Black Soldier Fly Farming—Basic Information

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Overview:

Black Soldier Flies (*Hermetia illucens*) (Diptera: Stratiomyidae) are abundant insects, naturally found near manure heaps of poultry, cattle, and pigs. Similarly, the larvae congregate on organic waste including vegetables, distillers' waste, coffee bean pulp, fish offal, decaying organic matter, and spoiled food waste.[1] Their principle food source in nature is manure, however.[2]

Black Soldier Flies (BSF) have potential to address problems with animal and food waste while simultaneously producing a nutrient-dense feed source for poultry, pigs, cattle, and fish.[2] The larvae have voracious appetites, and mature larvae (prepupae) can easily be harvested for use as feedstuff for animals.[2] Fortunately, BSF are not considered a pest, as adults are not attracted to food or human habitats.[3] They are also unlikely vectors of human disease. Adult BSF do not need to eat; they survive on body fat stores remaining from the larval stage.[2] They do not bite or sting humans and have a relatively short adult lifespan (5-8 days). BSF have been successfully cultivated for animal feed and waste management in a variety of climates and contexts, and they are practical candidates for mass production thanks to their waste reduction focused lifestyles.

Uses – Feed & Waste Management:

Commercially, BSF can be used to address environmental challenges associated with manure and organic waste build-up by reducing mass, moisture content, and unpleasant or hazardous odors in large scale systems.[1] This process, also has the potential to significantly reduce populations of common houseflies (*Musca domestica*), which are considered a nuisance.[4] Harvested BSF larvae can be more economically transported than manure, and are valued at approximately $200 per tonne as of 2001.[5] The process of breaking down manure also has the potential to relieve local nutrient overload.[6]

On small-scale farms, BSF larva can be fed directly (live) to **poultry**, **fish**, and **swine** without processing– offering potential cost savings and waste management benefits. Additionally, the process of composting manure and other waste by BSF larvae sufficiently reduces nutrient levels,[1] meaning that residual insect castings (frass) can be applied directly as a soil amendment in higher quantities than fresh manure.

As an animal feed, BSF larvae are highly nutritious (see Table 1 below), and dried prepupae are easy to store for long periods of time.[1] BSF larvae support healthy growth in fish (rainbow trout,[7] catfish,[8] and blue tilapia), pigs,[9] and chicks[10] when integrated as part of complete diet. Formulation of even more appropriate fish feed could be achieved by separating prepupae fat and protein to produce a

feed with over 60% protein.[11] Supplementing poultry diets with insects has been tested in Southern Africa. A 2014 study in Zimbabwe found that insect feed supplements (from *Macrotermes falciger* and *Encosternum delegorguei*) were an effective substitute for commercially available feeds for broilers.[12] BSF larvae also contain ample calcium, which is critical for egg shell generation by laying hens.

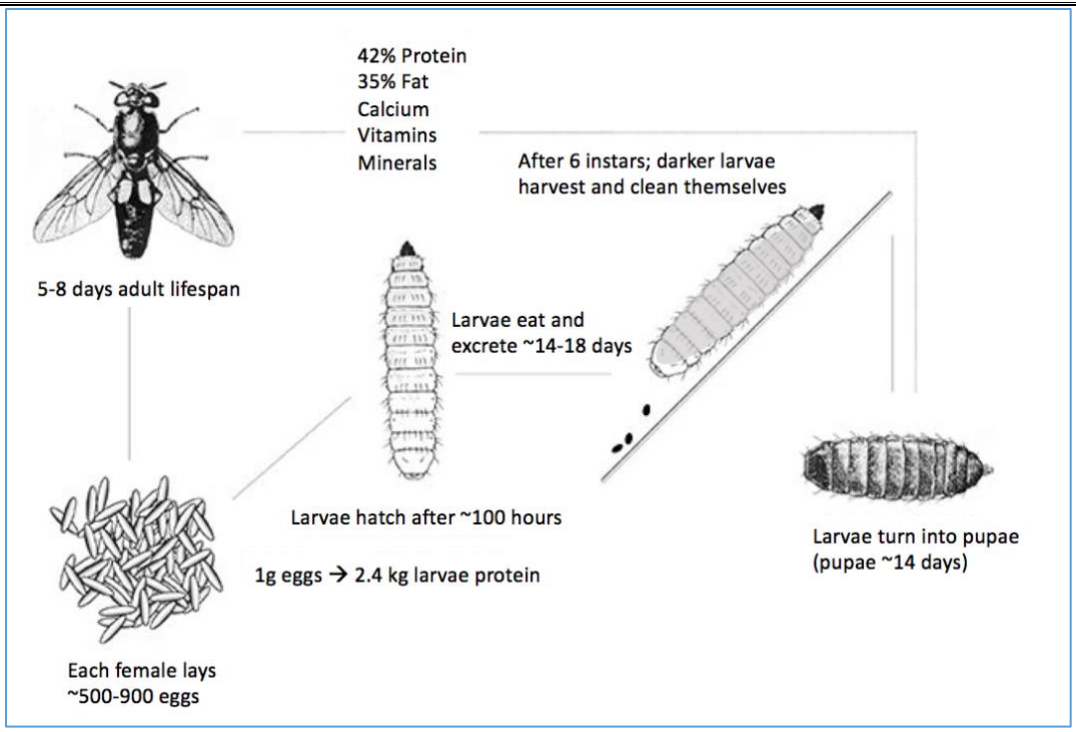
Table 1: Nutrient Composition of BSF Larvae Compared with Other Common Protein Feeds

	Crude Protein (%)	Crude Fat (%)
Dried BSF prepupae[9] (Other estimates)[13]	42 35-57	35
Live BSF prepupae (44% dry matter)[9]	18.48	15.4
Fishmeal[14]	61-77	11-17
Soybean meal (defatted)[14]	49-56	3

Life Cycle:

BSF have a relatively short lifespan compared to some insects. Their lifecycle consists of four primary stages (egg, larva, pupa, fly) including six larval instars. The total lifecycle is about 44 days depending on temperature. Once laid, BSF eggs take about four days to hatch, after which the hungry larvae proceed to eat and grow for 14-18 days (under ideal conditions). Prior to pupation, sixth instar larvae enter a state called “prepupa” where they change slightly in color, cease to eat, empty their guts, and proceed move away from feeding site to a clean, dry area for pupation. Pupation requires about 14 days preceding adult emergence. Adults mate and live for a final 5-8 days. Adult females produce about 500—900 eggs each, carefully deposited in a suitable location adjacent to an appropriate feed source (waste). Figure 1 below outlines this process. BSF larvae are incredibly robust and tough compared to other insect larvae.

Figure 1 – BSF Lifecycle



Farming BSF for Chicken Feed:

BSF farming is ideal on farms where manure build-up is problematic, but it can easily be integrated into small-scale farming systems or at the individual household level. Since BSF larvae can eat and digest a wide variety of putrescent waste (including dairy and meal products), farming systems are ideal side-activities to poultry/swine/cattle/fish production, food preparation operations, and even household compost. BSF larvae castings / frass can also be added back to soil for gardening.

Most small-scale or pastured chicken producers use a general feed ratio of 1/3 greens, 1/3 insects, and 1/3 grains to meet dietary needs. Alternatively, artificial, or formulated feeds are given to chickens at a rate of about 1/3 pound per chicken per day. BSF larvae can provide needed protein, calcium, and other vitamins and minerals to free range chickens as a substitute for expensive feed that includes protein from soy or fishmeal.

To ensure highly nutritious larvae, the BSF diet itself should be controlled. Diet composition is known to influence larval mortality and growth, while also determining the phisiological and morphological development of adult BSF.[15] BSF diet will also influence the fat content of larvae (differing even between various types of manure). BSF are not efficient at breaking down highly fibrous materials. Thus, manure and food waste (including fruit and vegetable scraps) are optimal feed substrates over sticks, leaves, or other agricultural byproducts. BSF eat immediately, so it is best not to overfeed (to avoid foul smells).

Conditions:
BSF are sensitive to temperature and humidity. Some research shoes that optimal temperatures should be maintained at between 29 and 31 ºC with relative humidity between 50 and 70%, but larvae can survive at more variable temperature.[16]

Approximately 45,000 larvae will consume 24 kg of swine manure in 14 days[17] and online farming forums estimate that to generate enough BSF larvae to feed 8-12 chickens, about 1 square foot of compost is needed as BSF feed per day. This will yield about 1 pound of BSF larvae in several weeks depending on temperature and humidity. Adjusting how much feed is given to the larvae will be necessary, based on the amount the insects can eat in one day. For example, if the bin waste is mostly uneaten from one day to the next, adjust by adding lest compost. If the bin becomes wet or foul smelling, improve drainage and add dryer compost. Add wetter compost if the bin is colonized by ants. About 4 inches of waste is suitable given you have less than 1 inch of grubs. About 5% of the consumed waste is converted into castings or frass, useful as a fertilizer. To clean out a farming bin, stop feeding the BSF larvae until the last grub crawls out and use the remainder as compost.

Some BSF farmers recommend setting aside around 5% of prepupae harvest under protected conditions so that adults emerge and generate a locally viable population of adults that will populate a the BSF farming bin / system.

Other notes on farming for chicken feed:

- Keep the bin or farming system in the shade; BSF require natural light, but not direct light
- No bedding is required for BSF larvae – just compost feed
- No water is required for BSF farming – the grubs extract water from their feed
- Every square foot of surface area in a feeding bin will accommodate about 3 pounds of food waste
- While BSF can go dormant and survive the winter, new starter larvae may be required due to winter losses
- Styrofoam may be one way to keep insect systems warm during colder months, eliminating the need for electricity
- Because BSF farming systems do not include carbon bedding to absorb odors, attention should be given to feed, and one should only add as much food to bin as larvae will eat in a day
- If 1/3-1/4 of daily chicken rations come in the form of BSF, most protein and calcium needs are met, so the remainder of the diet can be achieved with cheap components like greens and grains.
- Chickens should only be fed mature larvae

Yield:

- BSF Larvae: ~ 100 pounds of food waste fed to BSF larvae will yield ~ 20 pounds of prepupae (large larvae, ready to change into adults and ready to feed to chickens)
- Compost: ~5 pounds for every 100 pounds of food waste added to bin

Nutrition Requirements for Chickens:

Minimum requirements	Protein %	Calcium %	Phosphorus %
Broilers			
Starter (0-6 weeks)	23	0.9	0.5
Finisher (6 weeks to market)	10	0.8	0.5
Pullets			
Starter (0-8 weeks)	20	0.9	0.5
Developer (8 to 20 weeks)	14	0.8	0.5
Laying Hens			
Layer	16	3.0	0.5

Source: http://nwdistrict.ifas.ufl.edu/phag/2015/02/27/factors-that-affect-egg-production-in-chickens/

Nutrition Content of BSF Larvae:

	g/kg Dry Wt.
Protein	420 (42%)
Calcium	75.6 (7.56%)
Phosphorous	9.0 (0.9%)

http://www.feedipedia.org/node/16388

Farming Systems:

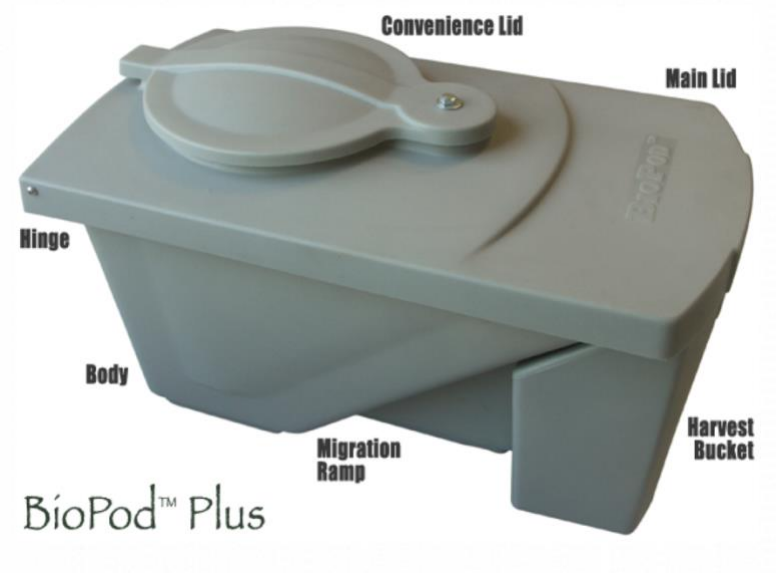
Requirements for farming systems:

- Moisture control – moist waste is acceptable to BSF, but not anaerobic waste; a lid and a drainage system is necessary
- Egg laying area – an enticing place for BSF adult females to lay eggs
- Ramp – a <35° useful for pupae to climb for self-harvesting into a collection bucket (as larvae mature they crawl out of the feeding area / basin, thereby self-harvesting)

Note:
Most BSF Bins / Systems are not fully contained, meaning that pupation and mating take place outside the unit. Female BSF seek out rotting food, and are attracted to the smell of the "tea" / liquid from the system. Then they will seek out the are and lay their eggs near the rotting food / active colony.

Pre-made Farming Systems

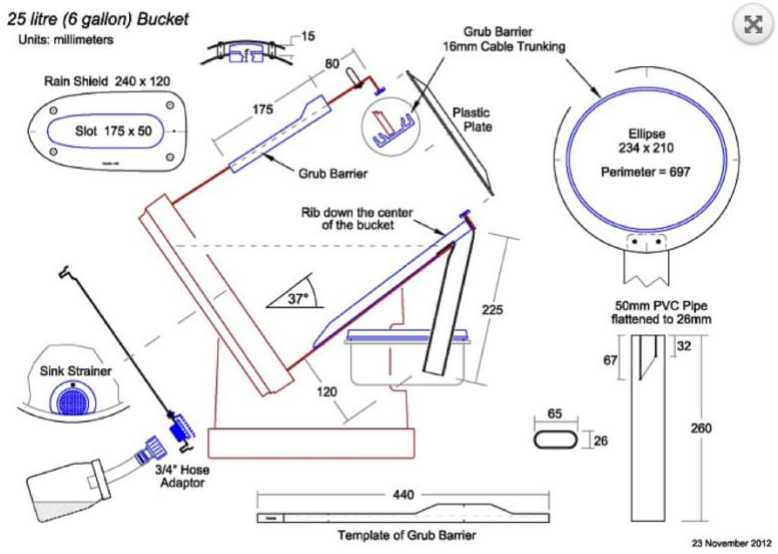
Bio-pod – Cost: *$179.00 – Composts 5 lbs. of compost per day (vs. Protopod, which composts 20 lbs. /day) – the smaller pod can generate feed for 3-5 chickens per day*
http://www.thebiopod.com/



*Unlike redworms, mature BSF grubs instinctively **auto-separate** from the active pile via crawl off ramps and collect in the handled harvest bucket without operator intervention. Advanced drainage system helps maintain aerobic conditions by separating liquid effluent from pod contents. Liquids are easily dispensed from external fittings.*

Make your own:

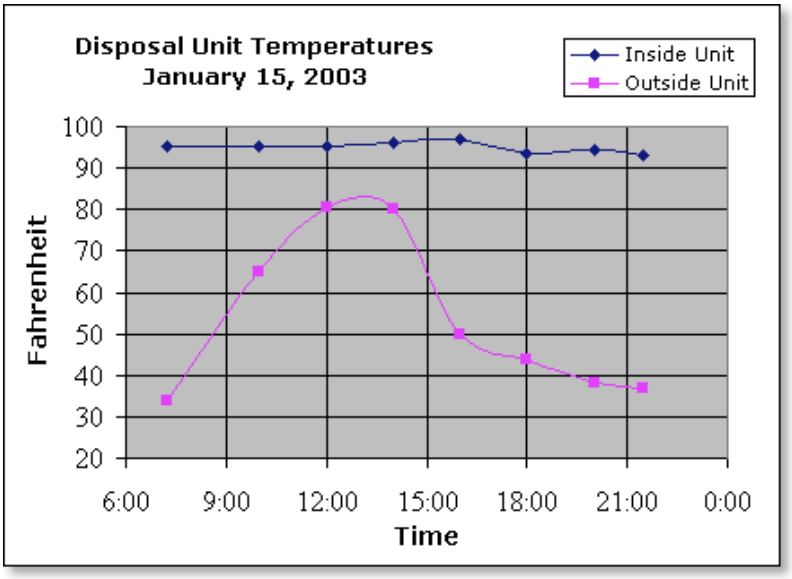
Creating one's own BSF bin is feasible, as long as key criteria are met (dark, lidded bin with internal ramp of at least 30 degrees that empties into a collection bucket, and a drainage system to ensure feed contents are not too wet). PVC piping is a good option for an exit ramp for mature larvae. BSF bins can be built out of wood, created from plastic utility bins (45 L), or generated from a simple bucket. Tilting the system can help with drainage and reduce the need for a liquid filter. Some picture of home-made systems are pasted below.


25 litre (6 gallon) Bucket
Units: millimeters
15
80
175
Rain Shield 240 x 120
Slot 175 x 50
Grub Barrier
16mm Cable Trunking
Plastic
Plate
Grub Barrier
Ellipse
234 x 210
Perimeter = 697
Rib down the center
of the bucket
37°
225
50mm PVC Pipe
flattened to 26mm
67
32
260
65
26
Sink Strainer
120
3/4" Hose
Adaptor
440
Template of Grub Barrier
23 November 2012

Do it yourself option with set-by-step instructions:
http://vermicomposters.ning.com/profiles/blogs/my-black-soldier-fly-bin?xg_source=activity

Challenges and Considerations:

Temperature:
BSF larvae are sensitive to temperature, and as the temperature drops below -6.1 °C. (21 °F), their ability to digest waste slows and eventually stops; if they freeze, they die. As a tropical fly, larvae need to be maintained at temperatures above 30°F.[18] Putting a Styrofoam sheet on top of the larval bed / residue is one possible way to save the heat generated by larval movement. If this heat is not allowed to escape, the temperature on the surface is kept high (exceeding 35 °C). The graph below plots daily temperature (both inside below the Styrofoam and outside the BSF bin) in a Texas study conducted by ERS international. While the outside temperature fluctuates dramatically, the inside temperature remains fairly stable.[18]



Graphic from http://www.esrint.com/pages/bioconversion.html

Labor:
Daily labor is required to maintain a highly productive system. However, BSF colonies can survive on little to no food for a period of time.

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