protein, fats and chitin.

- Maggot treatment for wounds is also making a major comeback as it has been found to be especially effective on serious diabetic lesions
- The system is not capital intensive, allowing start up projects to quickly make a turn around.
- The advantage is that the turn-around is not only measured in days, the value generated from “nothing” competes with supply chains (soya beans and fish meal) that are under heavy sustainability stress
- The power of a maggot business is the clustering of different applications which generates multiple cashflows, making the business resilient.

Maggots Farming * Revenue Centres

1. Natural and Sustainable Animal Feed

This is the core product consisting of dried and defatted maggots that are ground into a high protein meal. The feed can be blended into a variety of animal feeds and used just like any other protein such as fishmeal, its nearest nutritional equivalent. It is specifically useful for the feeding of monogastric animals including chickens, pigs and fish.

2. Oil

This is the purified fat removed from the maggots and has a high palatability for animals. It can be blended into a variety of animal feeds as any other animal or vegetable fat or oil.

3. Nutrient - rich fertilizer

This is the residue that is left after the maggots have recycled the nutrients in the organic waste. It is a fine and homogenous soil enhancer that is high in bio-available nitrogen, minerals and nutrients. Farmers use the soil as an organic fertilizer to improve their soils.

4. Whole Dried Larvae

This is simply de-hydrated maggots that are supplied in bulk to the pet food industry and small organic farmers. It can be fed to insect-eating reptiles and birds. It can also be used as a protein and energy

The Triple Bottom Line

Environmental

An estimated 10 tons of CO₂ are generated per ton of fishmeal produced, in comparison Magma meal only generates 2 tons of CO₂ per ton.



Social

Magma meal addresses the needs of a growing population and reduces pressure on scarce water and land resources



Economy

A single female fly will lay 750 eggs in under a week, which hatch into larvae and grow over 400 times in weight within just a few days.



Developed: South Africa

Some basic facts

- Did you know that it takes 2kg of wild fish used in fishmeal to produce 1kg of farmed fish?
- House fly larvae meal has been found to be not only rich in essential amino acids, but also highly available to poultry, pig and fish, save that it is not yet available in commercial quantity.
- The most impressive part of the process is nature. A single female fly will lay 750 eggs in under a week, which will hatch into larvae which grow in weight over 400 times in just a few days.
- 15kg of maggots will save you from purchasing 50kgs of feed.
- On average over 70% of the waste in low-income areas is organic waste.
- Thus our best shot is using nature to solve these problems.

In a study that was carried out, maggots were the most efficient in terms of average weight gain for the 4-5 week old broiler chickens.

It also significantly increased dressing percentage, breast muscle, and thigh muscle.

Why flies?

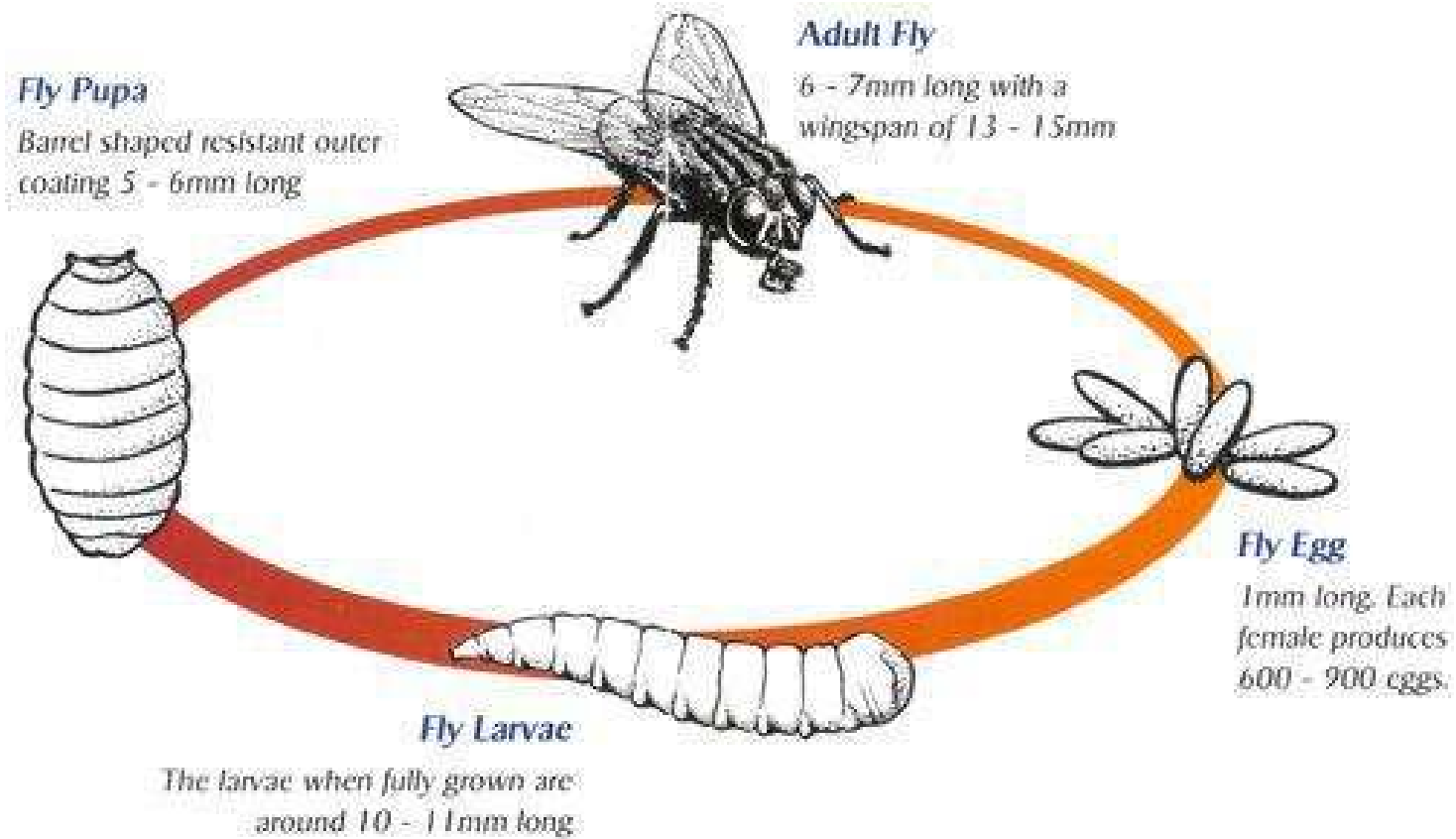
- fly larvae have a high protein content and also contain other nutritionally valuable products such as fats and minerals.
- They are capable of converting low-value organic waste into high-value protein.
- Insect larvae are the natural food of chickens and fish and their nutritional composition is as good as that of fishmeal and better than soy.
- Producing insect-based protein also doesn't have the adverse environmental consequences of producing animal protein, which requires more land and water.

Will consumers accept maggot-fed food?

- Many may not care
 - *after all, the realities of industrial food production are already hidden from view for most people.*
- A combination of the environmental benefits and the "back to nature" message will win over customers.
- Insects are currently used as animal feed ingredients across Africa and many other countries and in addition results of a recent public survey conducted by PROteINSECT revealed some encouraging results....
- *Specifically, 72.6 percent of those asked said that they would be willing to eat pork, poultry or fish products derived from animals fed on a diet containing insect protein*

Maggots Production using the Housefly

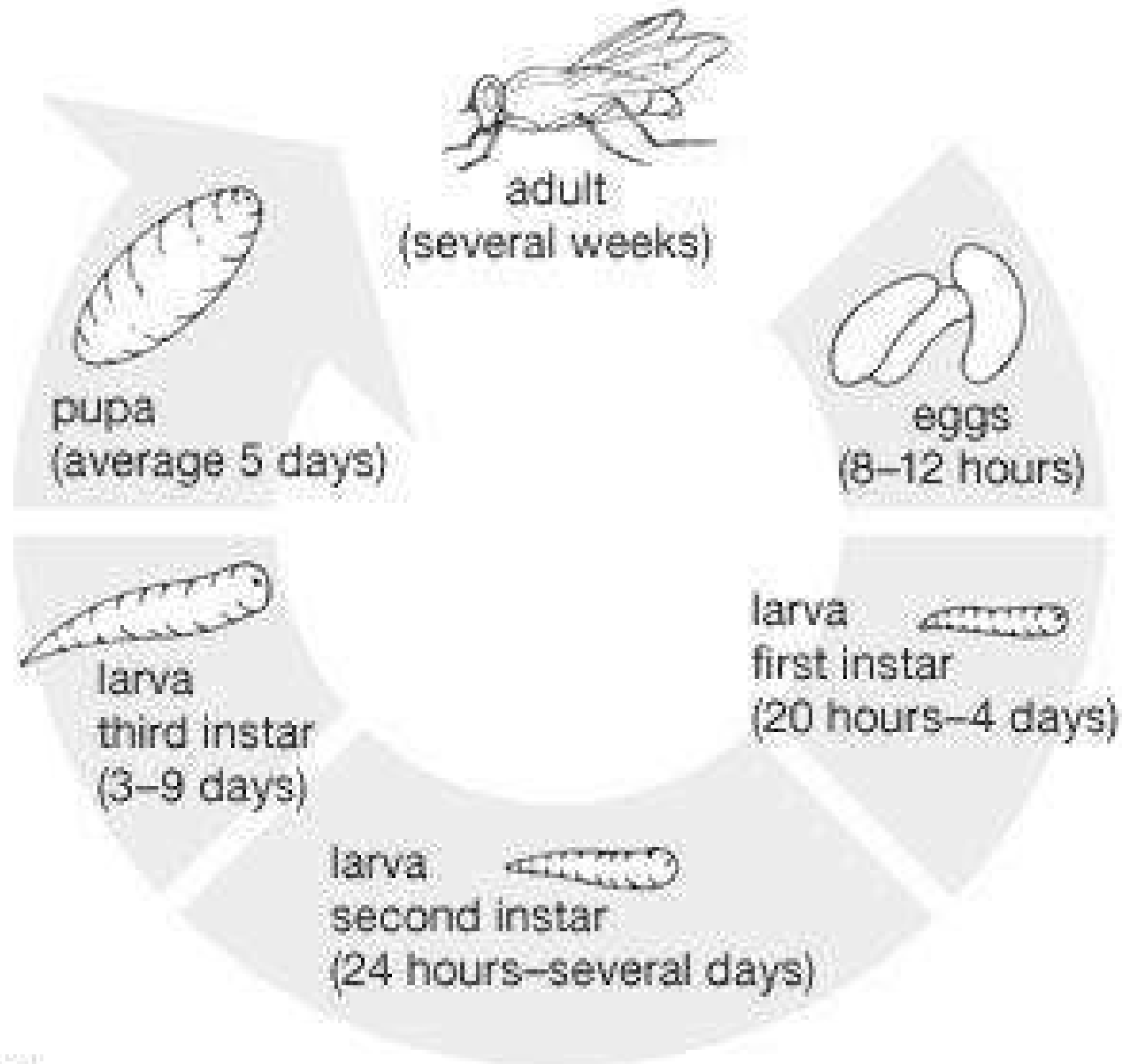
House Fly – Life Cycle



Life cycle

- Under natural conditions, housefly eggs hatch after 8 to 12 hours.
- The larval stage lasts about 5 days and the pupal stage 4 to 5 days.
- This 10-day cycle can be shortened to 6 days under controlled conditions.
- Adult female flies lay 500-600 eggs under natural conditions and more than 2000 eggs under controlled ones.
- The flies lay eggs in moist substrates such as manure and garbage heaps. Maggots feed for 4-5 days and then migrate to pupate in a dry place.
- The adult fly feeds mainly on decaying organic matter. The flies mate and lay eggs between feeding periods. Large populations of flies can be obtained from relatively small amounts of substrate: for instance,

- 450 grams of fresh manure can feed 1500 maggots (Hardouin et al., 2003).
- It is concluded that based on production cost, availability, biological value, growth and nutrient utilization, maggot meal is a viable alternative protein source. This is especially so in developing countries like where fish meal is imported at an exorbitant cost.



1. Choice of site for Maggotry

Maggottries should preferably be located away from human residence - in places where there are trees.

The leaves of the surroundings vegetation serve to absorb offensive odor from the maggotry and reduces the ambient temperature.

2. Housing

The building should preferably be oriented in an East-West direction to reduce the effect of direct sunlight on the substrate.

3. Housing Specifications:

The garble roof type of building with openings at the top and sides for ventilation is recommended. The roof can be made of corrugated iron sheets or thatch.



Songhai maggot farm in Porto Novo , Benin © 2006 , ZERI

a. Height of building:

- Floor to eaves = 2 meters
- Floor to ridge = 3.2 meters

b. Wall of building:

Open sided building with very short walls to allow for optimum free flow of air. The dwarf wall should be 0.4 meters higher than the maximum water level in the surrounding canal.

c. Floor :

The floor of the building is flat concrete and plastered. The rectangular building has a central passage (0.8m wide) in the middle with substrate tanks arranged on either sides of the passage.

d. Substrate tanks : Maggot substrate tanks are open shallow concrete tanks where the fly larvae are cultured. Each tank is 1 meter square and 0.1 meter deep. Each side has railings of 0.12m.

e. Collecting tanks :

These are narrow tanks 0.3m wide and 1 meter length running parallel to the substrate tanks where escaping maggots are trapped and harvested maggots are cleaned. At Songhai, we have 180 substrate tanks located on 307.1 sq meters of floor space

f

F. Surrounding Canals (or gutters) :

The entire building housing the maggotry is surrounded by a canal (or gutter) containing water to prevent the invasion of ants and other crawling predators. This canal which is 1meter wide is used in raising tilapia and catfish which feeds exclusively on stray maggots and phytoplankton in water.

Maggot Culture

To produce maggots, the following prerequisites must be satisfied :

- House fly (*Musca domestica*)
- Suitable substrate
- Fly attractants

The substrate used is fermented grain residue namely brewery spent grain. The fly attractants include animal manure like pig and poultry wastes ; animal offal from the abattoir, dead lizards, birds, rats and other animals - we also use decaying fruits like mangoes. Mango is a good attractant.

Production Procedure :

Maggot production is an aerobic fermentation process.

To produce maggots, proceed as follows :

1. In a clean substrate tank (1m x 1m) place 4 shovel full of fresh animal manure and 6 shovel full of fresh brewery spent grain. Mix them together.
2. Cut the animal offal into small pieces (10cm length) and spread them in the middle on top of the substrate.
3. The flies are attracted immediately to lay eggs.
4. During dry weather, water the prepared tanks, using a watering can.

5. Small maggots are observed about 6 hours later (after first contact of flies with substrate)

6. Water the substrate daily. The drier the weather, the more frequent the watering. Avoid water logging of substrate.

7. The maggots attain optimal size in 3 - 4 days and are then ready to be harvested. Minimal temperature of 30 C or more is required for maggot production.

Other points to note :

8. During unfavourable weather, decomposition is slow and the substrates should be turned daily, before the first harvesting. At about 6 days old, maggots become slow and relatively insensitive and are ready to be transformed into adult flies.

Harvesting of maggots

Harvesting of maggots begins on the 4th day after 1st contact of fly with substrate. The maggots are of the right size at this stage. To harvest, proceed as follows :

- i) Water the substrate (few seconds later, the maggots migrate to the surface of the substrate).
- ii) Place fresh brewery waste and some fresh pig or chicken manure at the corner nearest the migration terminus.
- iii) About 30 min later, the maggots are attracted to the substrate.

Scoop the maggots with a hand spade into the collecting tank where the remaining brewery waste is removed with a broom. Harvest the clean maggots into a rubber or plastic bucket.

iv) Wood ash is sprayed on maggots in the bucket to prevent them from escaping.

v) Harvesting is done twice daily (morning and afternoon).The morning field constitutes 73.7% of the daily total.

1m x 1m substrate tank yields 2.5 - 3.5Kg of maggot per day.

Factors affecting yield of Maggots

Season of the year

- a) Production is low during winter
- b) Temperature $\geq 30^{\circ}\text{C}$
- c) Humidity - Production is better in humid conditions
- d) Quantity of fly attractants / baits - More the quantity of attractants, the more number of flies and the greater the number of maggots produced.
- e) Predators - Rats at night ; lizards and birds in the day ; ants if not prevented cover the field of maggots.
- f) Operators skill can affect the quantity of maggot produced

Post harvest processing

- Maggots are cleaned and dried
- Rendering
- Fed direct to poultry
- defatted

Start up Basic Equipment

a. **Drier** (used to de-fat maggot)

b. **Pulveriser** (grind maggots into powder)



**The Pulveriser -
Model ZW17/02 - \$420**



Constraints of Production

Waterlogging of substrates during rains - Since the orientation of the building is impossible to alter after construction, increase the eave or height of the dwarf wall. Wind breaks are also useful around the building.

Dry air which dries the substrate faster - Water substrates frequently. Turn substrates after every harvesting.

Direct Sunlight on substrates - Cover the open sided walls with bamboo mats or dark colored plastic sheets well arranged for ventilation.

Ants (Soldier ants) - Maintain water regularly in the canal. Inspect and repair cracks inside the building

Birds - Line traps are used for birds outside. Trap nets are also placed in the open walls.

Lizards - Place trap nets in the open walls.

Rats - Place trap nets in the open walls

Human vigilance - The operator should also be vigilant enough to harvest the maggots earlier before they could pass to the next stage.

Utilisation of Maggots

Aquaculture : Feeding of fresh maggots to tilapia and catfishes is done twice daily. (late in the morning and later in the afternoon). An average of 100 Kg/day of fresh maggot is used for 87 concrete ponds of about 50 m² and 0.5 m depth each.

Poultry: Fresh maggots are used as basic component of feed for quail, chicks. Fresh maggots are included in the ration of poultry and guinea fowls.

Fertiliser : The spent substrates are used to fertilize directly plants in the field (ring application in mango, banana, papaw plantation) In farm yard manure, the spent substrates are incorporated into the compost production.

Who benefits from Maggot Production

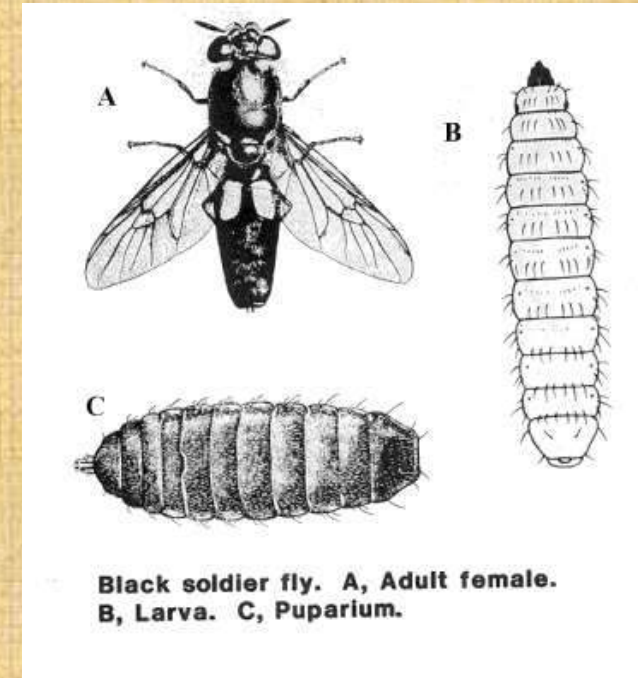
The beneficiaries include:

- Every individual harvesting the maggots,
- The nearby community members with livestock,
- Nearby farmers looking for organic fertilizer
- The entire community in general.

Maggot Production using the Black Soldier Fly (BSF)

Black Soldier Fly (BSF)

- *Hermetia Illucens*
- Naturally occurring in southern USA, Central and South America
- Considered non-pest
- Larvae are voracious organic matter eaters
- As adults they don't feed on live or decaying organic matter (no working mouth parts)



Black soldier fly. A, Adult female. B, Larva. C, Puparium.

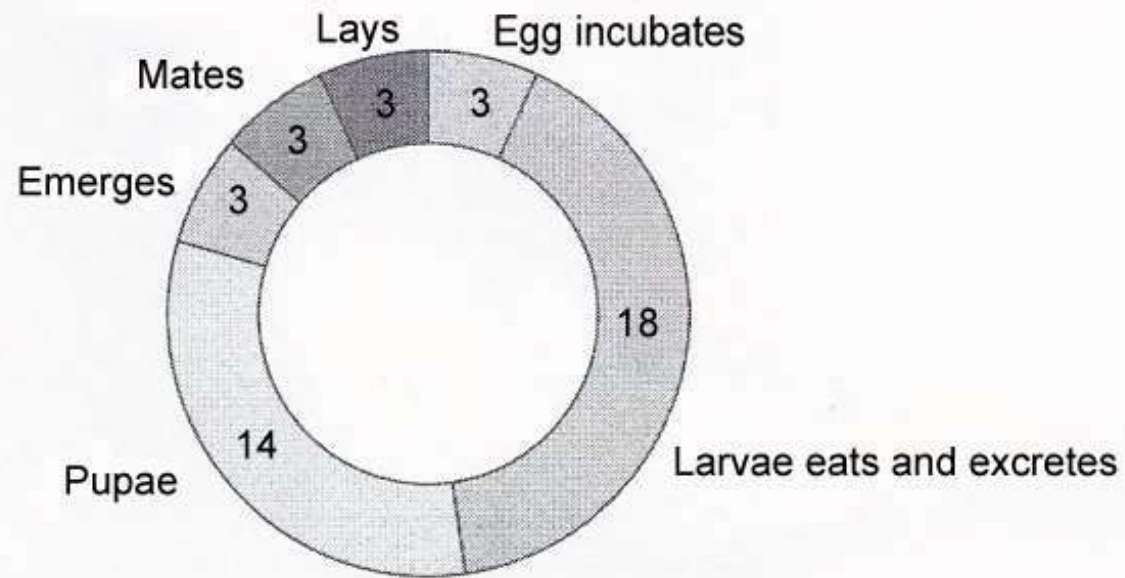


How Black Soldier Flies work?

- In nature, adults lay eggs mostly in manure (preferred), worm composting, decaying corpses, undisturbed garbage (less preferred)
- Larvae feed in the organic matter reducing its volume by 40 to 50%
- Larvae goes through six instars
- When reaching the pupae stage they migrate from the feeding area looking for a dry and protected place to finalize pupation

Black Soldier Fly – Life Cycle

Black Soldier Fly "*Hermetia Illucens*"
Life cycle in days=44



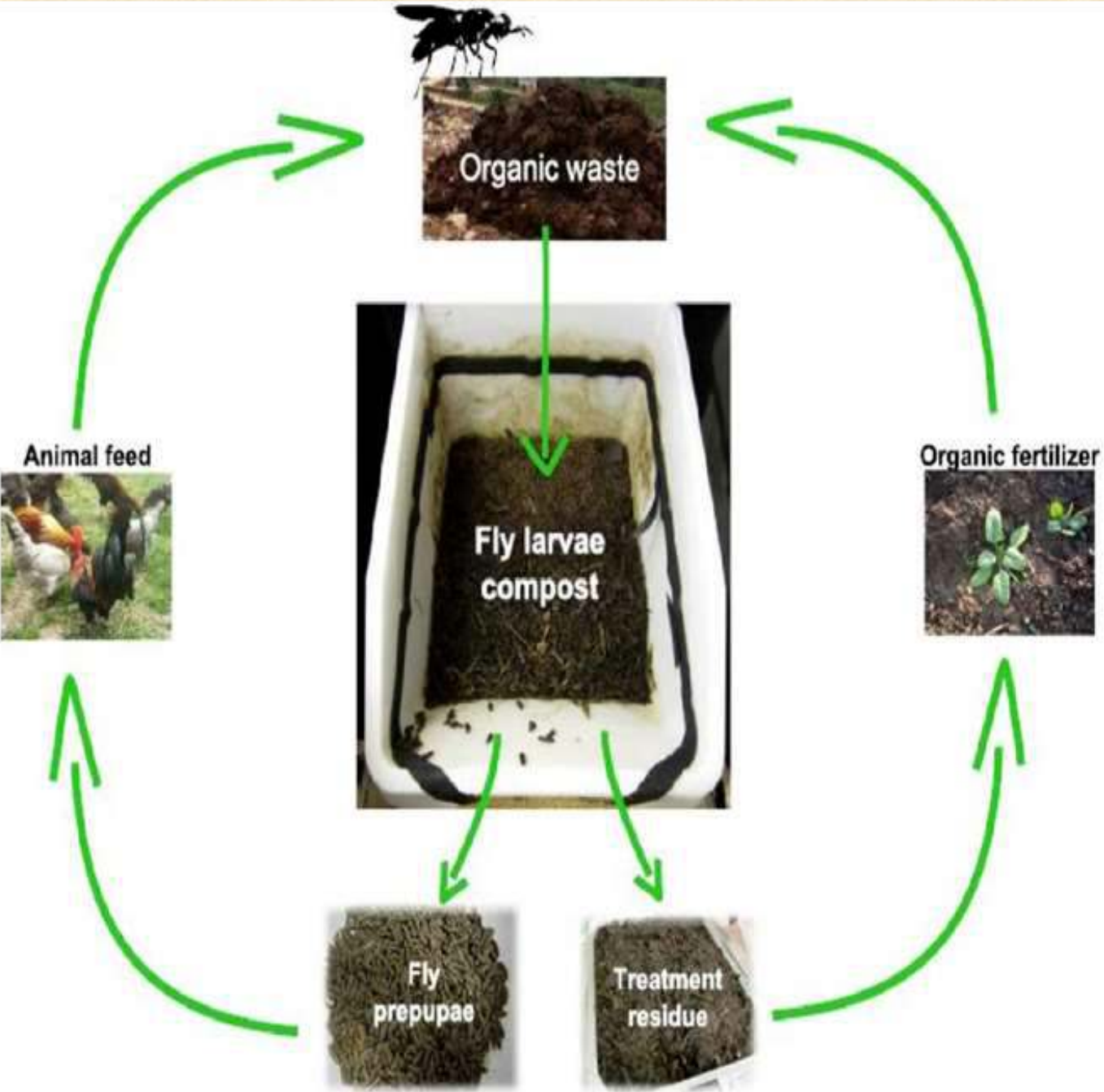


Fig. 1 graphical representation of the concept of fly larvae composting (Lalander et al., 2014):

fly larvae consume organic waste and the prepupae, larvae in the final larval stage, migrate out of the compost, which can be used as organic fertiliser.

The prepupae can be used as animal feed. Animal manure, human faeces and food waste serve as substrate for fly composting and the loop is closed.

BSFL Compost Bins



Black Soldier Fly Larvae



BSF Eggs



- The eggs of the BSF are about 1mm long and a creamy yellow colour in appearance.
- At optimum conditions of around 20° to 30° centigrade, they take around 4 days to incubate and hatch.
- At this point they seek out organic matter of either plant or animal origin.
- BSF larvae are photophobic and will bury themselves in the nearest organic material and start feeding on it.
- They will happily feast on most animal matter, including faeces, and the softer less cellulosic plant matter whether decaying or not but they

- tend only to feed on high cellulose plant matter once it has begun to decay.
- They cannot readily feed on plant matter high in lignin or animal bones.
- However, the range of organic material which they are able to digest is extremely varied and they are voracious feeders which can easily consume their own body weight in a day.
- The optimum temperature for BSF larvae is also in the upper 20s centigrade, but although growth is somewhat temperature dependent, the feeding action and metabolism of the larvae will generate some heat which allows their culture in colder climates.
- With optimum temperatures, larvae will reach full size of around 20 to 25mm in about 4 weeks. After this, they stop feeding, they become dark and their skin becomes harder

- This is the pre-pupa stage, at which point the animal leaves the feed source and searches out a dry, dark place in which to pupate and transform into an adult.
- Pupation takes around a week at optimum temperatures until emergence occurs. All stages take longer at lower temperatures and larvae will take much longer to grow if the availability of feed stocks is low.
- Some larvae may take over two months to reach full size if both temperature and feed availability are low.

BSF Eggs



Adult stage, mating and ovi-position

- After the adults emerge from their pupal cases, their primary focus is to mate and lay eggs.
- They do not feed, although they will drink water or other liquids if available.
- The availability of water can increase their lifespan to around 12 days whereas in absence of water they may only survive for around 6 days.
- In any case, many of them will die shortly after reproduction.
- The adult flies are photophilic and require strong daylight spectra as well as temperatures between 25°C and 35°C to encourage mating to occur.

- Large spaces for courtship are preferable but not absolutely essential as successful mating can be encouraged in illuminated boxes of less than 1m³.
- After mating has occurred, ovi-position may occur up to 2 days after.
- For this, dry crevices such as in wood or corrugated cardboard, close to sources of decaying matter are preferred. Some residue from BSF larvae feeding can often act as an attractant to egg laying.

Breeding





- Mini Fridge (insulation)
- Ventilation
- Sensors
- 60 WATT Halogen Light
- House Plant
- Leachate Spray
- Pupae Bin
- Water Bin
- Cardboard
- Screen



Black soldier fly breeding in captivity

- Essentially, the continual production of BSF requires two separate containing areas which operate dependently on each other.
- The insectarium maintains a population of adults which act as a broodstock.
- The eggs from this are transferred to a larvarium within which the larvae grow to full size and provide pupae for the next generation of broodstock.
- A population of adult flies should be maintained by allowing a proportion of larvae to pupate and adding the pupa to a container full of sawdust, wood-chips or other dry, absorbent material.

- Flies will emerge from the pupal cases in around two weeks.
- The most important criteria for successful BSF breeding are a strong source of daylight and a high temperature.
- BSF are widely reported to not breed in temperatures below 25°C.
- The breeding area, therefore, needs to be placed in a location where strong sunlight will enter for a substantial part of the day to provide both light and heat.
- This can also be achieved in temperate regions using a suitable light bulb.

- The enclosure should also be in an area where it is protected from other elements such as the wind and rain.
- The photograph above shows breeding enclosures in Ghana.

- The breeding area, therefore, needs to be placed in a location where strong sunlight will enter for a substantial part of the day to provide both light and heat.
- This can also be achieved in temperate regions using a suitable light bulb.
- The enclosure should also be in an area where it is protected from other elements such as the wind and rain.
- The photograph above shows breeding enclosures in Ghana.
- The adult flies are housed in side mesh enclosures, supported on metal frames, which allow adequate space for the flies to perform courtship rituals.

- The flies should be supplied with water which will prolong their life. Given enough light and adequate temperature, the flies should mate naturally within a couple of days of emergence.
- After a couple of days the female flies will seek a dry crevice in which to lay their eggs and can be attracted to lay eggs where desired by supplying a medium such as corrugated cardboard near some food waste and some residue (frass) from the feeding activities of the larvae.

Breeding Challenges

- Automization/ upscaling
- Temperature
- Relative Humidity
- Mites
- Mold
- Lighting

Larval on growing and collection

- Once sufficient eggs have been laid, they can be transferred to the larvarium.
- This can be achieved by suspending the cardboard strips above the feedstock so that the larvae will fall into it upon hatching.
- Alternatively, a dedicated nursery system can be adopted where eggs are transferred to a small box specifically for the hatching of the eggs, containing a small amount of feeding medium as shown in fig 4.1.
- Once this has occurred, typically around 4 days after the eggs have been laid, the contents of the box can be transferred to the larvarium.

- This method provides a larger level of control over the breeding and incubation, but is also more labour intensive.
- However eggs should be incubated in dry conditions.
- The larvarium may take several forms, depending on the goal of the project.



Figure 4.1 Nursery box containing developing eggs

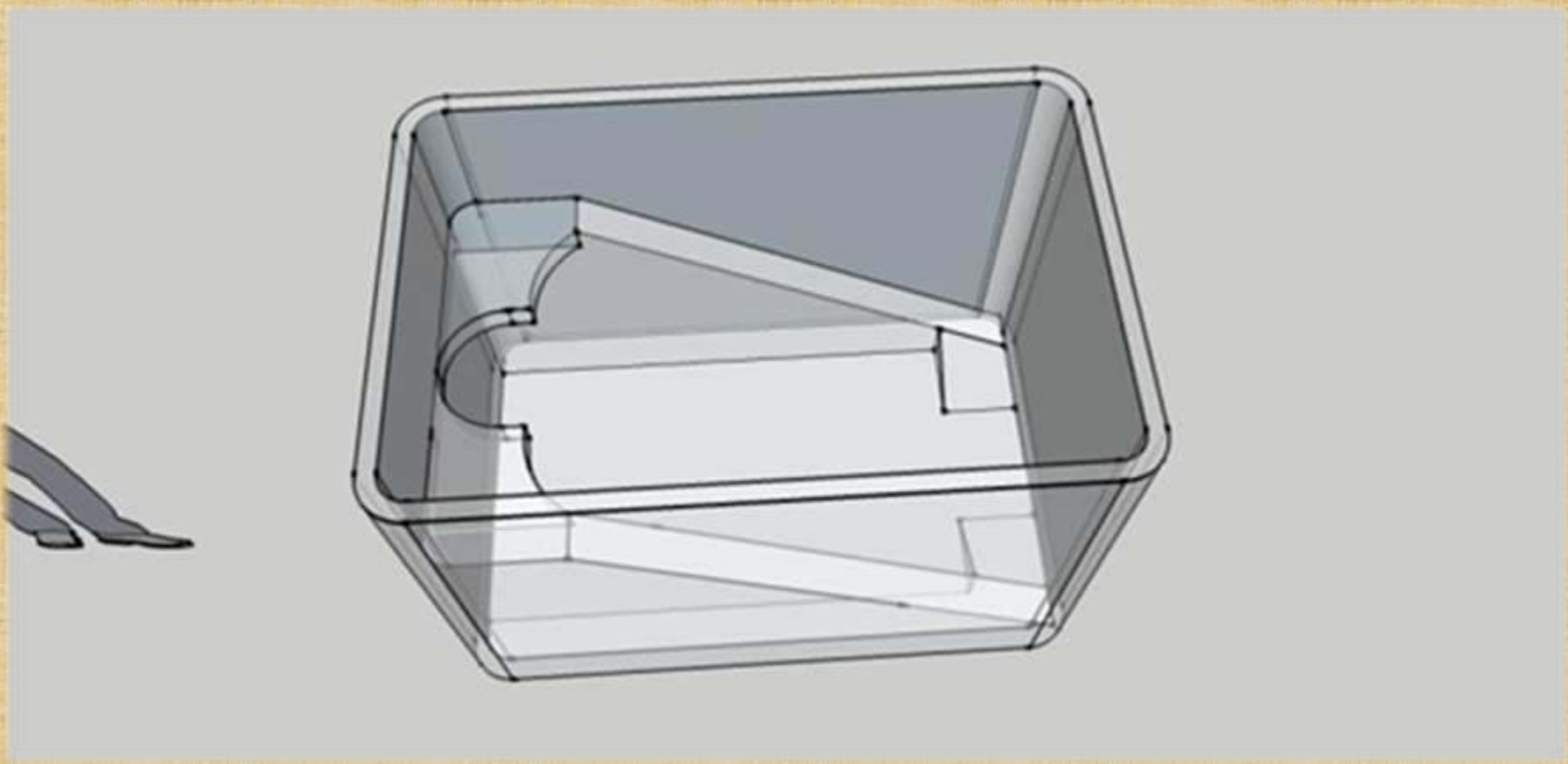
- If the goal is to produce fresh larvae, the larvarium may take the form of many small vessels which are easy to control and from which the larvae may be separated at the correct stage, i.e. when they are fully grown but before pupation has begun.
- Alternatively the goal may be to dispose of waste quickly, producing pre-pupae and biofertiliser along the way.
- The natural tendency for BSF pre-pupae to leave the feed medium and search out a dark, dry place to pupate, lends itself to self harvesting.
- Holding vessels can be constructed in such a way that pre-pupae will be directed to collection vessels, from which they can be removed periodically.

They may then be kept at 4°C for several weeks until such time as they are required.

The advantages of Figure 4.2 Larvarium box design, showing ramps for self-harvesting of this are that the vessels can be harvested larger and less monitoring is required.

Feed stock may be added and pre-pupae collected continuously until such time as the vessel is full.

At this time newly hatched larvae may be added for a further few weeks.



Typically it will take around 4 to 6 weeks for larvae to fully grow and reach the pre-pupa stage, therefore the addition of new larvae should be halted around 2 months prior to cleaning out the residue feed and frass.

Therefore it is desirable to have more than one holding vessel, so that continuous production can be maintained.

Harvesting the BSF larvae, prior to pupation, adds complexity to the process because they will not typically self-harvest. This may be desirable, however, if the goal is to produce optimum nutritional quality of the larvae. The pre-pupae and pupae have much tougher skins with high chitin content, which is anti-nutritional. Therefore to provide a high quality feed material for livestock, the larvae must be collected before

pupation occurs. The downside of this is that they must be collected in some way, either by hand or an automated system must be used. Figure 4.3 shows



Figure 4.3 shows manual sorting of larvae from Figure 4.3 Manually sorting BSF larvae from the feed larvarium production boxes in Ghana.

Residue The level of labour intensity is very high, using manual sorting. In order to collect large quantities of larvae quickly, other techniques need to be employed which have yet to be established.

One method which may be used is to use a rotating drum with a mesh screen. Another method might involve adding water to the larvarium vessel.

BSF larvae will naturally crawl out of the feed medium if the amount of water is sufficient. This could be achieved in a similar set up to figure 4.2. The water could be reused and finally used to water crops.

Residue and frass

- The quality and quantity of the left over material depends on the nature of the feedstock substrate and how many times it is used.
- Substrate may be left inside the larvarium vessel for several weeks or months before it is finally removed, which means that it will pass through the guts of several generations of BSF larvae.
- Having said this, some raw materials are not readily ingested such as woody materials. Alternatively, the residue may be used only once, depending on the objectives of the operation.
- The quality of the residue is sometimes considered to be too high in nutrients for direct use on crops as a bio - fertiliser.

- Some dilution of the residue may be required and some evidence has suggested that further treatment can be beneficial.
- This may include composting or vermi-composting, but both require further management to be viable.
- The nature of the BSF residue is that it is naturally high in nitrogen and may require bulking out with high carbon materials to compost efficiently
- Ideal composting conditions require a C:N ratio of around 30:1 and sufficient oxygen exchange.
- Higher nitrogen tends to lead to venting of ammonia and other nitrogen gases where as poor oxygen availability leads to anaerobic processes and the release of methane.

Diseases???

- Black Soldier Fly are **not** vectors for disease and do not spread pathogens in the same way as houseflies because they do not eat as adults.
- In addition The Black Solider Fly has been seen to reduce disease-carrying housefly populations by over 90%, so the more BSF around the less annoying disease carrying houseflies.

Ongoing research

- A south African company is investigating antibiotic activity in enzymes from these maggots!!!!
- The end result could be an innovative medical product
- Protein sources for livestock and fish farming are being investigated by other companies, especially in Asia, and include microbial and algal species, as well as silkworm pupae.
- AgriProtein is also preparing to apply for approval for an iron-rich product made from larvae fed on blood and guts for use as an additive for breeding sows; piglets aren't born with enough iron, and in the wild animals usually get what they need from soil. In captivity, they need iron supplements.

The End