Manure to Treasure: Converting animal wastes to valuable products by Black Soldier Fly

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Abstract

Organic waste pollution from small to medium-sized piggery and poultry farms poses a significant environmental challenge in Cebu, Philippines. This policy paper examines the transformative potential of Black Soldier Fly (BSF) technology in converting organic waste into valuable bioproducts (*i.e.,* animal feed, oil, organic frass, chitin, chitosan, and antimicrobial compounds). Despite its considerable potential, widespread BSF adoption faces challenges, prompting recommendations such as the adoption of BSF technology by local government units, capacity building, and enhanced monitoring and evaluation. Integrating BSF technology offers a sustainable solution to minimize pollution, optimize resources, and stimulate economic growth in agricultural communities.

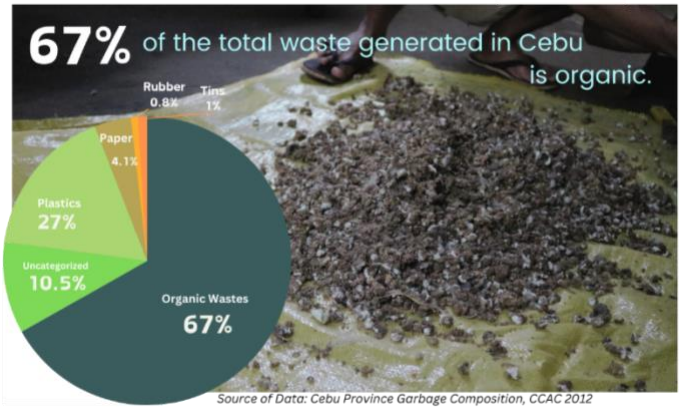


Figure 1. Waste generation in Cebu, Philippines

Cebu province, one of the bustling agricultural regions in the Philippines, is grappling with an escalating environmental challenge – organic waste pollution. According to the CCAC's Solid Waste Management City Profile report in 2012, organic waste in Cebu accounts for approximately 67% of the region's total waste generation, and it has not decreased up to the present (Figure 1). The province's agricultural landscape is characterized by a multitude of small to medium-scale piggery and poultry farms, contributing significantly to its economy.

However, the rapid expansion of these farms has led to the unchecked accumulation of organic waste, particularly animal manure (Diola et al., 2024). There is a lack of accurate data on the annual production of animal manure. Thus, available estimates are unreliable, posing a challenge to effective management and regulation. The problem is particularly severe for small and medium-sized farms where proper disposal practices are often lacking. Unfortunately, this improper handling of animal manure contributes to local pollution, adversely affecting both land and water ecosystems. Beyond the immediate environmental impact, there are additional threats, as it can be a breeding ground for diseases and pathogens, thereby endangering the well-being of both animals and humans within the region.

In response to these challenges, the Department of Agriculture's Agricultural Training Institute in Central Visayas has launched an animal waste management and utilization program. This initiative aims to equip farmers with training and resources to responsibly manage and utilize animal waste, transforming it from a pollutant into a valuable asset. Aligning with this goal, in 2021, the Department of Science and Technology's Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development funded a research project on Black Soldier Flies led by Dr. Fleurdeliz Maglangit.

These black soldier flies (Hermetia illucens L.) are emulating nature's methods to repurpose and reintegrate organic wastes, making them valuable once again. Using black soldier fly larvae for waste bioconversion is a beneficial alternative that reduces the reliance on excessive landfill usage. These insects are commonly found in various countries, particularly in tropical regions. They are widely acknowledged as beneficial and are not considered pests.

Waste Management

The bioconversion process of black soldier fly larvae on animal manure and food wastes resulted in a waste reduction index of up to 10.42% (Diola, et al., 2024) (Figure 3). These voracious eaters can eat twice their body weight daily and process waste 50% faster than traditional composting methods.

Case study: Integrating Black Soldier Fly Technology in Chesed Farm, Liloan, Cebu

Chesed Farm, a key participant in the aforementioned project, successfully implemented black soldier fly technology for recycling quail and chicken manure.

Figure 2. Chesed Farm Black Soldier Fly Larvae Bioponds in Liloan, Cebu, Philippines

Adopting a systematic approach, the farm redirected the disposal of manure from nearby swamps to bioponds of thousands of black soldier fly larvae (Figure 2). Upon reaching 14 days from hatching, these larvae were harvested and processed into an additive for animal feeds. This strategic utilization enabled the farm to achieve a noteworthy **10% reduction in feed expenses** for free-range chickens. Additionally, there is also a **marked reduction of housefly infestation** on the farm. Chesed Farm also capitalized on the organic fertilizer produced by the larvae, known as frass, generating supplementary income through its sale. The formal adoption of black soldier fly technology not only contributed to cost savings for Chesed Farm but also introduced an additional revenue stream, showcasing the economic viability of such waste management practices.

BSF meal and oil

The project has successfully used black soldier fly larvae to produce biomass rich in protein and fat, which was used as feed and supplements (BSF oil) for poultry quails and chickens (Figure 3). BSF meal inclusion in quail diets resulted in a faster growth rate over a short period, improved feed conversion efficiency, and a notable 23% increase in egg production. In addition, BSF fat can also be processed into biodiesel through trans-esterification reactions.

BSF chitosan

Chitin finds diverse applications in industries such as cosmetics, pharmaceuticals, agriculture, and textiles. Orchids treated with 128 ppm of chitosan (66.62% DD) exhibited superior results, producing inflorescences with the highest number of flowers, greatest length, and the highest mean root-shoot ratio (Figure 3). They also developed more buds, showing efficacy comparable to chemical concoctions in managing leaf diseases.

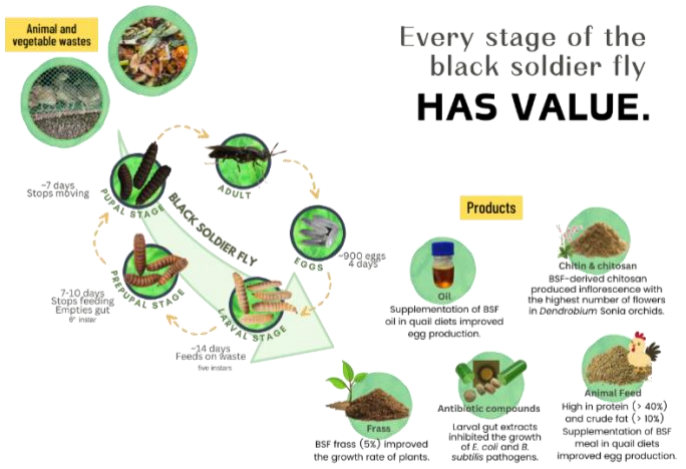
BSF Frass

After processing animal manure and food wastes, the larvae produced valuable frass—an organic fertilizer that can improve soil fertility and promote plant growth (Figure 3). A 5% inclusion of BSF frass showed a better growth rate on soybean, tomato, and pechay plants compared to the control.

BSF larval gut and antimicrobial compounds

Furthermore, the bioactivity tests conducted in the project have identified the black soldier fly larval gut as a source of antimicrobial compounds (Figure 3).

Figure 3. The Black Soldier Fly Cycle and its Valuable Products across each stage



The composting method of using black soldier fly larvae is an innovative technology that not only serves as a waste management solution but also creates entrepreneurial opportunities through the various products it generates during the process. This circular approach minimizes animal waste, maximizes resource efficiency, and offers a cost-effective solution for both environmental and economic benefits.

Policy recommendations / conclusions

Despite the promising potential of black soldier fly technology in addressing the waste management problem, there is still a significant lack of knowledge

and understanding of its utilization. The technology is relatively new in the Philippines, and its implementation is currently limited. The lack of widespread knowledge on breeding and managing black soldier flies and their larvae, as well as the necessary conditions for their efficient use in waste bioconversion, poses a critical barrier. Moreover, the regulations and guidelines for the use of this technology are not yet fully developed. Hence, the following recommendations are drawn:

- **BSF Technology adoption.** For local Government Units (LGUs) to adopt BSF technology for managing animal waste. Dedicated BSF facilities be established to process animal waste.
- **Capacity building.** For LGUs and government agencies, like the Department of Agriculture, collaborate with academic institutions to provide BSF training programs for farmers. This will help to build expertise and ensure the long-term sustainability of the project.
- **Monitoring and evaluation.** For LGUs to enhance monitoring and compliance mechanisms to ensure effective and sustainable waste management.

Acknowledgments

Project Black Soldier Fly is implemented by UP Cebu together with its partner industry, Chesed Farm. The Project started in 2021 and is funded by the Department of Science and Technology (DOST) through the Science for Change Program (S4CP) Collaborative Research and Development to Leverage Philippine Economy (CRADLE) and monitored by DOST Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) with Project No 8647. In 2023, the Project received funding from the Department of Agriculture – Bureau of Agricultural Research to continue research and development on the black soldier fly.

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