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TECHNICAL REPORT

Operational Efficiency and Economic Insights of Black Soldier Fly Farming: Evidence From a Facility in Kisumu, Kenya

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Back cover photo: Staff of IWMI BSF Plant, Agoro East, Kisumu County, Kenya (*photo:* Noah Adamtey/IWMI)

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Acronyms and Abbreviations

BCR	Bioconversion Rate
BSF	Black Soldier Fly
BSFL	Black Soldier Fly Larvae
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
Eq	Equation
FAO	Food and Agriculture Organization of the United Nations
FCR	Feed Conversion Ratio
IWMI	International Water Management Institute
KES	Kenyan shillings
N/A	Not available
UNCCD	United Nations Convention to Combat Desertification
USD	United States dollar
WRR	Waste Reduction Rate

Summary

The Black Soldier Fly (BSF) facility at Agoro East was established to address interconnected challenges of land degradation, biodiversity loss, and poor waste management issues compounded by water pollution, overexploitation of natural resources, and limited livelihood options. By converting organic waste into high-quality protein and organic fertilizer, reduces pressure on Lake Victoria fisheries and costly imports, while promoting sustainable resource use and community resilience.
The BSF facility aims to promote sustainable waste management, produce organic fertilizer, and supply alternative protein sources for poultry and aquaculture. It also serves as a hub for farmer training and stakeholder capacity building within the Agoro East community and Kisumu County. The objective of this report was to assess the operations and performance of the facility to guide its effective management by the Agoro East community following the handover. The BSF facility is located within the Aggregated Farm at Agoro East sub-location, situated in North Nyakach Ward of Nyakach Constituency, Kisumu County. The site lies at coordinates 0° 18'00.2"S, 35°02'49.8"E. The facility was established by the International Water Management Institute (IWMI) in May 2024 under the former Nature-Positive Program and is currently operated under the Multifunctional Landscapes Program. Operating on an experimental basis, the BSF facility converted 24.73 metric tons of organic solids and 953 liters of liquid waste into 1.94 metric tons of fresh larvae and 3.29 metric tons of frass between 2024 and 2025. Despite achieving an average monthly larvae yield of 162 kg, the facility incurred a net loss of KES 728,558.50 (~USD 5,828) due to high operating costs (KES 892,931 ≈ USD 7143), low output as a result of ongoing research into high quality substrate development, and the need to retain most larvae and pupae for life cycle continuity, in addition to the use of frass in the aggregated farm for traditional vegetable and spice crops production. Expected annual revenue was KES 1.65 million, primarily from egg and neonate sales. In November 2024, 46 farmers (25 female, 21 male) from Jimo East and Agoro East—including 13 youth aged 20–35 and 33 adults aged 35–80—were trained. Additionally, 12 community volunteers received training in 2025.

Key findings and recommendations: Waste delivery costs were significantly influenced by waste type, source distance and mode of transportation. Extreme mid-day temperatures (38.6–46.8 °C) and low humidity (15–18%) increased feed conversion rates but reduced bioconversion efficiency, which negatively affects larval growth, development and yield. The BSF production cycle followed a high–stable–low pattern driven by waste availability larvero capacity, and egg output, with 3.7 kg of fresh larvae producing 1 kg of dry larvae. Labor costs dominated expenses (62%), followed by waste sourcing (30%). Despite weather extremes, high operating costs, and weak market linkages, the BSF facility demonstrates strong potential for waste valorization and income generation, with clear recommendations provided in the final section of the report to enhance productivity, profitability, and sustainability as a circular bio-economy model for Kisumu County and beyond.

1. Introduction

Land degradation and biodiversity loss remain among Kenya's most critical environmental challenges, primarily driven by unsustainable land use practices, deforestation, overgrazing, and increasing climate variability. National estimates suggest that 30–40% of Kenya's land is affected by degradation, resulting in declining soil fertility and reduced agricultural productivity, particularly in arid and semi-arid regions (Kogo, Kumar and Koech, 2020). The associated loss of vegetation cover and accelerated soil erosion have further contributed to biodiversity decline, as habitats are destroyed and ecosystem functions become increasingly unstable (UNCCD, 2017; Mamboleo and Adem, 2023).

In Kisumu County, these challenges are exacerbated by rapid population growth, urban expansion, and inadequate waste management systems. The county generates approximately 500 tons of solid waste daily, predominantly organic in nature, which is often disposed of in open dumpsites such as Kachok (Dianati et al., 2021). The decomposition of this waste releases methane and leachates, contaminating surface and groundwater —especially during periods of heavy rainfall (Aguko et al., 2021). In neighboring towns like Sondu, limited waste collection infrastructure has led to informal dumping in the forest, intensifying water pollution and degrading aquatic biodiversity. These pressures are directly linked to declining ecosystem health and fish productivity within the Lake Victoria Basin (Masese et al., 2024; Nyamweya, 2023).

In the rural and peri-urban areas of Agoro East, poverty and limited livelihood opportunities hinder the community's ability to adapt to these environmental changes. Households rely heavily on natural resources such as wetlands, small forests, and communal grazing lands, which are increasingly overexploited for fuel (charcoal and firewood), agriculture, and construction (Kogo, Kumar and Koech, 2020) This overuse accelerates land degradation and biodiversity loss, perpetuating a cycle of ecological decline and economic vulnerability.

A related issue involves the competing use of protein sources such as *Rastrineobola argentea* (omena) and soybean meal. Omena, a cornerstone of Lake Victoria's small-scale fishery, is frequently diverted for use in livestock and aquaculture feeds, increasing fishing pressure on already stressed stocks (Outa et al., 2021). Soybean meals, largely imported and expensive, remains inaccessible to many smallholder farmers, limiting their ability to produce quality feed (Gachuiri et al., 2025).

The establishment of a Black Soldier Fly Larvae (BSF) facility in Agoro East, Kisumu County, forms part of an integrated farm component under the Multifunctional Landscapes Program (formerly Nature Positive Aggregated Farms). In the medium to long term, the facility aims to address key food system challenges through sustainable feed production and organic waste valorization.

BSF farming presents a locally adaptable and environmentally sustainable solution. The larvae efficiently convert organic waste into high-quality protein suitable for livestock and aquaculture feed (in both processed and unprocessed forms) (Mathai et al., 2024). Additionally, the residual frass left after larval feeding serves as an organic fertilizer, enhancing soil fertility and crop productivity (Gautam et al., 2025; Mathai et al., 2024). This closed-loop process not only reduces waste volumes but also contributes to improved food security and farm profitability (Mathai et al., 2024; Osuch et al., 2024).

The Agoro East BSF facility aims to promote sustainable waste management, produce organic fertilizer, and supply alternative protein sources for poultry and aquaculture. It also serves as a hub for farmer training and stakeholder capacity building within the Agoro East community and Kisumu County. The objective of this report is to assess the operations and performance of the facility to guide its effective management by the Agoro East community following the handover.

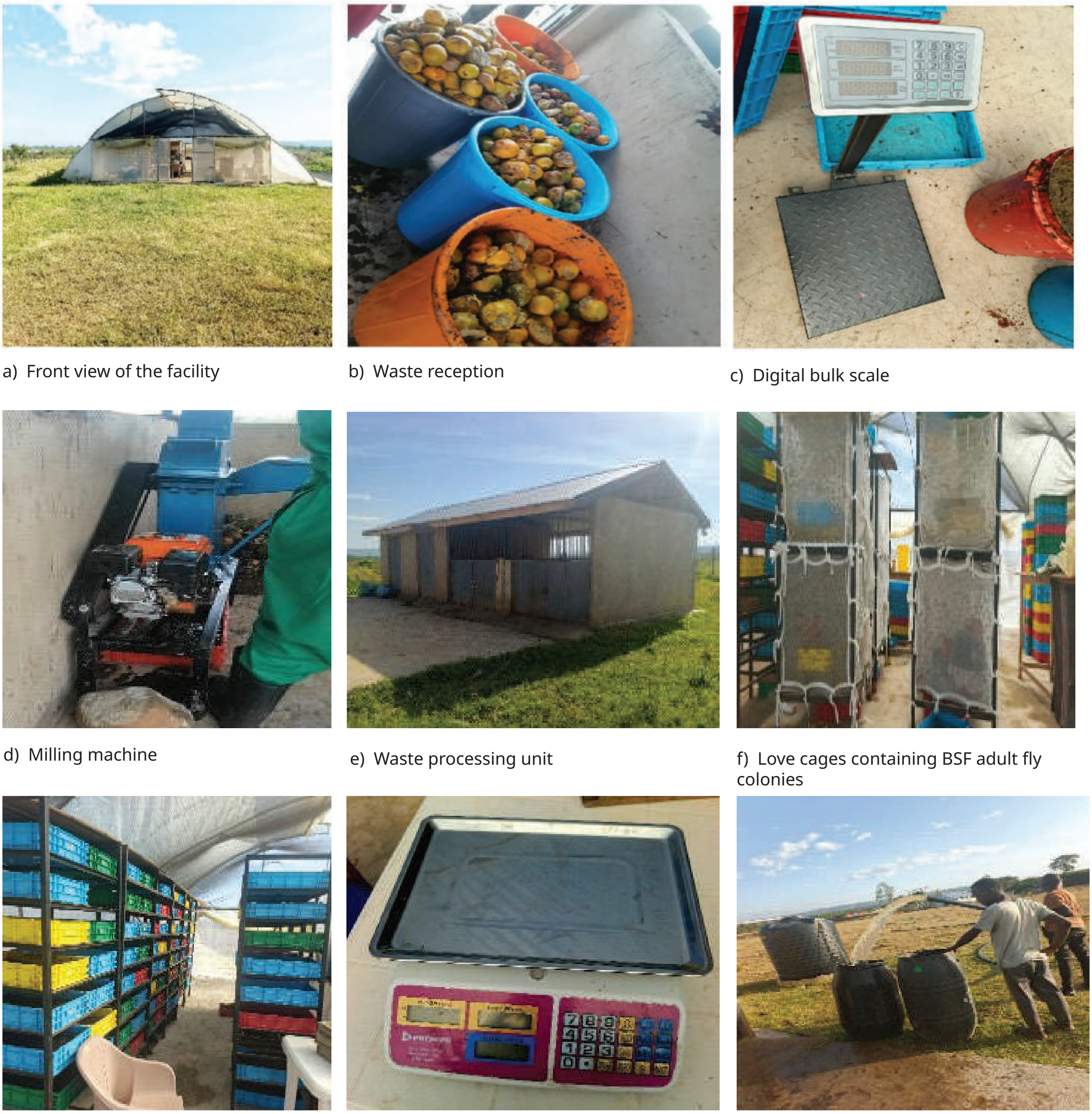
2. Project Site and Facility Description

2.1 Project Site

The Black Soldier Fly (BSF) facility is located within the Aggregated Farm at Agoro East sub-location, situated in North Nyakach Ward of Nyakach Constituency, Kisumu County. The site lies at coordinates 0°18'00.2"S, 35° 02'49.8"E (Figure 1). The facility was established by the International Water Management Institute (IWMI) in May 2024 under the former Nature-Positive Program and is currently operated under the Multifunctional Landscapes Program. Historically, the Aggregated Farm served as a communal livestock grazing area. The region experiences warm and humid climatic conditions, with average temperatures ranging from 23°C to 33°C (County Government of Kisumu, 2023). Rainfall is bimodal, with long rains occurring from March to June and short rains from October to December. The dry seasons span July to September and January to February. North Nyakach has a population density of approximately 513 people per square kilometer. Agriculture is the primary source of income for most households, contributing between 39% and 47% of their gross earnings (Kinuthia et al, 2024). Staple crops such as maize and beans dominate cultivation, alongside others like cowpea leaves, sweet potatoes, and cassava.

2.2 Black Soldier Fly Facility

The facility consists of a yellow greenhouse, polyethene and insect net with rollable side windows for temperature regulation and ventilation purposes (Figure 2a). Processes begin at the waste reception area (b), with incoming waste precisely measured using the large-capacity digital bulk scale (350kg capacity) (c). The waste is then processed at the waste processing area, where it is prepared using a powerful 7-horsepower milling machine (d) fitted with a 2.5cm screen sieve for optimal particle size. This entire area forms the waste processing unit (e), which also houses the substrate storage section, a frass fertilizer store and a general store for keeping the machines. The core cycle initiates in the enclosed love cage section (f) for breeding, followed by the mass production stage where larvae are reared on vertical racks in larveros (g), actively consuming the prepared substrate. Final products are measured precisely using the digital tabletop scale (h), confirming yields before selling. A 2300l water tank (i) serves as a temporary water storage unit for water received from a borehole drilled in the farm.



a) Front view of the facility

b) Waste reception

c) Digital bulk scale

d) Milling machine

e) Waste processing unit

f) Love cages containing BSF adult fly colonies

g) Larvae feeding larveros on racks on racks

h) Digital tabletop scale

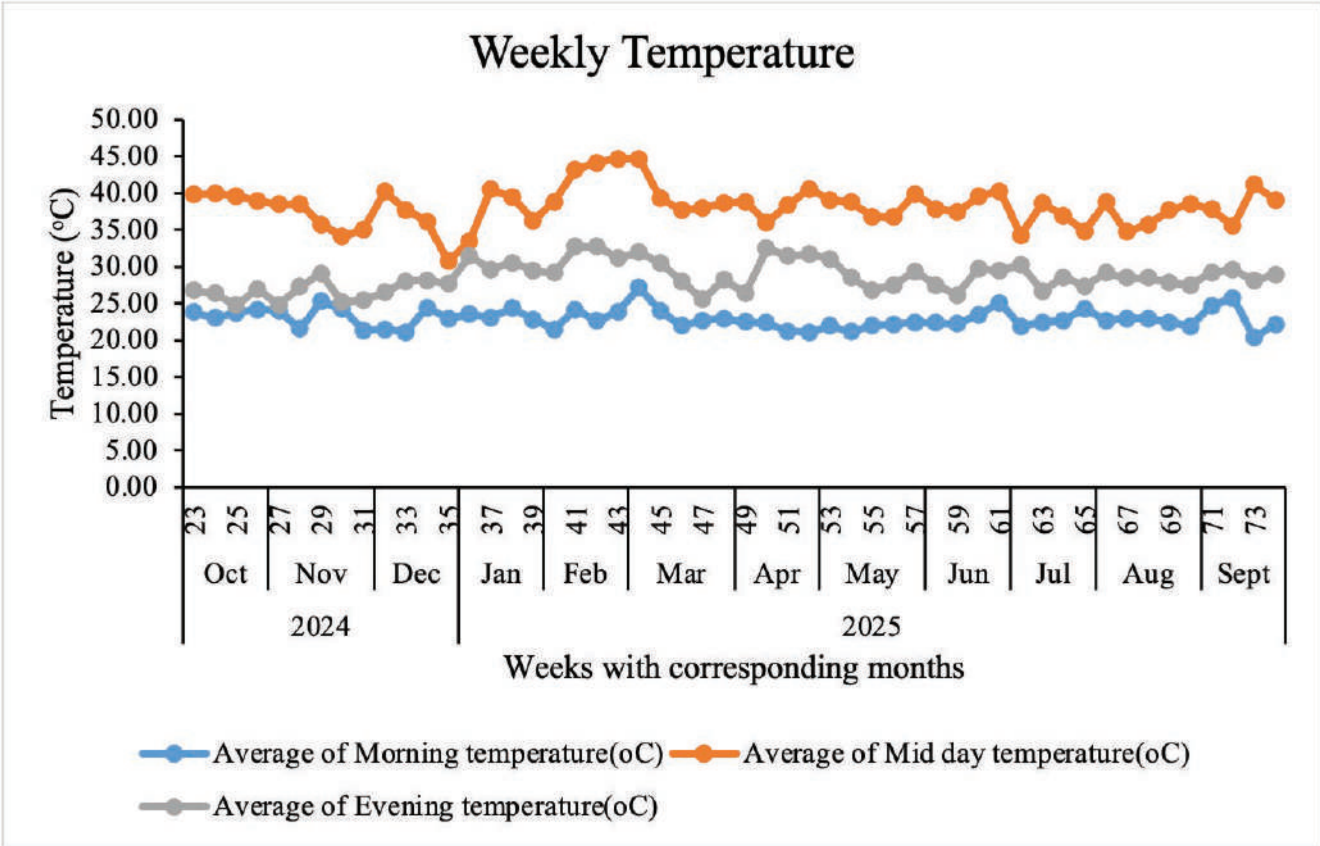
i) Water storage

Figure 2. BSF facility in Agoro East, Kisumu County, Kenya (source: author's creation)

2.3 Environmental Factors Within the Facility

The temperature within the BSF facility from October 2024 to September 2025 varied across morning, midday and evening periods, as expected. The average morning temperature was 22.92 °C, rising to 38.16 °C at midday, and dropping to 28.61 °C in the evening (Figure 3a). Relative humidity followed an inverse pattern, averaging 80% in the morning, decreasing to 25% at midday, and slightly increasing to 35% in the evening (Figure 3b).

(a)



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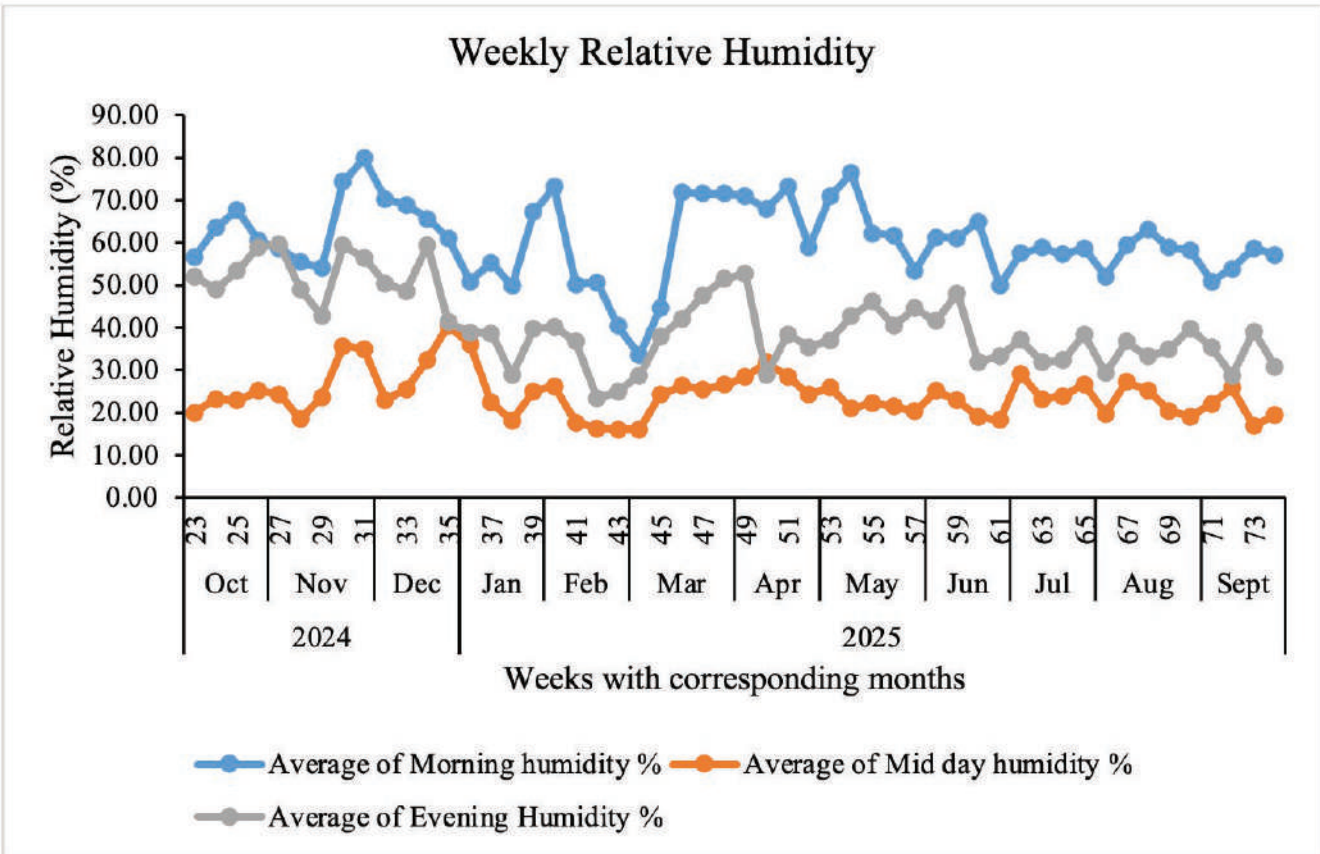

Figure 3. (a) Average weekly temperature, and (b) average weekly humidity in Agoro East, Kisumu, Kenya (source: author's creation)

3. Total and Waste Streams Processed, Facility Operation and Performance

3.1 Total and Waste Streams Processed

From October to December 2024, the facility processed a total of 6,316 kg of solid waste and 285 liters of liquid waste. Between January and September 2025, the volumes increased to 18,411 kg of solid waste and 669 liters of liquid waste (Figure 4). Cumulatively, the annual waste processed amounted to 24,727 kg of solid waste and 954 liters of liquid waste, yielding a solid-to-liquid waste ratio of approximately 26:1. On average, the facility processed 2,060.6 kg of solid waste and 79.5 liters of liquid waste per month.

The dominant waste streams included market waste, which accounted for 42% of the total solid waste processed, followed by pig manure (24%), poultry manure (13%), and brewery waste (13%) (Figure 5). Other waste types, such as cow dung, wheat bran, maize germ, rotten eggs, fish intestines, restaurant waste, and chicken feed remnants, collectively contributed the remaining 8%.

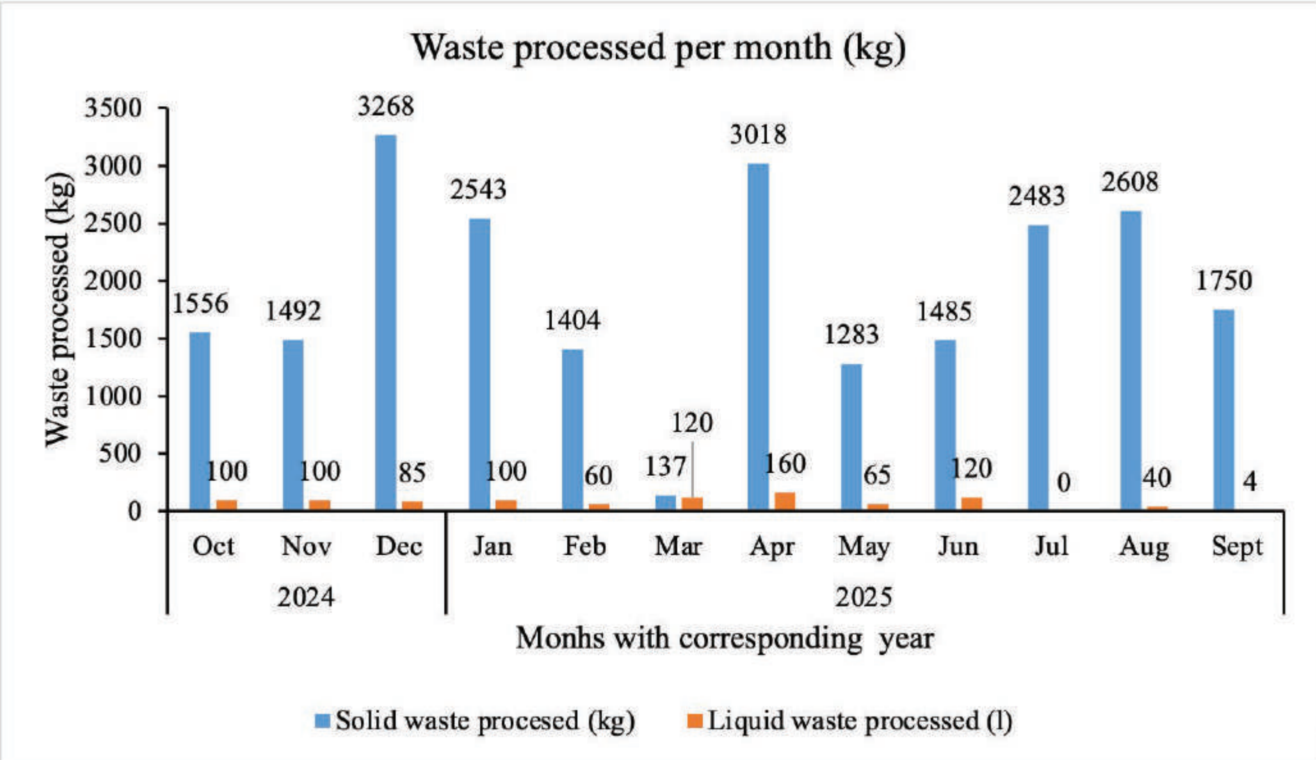

Figure 4. Waste processed per month for the year 2024 and 2025 at the BSF facility at Agoro East, Kisumu County, Kenya (source: author's creation)

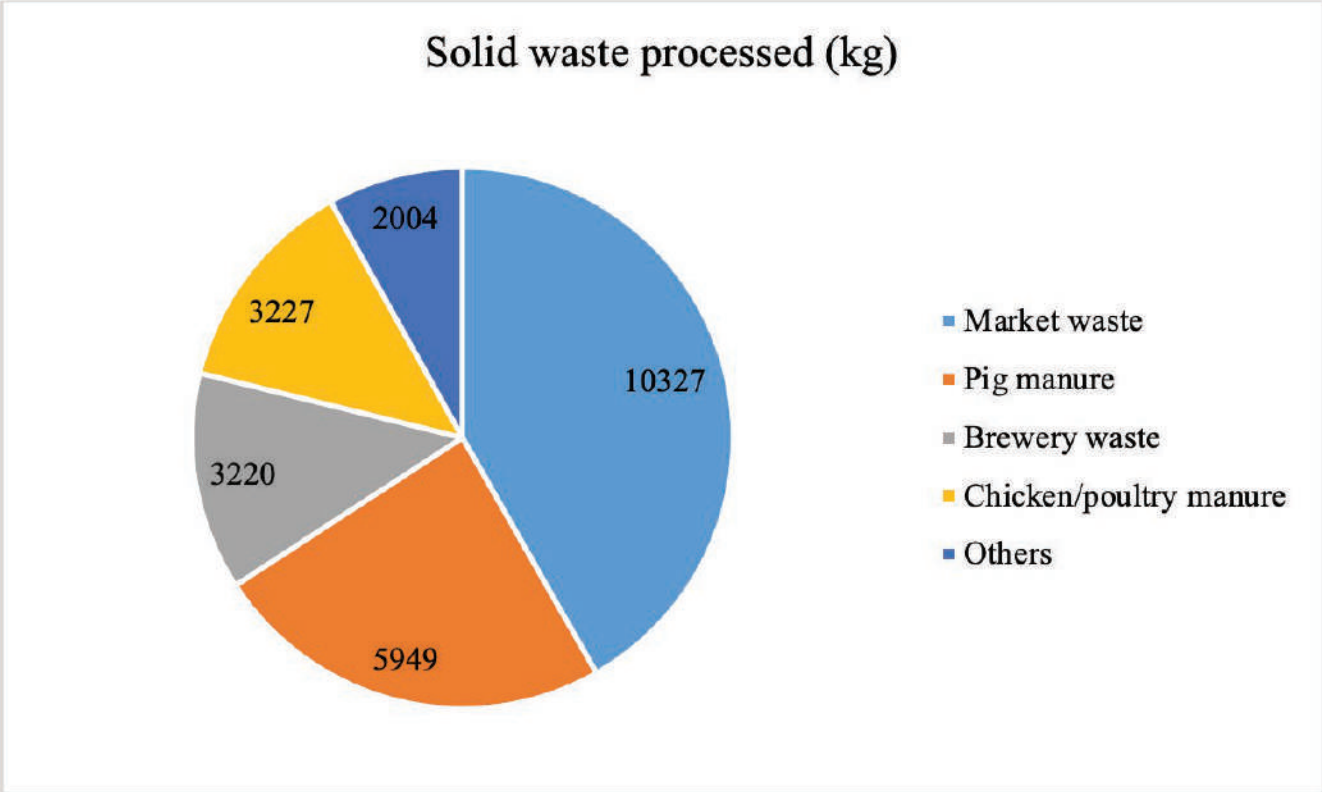

Figure 5. Solid waste streams processed from October 2024 to September 2025 at the BSF facility at Agoro East, Kisumu County, Kenya. Others include cow dung, wheat bran, maize germ, rotten eggs, fish intestines, restaurant waste, and chicken feed remnants (source: author's creation)

3.2 Facility Operation

Seasonal fluctuations in waste supply have influenced the facility's production capacity. The highest volumes of waste processed were recorded in December (3,268 kg) and April (3,018 kg) (Figure 4), coinciding with the harvesting and market processing of agricultural produce. These periods also marked peak operational performance, during which all love cages were active, resulting in high egg and neonate production.

However, this peak performance often strained resources, leading to shortages of larveros and nutrient-rich waste inputs such as fish intestines, slaughterhouse by-products, poultry, and pig manure. These constraints subsequently caused a decline in facility operations. The lowest processing volumes were observed in February and May, which corresponded with reduced egg production and a subsequent drop in neonate output, thereby lowering the demand for waste. These declines were largely attributed to elevated temperatures and low relative humidity.

Operating at low capacity requires careful management, as any error in waste quality, quantity, or handling can disrupt the rearing system and compromise the establishment of the BSF adult colony. Moderate and stable waste processing was maintained between July and August, indicating a period of relative operational stability.

Overall, the data reveal a cyclical production pattern regulated by waste availability, larvero capacity, and egg output. This underscores the need for increased larvero supply and improved regulation of temperature and humidity within the facility to ensure consistent performance.

3.3 Facility Performance

BSF eggs, larvae and pupae yield: The Black Soldier Fly (BSF) facility yielded a total of 8 kg of eggs, 1,943.3 kg of larvae, and 155.7 kg of pupae over the 2024–2025 period (Table 1). Additional by-products included dried larvae, dead flies, and pupae casings. Dried larvae were produced when surplus fresh larvae exceeded local market demand. During processing, 55 kg of fresh larvae yielded only 15 kg of dried larvae, resulting in a conversion ratio of 3.7:1 primarily due to moisture loss during drying. This means that approximately 4 kg of fresh larvae are required to produce 1 kg of dried larvae. The average monthly fresh larvae yield of 162 kg falls within the range of 80–320 kg typically reported for small-scale commercial producers. However, it is two to five times lower than the average monthly yield for lower- and upper-medium-scale commercial producers in Kenya (FAO, 2023). This reduction is attributed to the temperature effect, the experimental nature of operations at the facility and the unavailability of protein-rich waste materials (e.g., poultry manure, rotten eggs and slaughterhouse waste) during certain periods of the year. The Greenhouse facility induced high temperatures, as already shown above (Figure 3a). The temperature and humidity variations within the BSF facility, particularly high midday temperatures (38.16 °C) and low relative humidity (25%), have induced heat stress, which increases the feed conversion rate, meaning larvae utilize more energy for survival at the expense of biomass accumulation or bioconversion efficiency (Figure 6). Additionally, elevated temperatures in the facility accelerate substrate drying, contributing to reduced larval growth, increased mortality (data not available), and lower yields across all three BSF products, especially during the dry seasons of February to March and July to August (Table 1). Furthermore, the facility was under experimentation with a focus on identifying optimal waste combinations for achieving high and sustainable production. To sustain the BSF life cycle and ensure long-term production continuity, a portion of the neonates (97.9%), larvae (24.7%), and pupae (97.7%) were retained, with only a small fraction sold. The high retention rate of neonates was also influenced by limited market demand. Similarly, the high percentage of pupae retained was intended to support further egg and neonate production, as the facility was undergoing experimental trials to assess the impact of different substrate combinations on larval growth, yield, and quality.

Pupae casings and dead flies: Pupae casings and dead flies were produced in relatively low quantities due to their dry nature and minimal weight.

Frass: Frass (organic fertilizer) was the highest output by weight, totaling 3,207kg annually, approximately 1.6 times higher than the larvae yield. Frass production varied significantly throughout the year, with noticeable declines between February to March and between July to September 2025. These reductions were attributed to higher feed conversion rates driven by elevated temperatures (Figure 4), which led to increased waste reduction (Figure 7). In general, the waste reduction ratio (WRR) was above 78%, except in April and May 2025. This indicates that the facility effectively converted or degraded a large proportion of incoming waste, demonstrating strong system performance and microbial/larval efficiency under most conditions.

Table 1. BSF byproduct yields for the years 2024 and 2025 at the BSF Facility at Agoro East, Kisumu, Kenya

Month	BSF eggs (g)	Neonates (kg)	Fresh larvae (Kg)	Dried larvae (kg)	Pupae (kg)	Pupae casing (kg)	Dead flies (kg)	Residue (Frass fertilizer) (kg)
Oct	1000	20	157	0	15	5	2	320
Nov	1180	30	30	0	21	6	3	268
Dec	845	33	310	0	30	8	4	448
2024								
Total	3025	84	647	0	66	19	9	1036
Jan	890	11	245	0	24	7	3	430
Feb	765	21	120	0	7	3	1	260
Mar	525	14	98	0	10	4	1	192
Apr	1100	47	178	0	8	3	1	299
May	665	19	193	0	12	4	2	344
Jun	330	14	227	0	7	3	1	272

July	255	17	65	0	11	4	1	106
Aug	215	11	115	11	5	3	1	171
Sept	240	11	56	4	5	3	1	98
2025	4985	163	1296	15	90	34	12	2172
Total yield	8010	247	1943	15	156	53	20.38	3207.34

source: author's creation

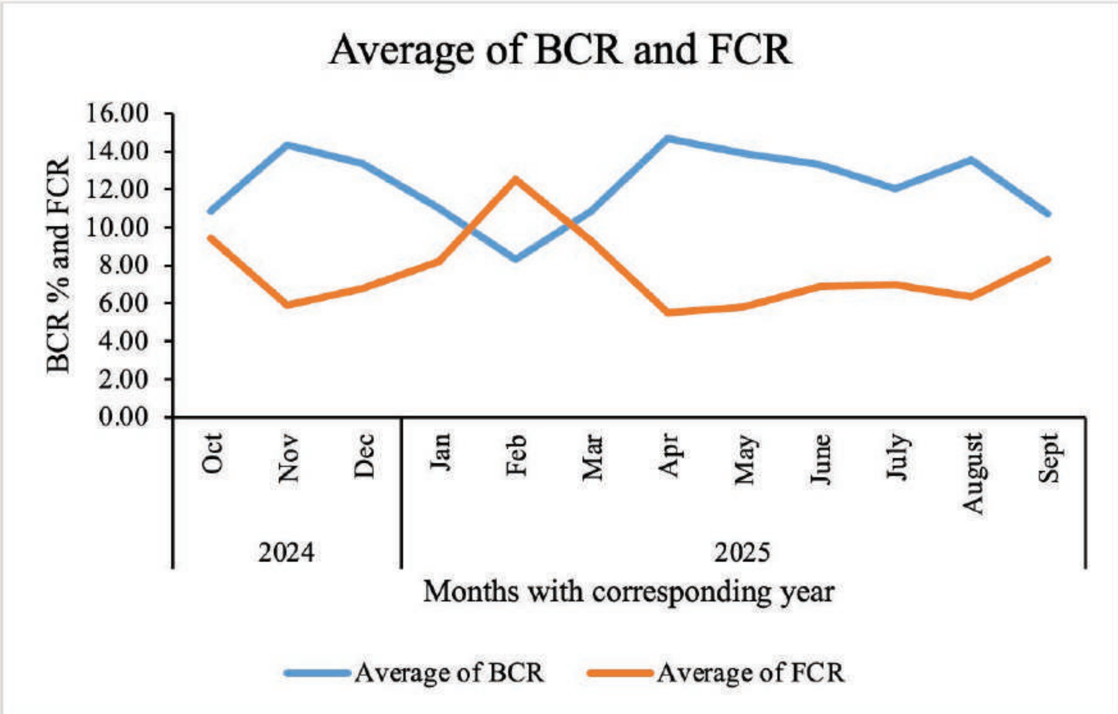

Figure 6. Average BCR (%) and FCR during BSFL production for the year 2024 and 2025 at the BSF facility at Agoro East, Kisumu County, Kenya (source: author's creation)

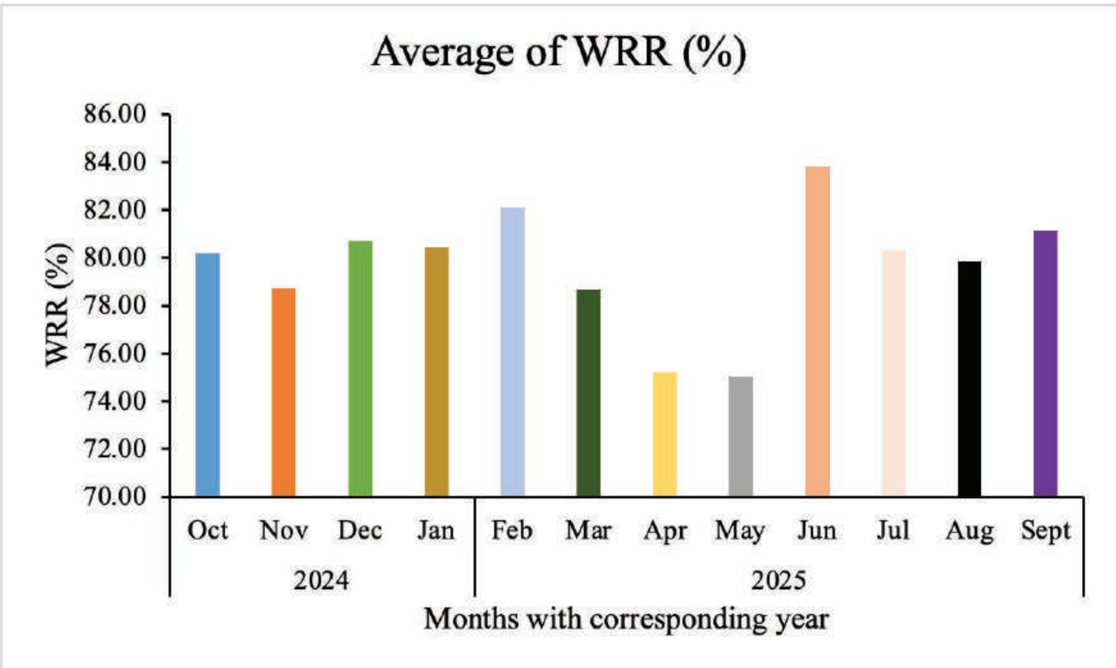

Figure 7. Average WRR % during BSFL production for the year 2024 and 2025 at the BSF facility at Agoro East, Kisumu County, Kenya (source: author's creation)

4. Economic Analysis

4.1 Impact of Waste Source Distance, Transport Mode, and Stream Type on Delivery Costs to the BSF Facility

The BSF facility sources waste from locations ranging from 1.7 km (Cherwa) to 55 km (Otongolo) (Table 2). For similar waste types, such as poultry manure, transportation distance significantly affects cost when using the same mode of transport. For example, 1,000 kg of poultry manure from Cherwa (1.7 km) cost KES 1,140 (USD 9), about 80% cheaper than the same amount from Wasare (18 km) and 88% cheaper than from Kapsoit (48 km). Costs for 1,000 kg of poultry manure vary by distance:
<2 km: KES 1,140 (USD 9)
2–20 km: KES 3,675–6,160 (USD 29–49)
30–50 km: KES 10,000 (USD 80)

Similarly, 1,000 kg of restaurant waste from Sondu (14 km) was 4.5 times cheaper than the same amount from Awasi (40 km). However, transportation mode can offset distance-related costs. For instance, transporting 1,000 kg of market waste from Kisumu (49 km) using a pickup truck reduced costs by 36.4% compared to transporting the same amount from Sondu (14 km) by motorcycle. A similar trend was observed for fish intestine waste collected from Kisumu and Nyakwere.

When waste is sourced from locations at comparable distances using the same mode of transport, the type of waste stream significantly influences transportation costs. For instance, transporting liquid waste was approximately 10% more expensive than market solid waste, 50% more than restaurant waste, and 80% more than pig manure.

These findings underscore the importance of strategic logistics planning in BSF facility operations, especially in rural areas where waste sources are dispersed and inconsistent. To reduce sourcing costs and improve operational efficiency, it is recommended that BSF facilities be strategically located near reliable and diverse waste sources to minimize transport distances and associated expenses. Cost-effective transport modes such as pickups and TukTuk should be prioritized over motorcycles, particularly for bulk or high-moisture waste streams. Moreover, transport mode selection should be guided by both the type and quantity of waste available at any given time, as liquid waste incurs higher costs due to its handling requirements. Establishing decentralized waste aggregation hubs near major waste sources is advised to reduce the need for long-distance scouting and enable bulk transport. Furthermore, regular monitoring and analysis of transport costs by waste type, distance, and mode should be institutionalized to support data-driven logistics planning and inform more efficient sourcing strategies.

Table 2. Effect of waste stream type, distance and mode of transport on waste transportation cost to BSF facility at Agoro East, Kisumu County, Kenya

Waste stream	Location	Distance (km)	Mode of transport	Quantity of waste collected (kg or l)	Number of trips to 1000kg or 1000l	Quantity of waste (metric tons)	Price per trip (KES)	Price per trip (USD)	Transport cost per metric ton (KES)	Transport cost per metric ton (USD)
Market waste	Kisumu	49	Pick up	1500	0.7	1.05	6500	52	4550	36
Market waste	Sondu	14	Motorcycle	110	9.1	1.00	750	6	6825	55
Slaughter waste*	Sondu	14	Motorcycle	40**	25		300	2	7500	60
Brewery waste	Otongolo	55	TukTuk	400	2.5	1.00	1700	14	4250	34
Fish intestines	Kisumu	49	TukTuk	70	14.3	1.00	1500	12	21450	172
Pig manure	Kadongo	40	Pick up	647	1.5	0.97	4500	36	6750	54
Poultry manure	Cherwa	1.7	Motorcycle	88	11.4	1.00	100	1	1140	9
Restaurant waste	Sondu	14	Motorcycle	80	12.5	1.00	400	3	5000	40
Poultry manure	Wasare	18	Motorcycle	130	7.7	1.01	800	6	6160	49
Restaurant waste	Awasi	40	Motorcycle	40	25	1.00	900	7	22,500	180
Poultry manure	Kapsoit	48	Motorcycle	80	12.5	1.00	800	6	10,000	80
Fish intestines	Nyakwere	34	Motorcycle	15	66.7	1.01	300	2	20,010	160
Slaughter waste*	Katito	12	Motorcycle	20* *	50		150	1	7500	60
Pig manure	Sondu	14	Motorcycle	120	8.3	1.00	500	4	4150	33
Poultry manure	Katito	12	Motorcycle	95	10.5	1.00	350	3	3675	29

(source: author's creation)

4.2 Economic Drivers of Waste Sourcing in BSF Operations

The total annual expenditure on waste sourcing at the BSF facility amounted to KES 270,232 (USD 2,161), with an average monthly cost of KES 22,519 (USD 180) (Table 3). Of this total, the cost of waste accounted for 43%, while transport costs accounted for 38%. The remaining 19% comprised costs related to waste scouting, packaging materials, and labor for waste collection. Notably, the cost of waste was nearly equivalent to the cost of transportation, highlighting the financial burden associated with sourcing and delivering waste to the facility.

These high sourcing costs are largely attributed to the facility's location, which is distant from consistent waste sources. The facility was strategically sited as part of an integrated farm system, with the expectation that, once fully operational, the farm would generate sufficient internal waste to supply the BSF facility. However, in the current context, the findings underscore the importance of considering proximity to reliable waste streams and the mode of transportation when selecting sites for BSF facilities, to ensure cost-effective and sustainable operations.

Table 3. Costs involved per month of waste sourced at the BSF unit in Agoro East, Kisumu Kenya

Months	Transport cost for waste scouting and sourcing (KES)	Transport cost for waste haulage (KES)	Cost of waste (KES)	Labor cost for collecting waste (KES)	Labor cost for collecting waste (KES)	Total expense on waste sourcing (KES)
			2024			
Oct	3000	4550	4350	200	260	12360
Nov	0	12479	10185	1700	80	24444
Dec	2300	12930	14650	3620	1370	34870
2024 Total	**5300**	**29959**	**29185**	**5520**	**1710**	**71674**
			2025			
Jan	2130	1700	8135	1000	1270	14235
Feb	2200	5880	9550	1010	300	18940
Mar	2000	7750	7585	2200	0	19535
Apr	4900	14800	8995	2600	1520	32815
May	2800	12000	11583	1750	770	28903
Jun	1000	6700	13347	1800	700	23547
Jul	1455	9990	10713	900	590	23648
Aug	2000	8850	11245	2280	1050	25425
Sept	0	3900	6480	950	180	11510
2025 Total	**18485**	**71570**	**87633**	**14490**	**6380**	**198558**
Total expenses	**23785**	**101529**	**116818**	**20010**	**8090**	**270232**
Monthly average	**1982**	**8461**	**9735**	**1666**	**674**	**22519**
Percent of the total cost	**9**	**36**	**43**	**7**	**3**	

4.3 Key Operational Expenses in BSF Farming

The annual expenditure for operating the BSF facility from October 2024 to September 2025 was KES 892,931 or USD 7143, with an average monthly expense of KES 74,403 or USD 595 (Table 4). Labor accounted for the largest share of the total cost at 62%, followed by waste sourcing at 30%, while maintenance of the facility and miscellaneous amounted to 8%. The high labor cost indicates that BSF farming is labor-intensive and that labor efficiency strategies are critical for cost reduction. Waste sourcing, accounting for 30% of total expenses, highlights the need to optimize procurement and transport logistics, especially in rural setups like Agoro East. The relatively low expenditure on maintenance and materials (8%) suggests that while infrastructure costs are manageable, long-term durability and efficiency may require further investment. Overall, the cost structure underscores the importance of improving labor organization, exploring cost-effective waste sourcing strategies and partnerships, and investing in scalable infrastructure to enhance profitability and ensure the financial sustainability of BSF operations.

Table 4. Costs involved in key operations at the BSF unit in Agoro East, Kisumu, Kenya

Months	Total cost for waste sourcing (KES)	Miscellaneous Cost (KES)	Labor cost (KES)	Maintenance cost for BSF facility (KES)	Total variable cost (KES)
Oct	12360	N/A*	N/A*	N/A*	12360
Nov	24444	3055	50,000	570	78069
Dec	34870	5410	50,000	0	90280
2024 Total	71674	8465	100000	570	180709
Jan	14235	4110	50,000	3400	71745
Feb	18940	4210	50,000	2850	76000
Mar	19535	4534	50,000	4900	78969
Apr	32815	5720	50,000	0	88535
May	28903	3400	50,000	7050	89353
Jun	23547	800	50,000	3600	77947
Jul	23648	5495	50,000	0	79143
Aug	25425	3590	50,000	0	79015
Sept	11510	9905	50,000	0	71415
2025 Total	**198558**	**41764**	**450,000**	**21800**	**712122**
Total expenses	**270232**	**50,229**	**550,000**	**22,370**	**892831**
Percent of the total expenditure	**30**	**6**	**62**	**3**	

N/A*-Data not available

4.4 Profitability of BSF Farming: A Product-level Revenue Analysis

4.4.1 Expected revenue

If all by-products were sold, the BSF facility could generate an estimated annual gross revenue of KES 1,657,246 (USD 13,257) from October 2024 to September 2025 (Table 5), with an average monthly revenue of KES 138,047.70 (USD 1,104). Of this projected annual revenue, egg sales would contribute approximately 48.3%, followed by neonates at 22.4%, fresh larvae at 11.7%, pupae, pupal casings, and dead flies at 9.6%, and frass at 7.7%. The expected annual profit was calculated using Table 5 and Equation (Eq.) 1 below.

Expected Annual profit = Total expected gross revenue-total variable cost Eq 1

Total variable cost Expected = KES. 1,657,246 - KES. 892,83
Annual profit = KES. 764,415 (USD 6115)

Where
Total variable cost (Waste acquisition cost+ labor+ material + maintenance cost), (Table 5)

NB: The profit was calculated without the deduction of fixed cost (land, depreciation on BSF building and equipment)

4.4.2 Revenue at stake

To sustain the BSF life cycle and ensure long-term production continuity, a portion of the neonates (97.9%), larvae (24.7%), and pupae (97.7%) were retained, with only a small fraction sold. All frass produced were utilized as organic fertilizer for vegetable and spice crop production within the aggregated farm to enhance soil fertility and improve yields. Consequently, the actual annual gross revenue is presented as in Table 6.

Larvae contributed the largest share of income, accounting for 89.1% of total gross revenue, followed by neonates at 4.8%, pupae, pupal casings, and dead flies at 4.2%, and dried larvae at 1.9%. Revenue calculations were based on local community prices: KES 100 per kilogram of fresh larvae, KES 250 per kilogram of dried larvae, and KES 50–100 per kilogram for pupae, pupal casings, and dead flies. These prices were lower than prevailing rates in Kisumu Township, which range from KES 100–300 for fresh larvae depending on the category of the consumer. The lower prices in the local community can be attributed to limited awareness among farmers and feed producers regarding the benefits of BSF by-products.

The zero or low revenue recorded for some products does not indicate production failure but rather reflects intentional internal utilization, as explained under expected revenue. Although dried larvae are more stable and suitable for storage and transport, their market price of KES 250 per kilogram remains relatively low, limiting overall revenue. Surplus larvae produced can be consumed by other farms within the project site, such as fish and poultry units (if publicity is made). This highlights the need for market development.

Actual annual profit = Total gross revenue-total variable cost Eq.2
Total variable cost (Waste acquisition + labor+ material + maintenance costs), (Table 6)

Total variable cost Expected = KES.164, 272.50 - KES. 892,831
Annual profit = KES. -728,558.50 (~-5828 USD)

Profit without the inclusion of depreciation on fixed assets.

Table 5. Expected BSF by-product revenue for the years 2024 and 2025 at the BSF facility in Agoro East, Kisumu, Kenya

Product	Average yield per month (kg)	Annual total yield (kg)	Price per (kg)	Gross revenue per month (KES)	Gross revenue per annum (KES)
BSF eggs	666	8010	100	66750	801000
Neonate	21	247	1500	30870	370485
Fresh larvae	162	1943	100	16194	194330
Dried larvae	1	15	250	258	3750
Frass/Residue	267	3207	40	10691	128293
Pupae	13	156	1000	12980	155730
Pupae casing	4	53	50	220	2638
Dead flies	2	20	50	85	1020
Total				**138,048**	**1,657,246**
*grams, **price per gram					

(source: author's creation)

Table 6. Actual larvae, neonate, pupae and pupae casing revenue for the year 2024 and 2025 at the BSF unit Agoro East, Kisumu, Kenya

Product	Average yield per month (kg)	Annual total yield (kg)	Quantity sold (kg)	Price per (kg)	Gross revenue per month (KES)	Gross revenue per annum (KES)
BSF eggs	668	8010	0	100	0	0
Neonate	21	247	5	1500	0	7875
Larvae	162	1943	1464	100	12200	146410
Dried larvae	1	15	12	250	258	3100
Frass	267	3207	0	50	0	0
Pupae	13	155	4	1000	292	3500
Pupae casing	4	53	53	50	220	2638
Dead flies	1	15	15	50	625	750
Total					**13,595**	**164,273**
*grams, **price per gram						

(source: author's creation)

The negative profit of KES 728,558.50 (~USD -5,828) indicates that the BSF facility is operating at a loss, primarily due to the internal utilization of some by-products. High labor and waste sourcing costs, combined with the facility's low monthly output, also contributed to the unfavorable profit outcome. It is important to note that the BSF facility is currently being used for research purposes and has not yet transitioned into full commercial production.

Nevertheless, the monthly average revenue provides a useful benchmark for financial planning, while the distribution of income across products offers insights for resource allocation and investment decisions aimed at improving profitability and ensuring the long-term sustainability of BSF farming operations.

5. Conclusion and Recommendations

Although the Agoro East Black Soldier Fly (BSF) facility is currently operating on an experimental basis, it has demonstrated significant progress in sustainable feed production and waste management. Between 2024 and 2025, the facility successfully converted over 24.73 metric tons of organic solids and 953 liters of liquid waste into 1.94 metric tons of fresh larvae and 3.29 metric tons of frass (including dead fries and pupal casing). Despite challenges such as adverse weather conditions, high waste and transport costs, high labor cost, and weak market linkages, the facility has demonstrated strong potential to support poultry, aquaculture, and crop production enterprises within the communities, generate income through the sale of BSF by-products, and enhance local livelihoods.
To enhance productivity, profitability, and long-term sustainability and to establish the facility as a benchmark for circular bio-economy innovation in Kisumu County and beyond, the following actions are recommended:

1. **Facility infrastructure and environmental conditions:**
   To mitigate temperature-related risks, it is crucial to provide shades around the facility, enhance ventilation and regulate humidity levels in the facility to maintain optimal environmental conditions for BSF larval development and productivity. Enhancement of the robustness of the Greenhouse facility against heavy storms and rains is also paramount. Existing storage bins should be upgraded with more robust containers to enhance operational longevity, and the number of BSF rearing trays should be increased from 200 to 500 to enable full-capacity operations.

2. **Waste supply and feedstock management:**
   To ensure scalability and operational efficiency, it is crucial to develop a reliable and diversified waste supply chain for consistent feedstock availability. Waste supply management should be strengthened to maintain a steady inflow and allow adjustments to production schedules during periods of reduced waste degradation. Additionally, to overcome seasonal unavailability of protein-rich waste materials such as rotten eggs and dead chicken, and slaughterhouse waste, strategies should be implemented to enrich low-nutrient waste streams (e.g., cow dung) and explore alternative substrates to enhance production quality and resilience. It is also important to optimize feedstock composition by introducing co-substrates or blending materials to maintain an appropriate nutrient balance and moisture content for optimal larval development. In the absence of these interventions, farmers who want to go into BSF farming should establish the facility near reliable and diverse waste sources to minimize transport costs and ensure a consistent feedstock supply.

3. **Operational efficiency:**
   Keep the moisture levels in substrates balanced by methods such as sprinkling water, adding wheat bran or maize germ, or reusing watery by-products from fermentation. Be careful when transferring hatchlings with feed to prevent creating imbalanced populations, which could lead to underutilization or overcrowding. Decide the minimum proportion of neonates, larvae, and pupae to keep for ongoing BSF cycle maintenance and sustainable production.

4. **Cost reduction and labor management:**
   Review labor costs and workforce models to minimize production expenses. Prioritize cost-effective transport options such as pickups and TukTuk over motorcycles, particularly for bulk or high-moisture waste streams. Moreover, transport mode selection should be guided by both the type and quantity of waste available at any given time, as liquid waste incurs higher costs due to its handling requirements. Institutionalize regular monitoring and analysis of transport costs by waste type, distance, and mode to support data-driven logistics planning.

5. Market development and revenue streams:

To strengthen market presence and enhance revenue generation, it is essential to establish robust links with aquaculture, poultry, and crop production industries to secure stable, long-term demand. Targeted awareness campaigns and farmer training should be conducted to increase understanding of BSF byproduct benefits and drive adoption. Local pricing should be aligned with regional market standards by improving product quality and consistency, complemented by tiered pricing structures for bulk purchases. Quality of frass should be upgraded and commercialized as a certified organic fertilizer, supported by partnerships with agro-dealers to expand distribution networks. Additionally, closed-loop farming systems should be promoted by selling frass back to local farmers and integrating BSF units with complementary farming activities such as poultry or pig production to create self-sufficient operations and diversify revenue streams.

Closeup on a black soldier fly (*photo:* Envato)

Larvae of Black Soldier Fly given to livestock chickens (*photo*: Shutterstock)

Close-up of Black soldier fly larvae (*photo:* Envato)

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