TECHNOLOGY PROFILE & BUSINESS CASE

BLACK SOLDIER FLY LARVAE PRODUCTION AND USE AS AN ALTERNATE PROTEIN SOURCE FOR POULTRY FEED

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LIST OF ABBREVIATIONS AND ACRONYMS

BSF	Black Soldier Fly
BSFL	Black Soldier Fly Larvae
CSIR	Council for Scientific and Industrial Research
DOC	Day-Old Chicks
Ft	Feet
GHS	Ghana Cedis
GHP	Good Hygienic Practice
HACCP	Hazard Analysis and Critical Control Point
IFWA	Insect as Feed West Africa
IIR	Internal Rate of Return
Kg	Kilogramme
mm	Millimetre
MMDA	Metropolitan Municipal and District Assemblies
NGO	Non-Governmental Organization
NPV	Net Present Value
PPE	Personal Protective Equipment
SEM	Standard Error of the Mean

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EXECUTIVE SUMMARY

CAB International, West Africa Centre in collaboration with CSIR-Animal Research Institute under the auspices of the Insect as Feed in West Africa (IFWA) Project has been researching into and exploring sustainable and affordable alternatives to conventional protein sources for livestock feed formulation using the black soldier fly larvae for the production of broiler birds.

To facilitate adoption and effective transfer of the technology to relevant end users willing to adopt the technology, CAB international teamed up with the Sustainable Agriculture Intensification Research and Learning Alliance (SAIRLA) Ghana Learning Alliance to develop this business plan that provides adequate information required for making policy and investment decisions regarding the black soldier fly larvae technology as an alternative protein source in livestock diet.

The black soldier fly larvae bioconversion technology involves the domestic growing of black soldier fly larvae on segregated bio-wastes such as crop waste, household waste, animal waste such as fish and meat processing waste, etc. The reared larvae grow on the waste feedstock from which they extract nutrients, deposit their waste and reduce the waste mass at the end. Larvae are harvested and may be processed into suitable animal feed ingredient. End users of the technology are animal feed manufacturers, poultry, pig and cultured fish farmers.

A poultry business using black soldier fly larvae as a protein source in the formulation of broiler starter, grower and finisher diets is economically viable. The estimated cash flow indicates that the farmer is required to invest a sum of GHS27,650.00 as inputs that will be used to produce a batch of 200 broilers. It is estimated that the farmer requires further amount of GHS19,520.00 to raise 800 broilers per year and generate about GHS21,600 as income for a year.

Potential investors should contact CSIR Animal Research Institute and CAB International West Africa Centre with the addresses below for training on how to use the technology and further information.

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1.0 INTRODUCTION

1.1 Background

The increase in world population has catapulted demand for animal proteins beyond supply. Limited and unsustainable supplies of fishmeal are among factors such as diminishing land sizes and increasing urbanisation that hinder conventional livestock production and increase protein insecurity. The black soldier fly (BSF) larvae bio-conversion technology that uses organic waste to produce a nutritive biomass rich in proteins offers a potential solution to the problem. Proteins used in livestock and cultured fish diets are mainly from fish, soybean, copra, groundnut and sometimes, sunflower sources which are expensive and unsustainable to produce. Research however, has proven the black soldier fly (BSF) larvae as an alternative protein source in animal feed with high nutritional content (Hale, 1973; Jozefiak et al., 2016; Wallace et al., 2017).

To research this further, CAB International (CABI) partnered with the Council for Scientific and Industrial Research - Animal Research Institute (CSIR-ARI) under the Insect as Feed in West Africa (IFWA) initiative funded by the Swiss Agency for Development and Cooperation and the Swiss National Science Foundation. Under the framework of the Swiss Programme for Research on Global Issues for Development (R4D), the partners experimented with BSF larvae bioconversion technology for the production of broiler birds and trained farmers in its production and subsequent adoption by potential investors.

1.2 Objectives of the business case

The objective of this business case is to provide a referral point for entrepreneurs hoping to invest in BSFL meal production for inclusion in the diets of poultry.

1.3 Why the BSF larvae technology is worth investment consideration

Strengths of the black soldier fly larvae technology are as follows:

- The adult black soldier flies are easy to culture and does not require feed.
- The larvae are easily harvested.
- The larvae are good at converting large amount of organic waste into protein stored in their body.
- The larvae can cope with a broad range of environmental conditions such as pH, temperature and humidity.
- The larvae reduce the smell of decaying organic matter.
- Rearing larvae requires less skill, effort and time.
- Both adult and larvae of the Black Soldier Fly are not associated with any health hazard.
- The larvae meal increases broiler growth rate.
- The larvae meal improves feed utilisation.
- The larvae meal increases broiler productivity and profitability.
- The larvae meal improves flavour and taste of the chicken.

The key challenge identified with producing the larvae is the need to have breeding stock of high laying capacity. BSF breed improvement programme will begin soon.

1.4 End users of the technology

The larvae can be used by animal feed manufacturers, poultry, pig and cultured fish farmers. The residue can be matured as compost to be used by crop farmers and floriculturists as soil amendment and potting material.

1.5 Information on where to procure the technology

Potential investors should contact the following addresses for training on how to use the technology and further information:

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Located at Frafraha, Forster Home Down
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2.0 PROFILE OF THE TECHNOLOGY

This section provides basic information about the black soldier fly, its larvae production and usefulness in broiler production in Ghana.

2.1 Innovative characteristics of the BSF and larvae

The black soldier fly, (*Hermetia illucens*) is a Diptera (two-winged) fly of the Stratiomyidae family that is widespread due to its tolerance for a wide range of environments. It is a wasp-like smooth and glossy looking fly with no stingers that likes basking in the sun. The adult fly varies in colour ranging from black, metallic blue, green or purple to brightly coloured black and yellow patterns (Picture 1). It is 15-20mm long with elongated antennae that have three segments. Each leg of the adult fly has a white coloration near the end. They are sluggish and poor flyers.


Picture 1: Adult Black Soldier Fly

The larvae have a creamy white colour and a small head with a mouthpiece for feeding (Picture 2). At the final developmental stage (prepupa) of the larvae, they attain a dark brown to black colour (Picture 3) and measure about 27mm in length, 6mm in width with an average weight of about 220mg.


Picture 2: BSF larvae (creamy white)


Picture 3: BSF larvae at prepupa stage

2.2 Life cycle of the Black Soldier Fly

The Black soldier fly undergoes a complete life cycle, comprising of four live stages: egg (embryo), larva, pupa and adult (imago). Eggs hatch into larvae within three to four days of being laid. Under the right conditions of feeding, relative humidity and temperature, larvae mature into prepupa within about two weeks. The prepupa, given the right conditions take two weeks to change into an adult.

The prepupae change into pupa after they have found a dry medium to burrow in. In the dry medium, the pupae go into a sleeping mode for a period of at least two weeks during which time the pupae further develop within their outer casing. When fully developed, the casing breaks up at the tip to release a fly. Freshly emerged nymph has folded wings which gradually unfold within 15 minutes and also have slightly larger, softer and greenish coloured bodies compared to one day old adults.

Adult black soldier flies have a lifespan of five to twelve days during which time they mate and lay eggs. Eggs are laid in masses of 500-1200 eggs depending on the fertility level of the female, which in turn is dependent on the diet and rearing conditions at the larval stage. The life cycle of a black soldier fly from egg to adult is estimated to last about 40-43 days under optimum rearing conditions but under unsuitable rearing conditions, the period can stretch up to six months.

2.3 Nutrient composition of BSF larvae meal and use in poultry diets

The black soldier fly larvae meal is a very rich ingredient that can suitably be used as a source of protein. Its nutritional value in comparison with other protein sources is presented in Table 1.

Table 1: Nutritional Value of Black Soldier Fly Larvae Meal and Conventional Protein Sources

Nutrient	Black soldier fly larvae meal	Fishmeal	Soybean meal
Metabolizable energy (MJ/kg)	20 - 24	10.9 - 11.8	9.4 - 10.3
Crude protein (%)	38 - 60.4	61.0 - 65.0	42.0 - 47.0
Crude Fat (%)	9.0 - 26.0	4.0 - 10.0	0.5 - 3.5
Crude fibre (%)	1.6 - 8.6	1.0	6.5 - 7.3
Digestibility (%)	89 - 90	-	-

Source : Jozefiak et al., (2016); Arango Gutierrez et al., (2004)

It is recommended that BSF larvae meal, like fishmeal, should be used in combination with vegetable (soybean) protein in poultry diets. Evidence suggests that BSF larvae meal can be included up to 10 per cent in the formulation for starter diets and three per cent in finisher diets without any detrimental effect to the meat. The crude protein content and the inclusion level of BSF larvae meal in broiler feed types are shown in Table 2.

Table 2: Crude Protein of Broiler Feeds and Black Soldier Fly Larvae Meal Inclusion

	Starter	Grower	Finisher
Crude protein of diet (%)	22-23	21-22	19-20
BSF larvae meal inclusion level in feed (%)	10	5	3

During feed preparation, the required quantity of larvae meal should be added to the grains (maize or wheat bran) and milled to avoid sticking inside the hammer mill. The other ingredients are weighed, added and thoroughly mixed up. The feed can then be packaged and stored to be used.

2.4 Principles of the BSF larvae production technology

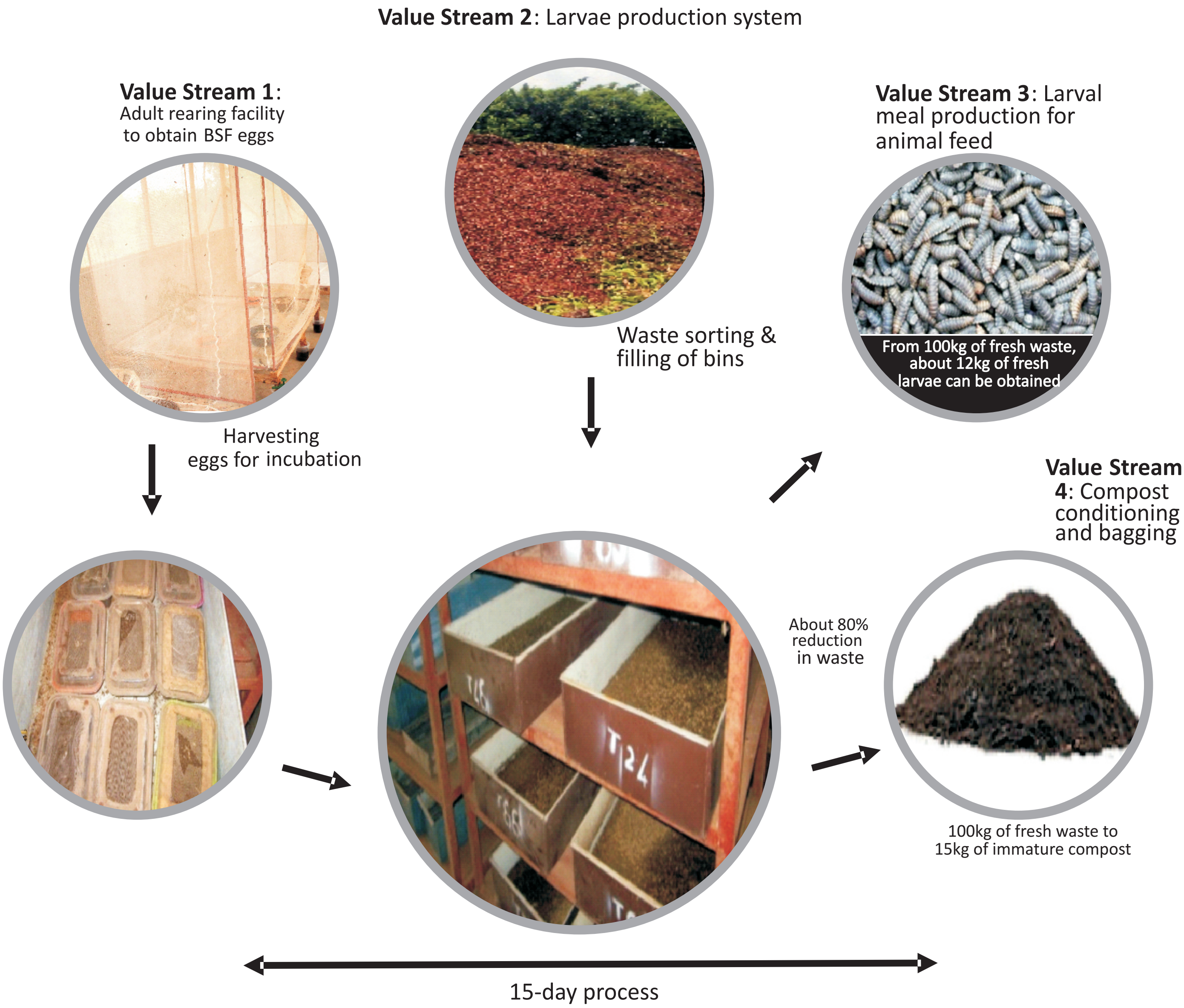
The BSF larvae production technology is based on the following principles:

- Bioconversion which is the transfer of nutrients in an organic substance into the body of a living organism.
- Water use efficiency principle where black soldier fly (BSF) requires very little water to survive.
- Biosafety principle where heat is generated during bioconversion while the larvae also secrete substances into the substrates. Both the heat and larvae secretions sterilize the substrate making it less harmful from microbes. The larvae feed rapidly on the waste substances restraining bacteria growth and reducing bad smell.

2.5 How the technology works

The black soldier fly larvae bioconversion technology involves the artificial growing of BSF larvae on segregated bio-wastes such as food waste, household waste, animal waste such as fish and meat processing waste, etc.

Diagram 1 BSFL production and waste management flow chart



Value stream 1: Adult rearing facility to obtain eggs.

Raise adult black soldier flies in love cages to mate and lay eggs on dried leaves or in holes of cardboard papers placed in the love cage. Expose egg mass from cardboard holes to harvest. Harvest the eggs with the help of clean stick (or brush) onto a substrate. BSF egg production can be a stand-alone business for someone to supply to waste management companies and farmers who want to raise the larvae as animal feed.

Value Stream 2: Larvae production system.

Place about 0.15g of eggs on paper and place on every 200g organic waste material known as substrate (eg. wheat bran, brewers spent grain, animal dropping, fruit waste etc.) in incubation bowls. Cover the incubation bowls with net and store securely at room temperatures for about five days to allow eggs to hatch. Eggs hatch by the end of the fifth day. The newly hatched larvae migrate from the paper into the substrate and can be seen moving and feeding in the substrate.

Transfer the content of three incubation bowls into seven kilos of substrate in larger bowls or troughs or windrows. This means that for a ton of organic waste, one needs 65g of BSF eggs for the bioconversion process to obtain larvae.

Allow the larvae to feed on the substrate for eight to ten more days. At this stage the larvae are matured for harvesting. The larvae will pupate immediately after this stage. The troughs can be built with concrete/tin/wood and can have different sizes depending on the scale of production.

NB: Do not allow larvae to pupate except when you are producing brood stock of adult flies. The pupae are not good for feeding because they have high amount of chitin (a hard-structured covering – an outer skeleton) which is not very digestible and is nutritionally poor.

Value Stream 3: Larval meal production for animal feed.

Harvest the larvae by carefully removing the top of the substrate, layer by layer. Larvae are mostly found covered by the substrate. Some production systems use self-harvesting hives (picture 4) that reduce the drudgery of harvesting the larvae. In windrows, spouts can be inserted at intervals for larvae to creep out into receptacles.

Pour the larvae onto dry sawdust and allow it to stand for about 24 hours. This is to purge/clean the larvae by allowing them to empty their guts.

Picture 4: Self-harvesting hives

Separate the purged larvae from the sawdust using sieve or by hand. Immobilize the larvae by briefly dipping them into hot water for about one to two minutes. Live larvae are likely to escape when drying especially when using solar dryer.

Dry the larvae using solar dryer, gas or electronic oven. Drying temperature should not exceed 60°C in order not to denature the proteins. Package whole or milled for storage by placing in appropriate containers (polythene bags, bottles or cans) and store in a cool dry place away from vermin (mice, rats and insects) and contaminants.

Value Stream 4: Compost conditioning and bagging.

The waste residue can also be further matured into compost, and sold for use as soil amendment with fertilising properties.

2.6 Resources required for adoption and utilisation of the innovation

The following key resources are required for production of the black soldier fly larvae: land, love cage (Picture 5), bowls, troughs/hives, card boards, a shed, rearing drawers, solar drier and adult fly.

Picture 5: Love cage with adult black soldier flies

2.7 Processing of the BSF larvae

Even though the larvae can be served fresh to livestock, it is recommended that the fresh larvae are dried to a moisture content of about 12 per cent, milled and bagged for storage. The milled meal can be mixed with other ingredients into feed for livestock. The dried larvae meal should be stored in a cold and dry room with adequate aeration and free of vermins (mice, rats and insects) for a period not exceeding six months.

2.8 Industry standards and intellectual property issues

The Ghana livestock policy accepts the use of insect meal as feed ingredient, however there is the need to comply with the Ghana Standard Authority code of hygiene practice for meat (GS CAC/RCP 58-2005) by contacting the Ghana Standards Authority documentation centre for briefing on the code. The information covers principles of meat hygiene applying to primary production of livestock (poultry production). A gist of the 5.1 code relevant for the business is presented below:

i. Primary production should be managed in a way that reduces the likelihood of introduction of hazards and appropriately contributes to meat being safe and suitable for human consumption.

ii. Whenever possible and practicable, systems should be established by the primary production sector and the competent authority, to collect, collate and make available information on hazards and conditions that may be present in animal populations and that may affect the safety and suitability of meat.

iii. Primary production should include official or officially-recognized programmes for the control and monitoring of zoonotic agents in animal populations and the environment as appropriate to the circumstances, and notifiable zoonotic diseases should be reported as required.

iv. Good hygienic practice (GHP) at the level of primary production should involve, for example, the health and hygiene of animals, records of treatments, feed and feed ingredients and relevant environmental factors and should include application of HACCP principles to the greatest extent practicable.

3.0 PLANNING FOR THE PRODUCTION AND USE OF BLACK SOLDIER FLY LARVAE MEAL IN BROILER DIETS

3.1 Key inputs for BSF larvae meal production

Black soldier fly larvae production requires a shed, fly-proof cage(s) to house adult flies, incubation boxes, troughs/hives to rear larvae, solar dryer, organic waste (substrate), shovel, gloves, packaging materials and labour. Larvae yield is about 2.5 per cent of the fresh waste and compost is about 15-17 per cent of the fresh waste. Thus, 3600kg of organic waste (substrate) would yield 90kg of dry larvae and 540kg of compost. The financial viability analysis was computed with the assumption that inputs are bought from open market and output prices assumed as GHS3.20/kg of dried BSF larvae and GHS0.8/kg of compost. The cash flow estimates for a small scale BSF production capable of handling 24,000kg of organic waste per year is presented in Table 3 below.

Table 3: Cash Flow Estimates for Black Soldier Fly Larvae Meal Production

Item	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Total revenue (GHS)	0	1708.62	1708.62	1708.62	1708.62	1708.62
Total cost (GHS)	1235.00	610.00	610.00	610.00	610.00	610.00
Gross profit (GHS)	-1235.00	1098.62	1098.62	1098.62	1098.62	1098.62

Profitability estimates for black soldier fly larvae meal production is presented in Table 4. The results suggest that it is profitable to produce the larvae meal on small scale. One would require a total of GHS4285 to generate GHS8543 over a five-year period. The discounted Benefit-Cost Ratio (BCR) will be 1.63 showing that the discounted benefits exceed the present value of the costs and investments made.

Table 4: Profitability Estimates for Black Soldier Fly Larvae Meal Production

Total investment capital and production cost	GHS 4285.00
Total revenue	GHS 8543.08
Net Present Value at 23% discount rate	GHS 1844.94
Discounted Benefit-Cost Ratio	1.63
Internal Rate of Return (IRR)	84.83%
Payback period	18 months

This translates to a positive net present value (i.e. the value today of a sum of money, in contrast to some future value it will have when it has been invested at compound interest) of GHS1844.94. The IRR (a measure to estimate the profitability of a potential investment) of 84.8% meaning the business will have an annual growth rate of 84.8%. The initial capital cost will be paid within 18 months.

4. 0 FINANCIAL ANALYSIS FOR PRODUCING 200 BROILER BIRDS PER BATCH USING BLACK SOLDIER FLY LARVAE AS PROTEIN SOURCE: Case Study

A batch of 200 broiler birds was produced on four diets with varying protein sources. The results formed the basis for analysing the profitability of producing broilers on Black Soldier Fly Larvae meal over a period. Some advice to those who want to venture into it and requirements to raise four batches of 200 broilers per batch yearly for an estimated period of six years are given below.

4.1 Key inputs for broiler production

Poultry production basically requires inputs such as housing, chicks, feed, water, medication, labour and equipment. Ultimately funds are required to procure these inputs and to finance operation.

4.2 Housing:

Poultry houses are built using conventional building materials however, it is better to use locally available and cheap materials that can provide durable housing.

4.3 Source of inputs for production of broilers birds

Chick supply: There are several sources and breeds of broiler day old chicks in Ghana. Broiler chicks in Ghana are obtained either from local hatcheries or imported and are sold through agents that are distributed within the country. Due to inadequate supplies, chicks must be ordered in advance with payment and farmers should insist on supply dates and quantities. Four batches of 200 broilers per batch will be produced yearly for an estimated period of six years.

Feed supplies: The cost of feeding poultry is a serious concern contributing about 60 -70% of the production cost. Thus, to increase profitability feed acquisition and use must be carefully decided. The single most important ingredient in feed is protein which is mainly soybean and fishmeal.

The replacement of fishmeal with black soldier fly larvae meal is an attempt to reduce feed cost and increase profitability which has so far proven positive. Black soldier fly larvae meal is produced from organic wastes and depending on the scale, it can be at no cost or attract high investment cost. However, the cost of BSF larvae meal has been estimated at GHS3.20 per kilogramme as against GHS6.00 per kilogramme of fishmeal.

A broiler requires about 6kg of feed over a rearing period of about nine weeks. Thus, a small-scale farmer with 200 broilers would require 1200Kg of feed from start to finish within nine weeks. Thus, for a year 2400kg of broiler feed will be required. The cost of vaccines and medication is estimated to be 10 per cent of the feed cost. The list of both fixed and variable inputs for 200 broilers is presented as an annex in this document.

4.4 Facilities required for the production of BSF larvae and 200 broiler birds

A small land area (40ft X 30ft) or (12m X 9m) would be adequate for this business. A shed can be constructed at where the BSF larvae would be produced and the poultry pen for housing 200 birds. The facility required must have specific characteristics of which the potential investor must contact the custodians of the technology at CSIR Animal Research Institute. The main materials and cost for constructing the facility, production of the BSF larvae's and production of the broiler birds are presented at the annex.

4.5 Human resources requirements

One person or farmer trained on the job can manage the production of the BSF larvae and broiler birds. For this business, an amount of GHS500.00 per month is provided as wage and the net income belongs to the farmer. The person must be provided with personal protective equipment (PPE) such as wellington boots, nose mask, rubber gloves etc.

4.6 Strategies to remain competitive and grow business

Studies have shown that insect meals improve productivity and can reduce broiler feeding cost which is expected to translate into profits as shown in Table 5 below.

Table 5: Experimental results showing the benefits of using BSF larvae meal

Parameters*	Soybean	Fishmeal	Housefly Larvae	BSF Larvae	SEM
Initial body weight (g)	45.83	47.91	44.19	48.15	
Weight Gain (g)	1528.47^{a}	1980.84^{bc}	1897.87^{b}	2122.16^{c}	30.46
Feed Intake (g)	4149.53^{b}	4489.83^{c}	3973.48^{a}	4299.87^{b}	34.70
FCR*	2.72^{c}	2.27^{b}	2.03^{a}	2.02^{a}	0.03
Mortality (%)	12.0^{b}	1.75^{a}	1.50^{a}	1.75^{a}	1.98
Feed Cost (GHS)	2.20	2.30	1.80	1.80	-
FCPG* (GHS/Kg)	9.12^{c}	10.32^{d}	7.15^{a}	7.74^{b}	0.07
PEF*	71.87^{a}	160.36^{b}	174.64^{bc}	189.87^{c}	4.85

*FCR – Feed Conversion Ratio; FCPG – Feed Cost per Gained Weight; PEF – Production Efficiency Factor

To sustain competitiveness and grow the broiler production business using the BSF Larvae as a protein source, the following strategies must be adopted:

- By-passing the middlemen and selling both in wholesale quantities and retail quantities by having sales outlets where dressed and live birds will be sold.
- Take the business online by using your social media account to promote the business and increase awareness of your unique broiler birds.
- Feed the broiler birds very well to gain weight.
- Have your own means of dressing and packaging branded products for sales and supply.
- Carry out marketing research regularly to have a clear idea of what your customers want, areas where there is insufficient supply of products and things you can do to improve the quality of birds you offer to your customers.
- Offer home delivery services for birds.
- Use attractive designs when packaging materials for the broiler products. Ensure that it is attractive and stands out from every other product in the market.

4.7 Cost-benefit analysis summary for the broiler business

The business is proposed to be operated under certain assumptions. It is projected that four batches of 200 broilers would be produced per year. Based on the investment cost, working capital required, production cost and selling price per broiler. The cost benefit analysis is summarized in Table 6 below with the following assumptions:

- Free land for production (Backyard)
- Free sunlight for operating the solar drier
- Labour to use 24,000 kg of waste per year.
- Cost of larvae meal is GHS3.20 per kilogramme.
- The farmer is paid GHS500.00 per month.
- The farmer produces broilers four times a year with 200 birds per batch.
- 10 per cent mortality rate.
- Feed (BSF) cost is GHS2.00 per kilogramme.
- Selling price of broilers: GHS30.00 each.
- Selling price of compost: GHS0.80 per kg.
- Constant price for inputs and products over the six-year estimated period.
- All fixed inputs have no salvage value after six years.

The Net Present Value is positive GHS 3,745.49 as shown in Table 6 indicating that the cumulative revenues generated is enough to offset all investment or expenditure. The present value Benefit-Cost Ratio is 1.13 indicating that the investor will generate additional income GHS 0.13 for every cedi invested. The Internal Rate of Return is 75.61%. The figures show that the business generates about GHS 9,019 which is about 58.5% more than the discount rate (GHS 3,745.49). The payback period is two years eight months indicating that the cost of the investment will be completely offset within three years. The profitability indices as presented in Table 6 below indicate that it is financially feasible to use Black soldier fly larvae meal to produce broilers and make profit.

Table 6: Summary of Cost-Benefit Analysis for the Black Soldier Fly Larvae Production Business

Total investment capital and production cost	GHS 47,935.00
Total revenue	GHS 56,953.85
Net Present Value at 30% discount rate	GHS 3,745.49
Discounted Benefit-Cost Ratio	1.13
Internal Rate of Return (IRR)	75.61%
Payback period	2years 8 months

4.8 Projected six years cash flow estimates for broiler production

The estimated cash flow indicates that the farmer is required to invest a sum of GHS27,650.00 as fixed inputs and labour cost to produce 200 broilers per batch. It is estimated that the farmer requires further amount of GHS19,520.00 to raise 800 broilers per year and generate about GHS21,600.00 as income for a year as shown in Table 7 below. The excess income (gross profit) would be used to defray the initial investment. The total investment required for the six-year period is less than the cumulative revenue or income accruing to the investor over the same period.

Table 7: Projected Six (6) Years Cash Flow Estimates in Ghana Cedis (GHS)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Annual cash inflow	21600.00	21600.00	21600.00	21600.00	21600.00	21600.00
Investment and production cost	27650.00	19520.00	19520.00	19520.00	19520.00	19520.00
Gross profit margin	-3330.00	2080.00	2080.00	2080.00	2080.00	2080.00

5.0 MARKET ANALYSIS FOR BSF LARVAE MEAL AND BROILER PRODUCTION

5.1 Market structure, dynamics and trends

Ghana's livestock policy permits the use of insect meals in livestock and poultry production. Even though the feed ingredient market is a competitive one, the black soldier fly larvae meal is new and not available on the market now. A survey conducted in Ghana suggests that poultry farmers are very willing to use it and are willing to pay about GHS3.20 for a kilogramme of it. Producers of BSF larvae meal would enjoy some monopoly until the market is flooded with it. The larvae meal will however require investment into advertising to encourage farmer and chicken consumers to accept the technology.

Broiler farmers in Ghana operate in a competitive market where a large number of producers produce undifferentiated chicken and therefore compete against each other. Even though the Ghana Poultry Farmers Association and other similar associations exist they pose little or no resistance to entry of new farmers and do not control product price. The prevailing market dynamics and trends are that, any increase in the price of day-old chicks and feed ingredients results in an increase in the selling price of the broiler birds. Potential customers of the broiler birds are individuals, commercial restaurants, hotels, supermarkets, retailers and processors.

5.2 Competition and competitive edge

Ghana imports frozen chicken and processed meat products from countries such as the Netherlands, Brazil, etc. This means that local supply is less than demand given an indication that there is great potential for increase poultry production. The proposed business would compete enormously with broiler producers using fish, soya or sunflower protein sources for production. However, this business would have a competitive urge over others due to the reduction in feed cost through the use of BSFL meal.

5.3 Market entry barriers, distribution channels and promotional strategy

There are currently no barriers of entering into broiler production business in Ghana. It is recommended that both the direct and indirect distribution channels be adopted for the business thus allowing customers to buy directly from the poultry farmer and also retail from sales points. Suggested promotional strategies to market the broiler birds live or dressed is by participating in fairs, organizing promotions on the radio, television social media, newspaper, by word of mouth and distribution of flyers.

Poultry farmers can adopt several measures, developed through research, to improve their competitiveness. The major strategy to increase the competitiveness of local poultry farmers is by reducing waste and cost in their farm operations. For instance, the replacement of fishmeal with BSF larvae meal would help reduce feed cost to between 15 and 30 per cent and improve profitability.

ANNEX

Investments Required for Producing 200 Broiler Birds

Description	Quantity	Unit rate (GHS)	Total (GHS)
Land	-	-	Free
Cement	30	35	1050.00
Roofing sheet	24	25	600.00
Wood			
Wood (2X6)	12	26	312.00
Wood (2X4)	12	24	288.00
Nails	Bulk		100.00
Wielded mesh	8	80	640.00
Sand	1.5 cubit	150.00	225.00
Gravel	1.00 cubit	360	360.00
Workmanship			1000.00
Cost of construction of poultry pen			**4575.00**
Cost of Solar dryer	1		300.00
Feeding trough	2		80.00
Watering trough	2		70.00
Shovel	1		35.00
Wheel barrow	1		300.00
Protective clothing	1		50.00
Labour (monthly rate)	1	500.00	6000.00
			6835.00
Total fixed Cost			**11410.00**
Variable cost per batch			
Feed (8-9 weeks)	1200kg	2.00	2400.00
Vet. Drugs (10% of feed cost)			160.00
Cost of day-old chicks	200	6.00	1200.00
Utility	Bulk	Bulk	300.00
Total variable cost per batch			**4060.00**
Total variable cost per year		**(4X4060.00)**	**16240.00**
Estimated Total Initial Cost			**27650.00**

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GLOSSARY

Bio Conversion	The conversion of organic materials, such as plant or animal waste, into usable products or energy sources by biological processes or agents, such as certain microorganisms or life-stages of insects.
Embryo	An organism in early stages of development, before hatching from an egg.
Feed Conversion Ratio (FCR)	The efficiency with which the bodies of livestock convert animal feed taken into the desired output (eg. Meat, eggs, milk, etc.). FCR is the mass of feed taken in divided by the output. In our case it is the amount of poultry feed measured in kilograms that have been used to gain 1 kilogram of live weight in the broiler.
Imago	The last stage an insect attains during its process of growth and development from an egg, where it attains maturity. It is also known as the adult.
Internal Rate of Return (IRR)	It is used to estimate the profitability of potential investments. It is an estimate of the rate of return of a potential investment after accounting for all its projected cashflows together with the time value of money. Where the time value of money (TVM) is the notion that money you have now is worth more than the identical sum in the future due to its potential earning capacity.
Larva	The immature, wingless, and often wormlike feeding form that hatches from the egg of many insects. They keep molting while changing in size and finally turn into pupa.
Net Present Value (NPV)	It is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. NPV is used to capture the total value of a potential investment opportunity when all the future cash inflows and outflows are discounted to the present-day value. This tells you if you will make money or not if you proceed with the investment.
Nymph	The sexually immature form of an insect, usually similar to the adult that does not change greatly as it grows into a full adult.
Pre-pupa	An insect in the nonfeeding, inactive developmental stage between the larval period and the pupal period. This is the period in which preparations for the transformation into a pupa take place (see Pupa).

Production Efficiency Factor (PEF)	Production efficiency is the level at which the maximum production capacity has been reached and any additional input will not reflect in an increment in output. Output Rate ÷ Standard Output Rate x 100. To compare live bird performance amongst flocks, between producers or against breed standards and international benchmarks, the PEF is used and calculated as: {[live weight (kg) x survivability (%)] ÷ [Age at depletion (days) x Feed Conversion Ratio]} x 100.
Pupa	The inactive immature form of an insect between larva and adult stage of development. The plural is pupae.
SEM	The Standard Error of the Mean (SEM) describes how precise the mean of a sample is as an estimate of the true mean of the population the sample was taken from.
Water Use Efficiency	The ratio of water used in metabolism by an organism to water lost by the organism through either excretion or transpiration.

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