International Water Management Institute

Innovation Brief

Black Soldier Fly Technology Transforming Agri-Food Systems

Summary

- Rising from mountains of food waste to soil and water contamination, and a changing climate, the perils loom large. Global food security and sustainability are hanging by a delicate thread that commands attention.

- For sustainable Agri-Food Systems, the black soldier fly larvae (BSF) technology has emerged as a transformative force and a potential game-changer in waste management, soil health enhancement, animal feed production, water savings, carbon mitigation, agricultural and environmental sustainability.

- BSF technology is the circular economy's' new hero, turning waste into protein, fertilizer, oil, plastics, and more! But safety, regulations, smarter and cost-effective production are key. Let's invest in innovative R & D, scale up production, highlight the quality and nutritional food, and jobs that the technology can create, prioritize strategic planning to bolster market penetration, credibility, and competitiveness.

Introduction

Imagine a vast web where land, water, inputs, knowledge, tools, and capital feed into a process, yielding not just food but also emissions, waste, and resources. That's the Agri-Food System, a complex balance of inputs, processes and outputs shaping our world. More than just food on a plate, the Agri-Food System is a dynamic mix of cultivating, harvesting, processing, and delivering (including food loss and wastes-FLW). Approximately 30% of the world's food production is lost or wasted annually, contributing to 1.3 billion tons of waste and about 9.3 billion metric tons of CO_2 equivalent emissions in 2017 (FAO, 2023). Additionally, waste can impact negatively on water, land and biodiversity (FAO, 2013).

The ever-increasing food demand due to population increase is expected to exacerbate the challenges associated with food loss and waste accumulation. Therefore, it is crucial to look for an innovative approach capable of recovering resources lost along the food chain (from production to consumption) and transforming them into value-added products. A scoping review done across Europe, Asia, Latin America, North America, and Sub-Saharan Africa by Adamtey et al. (forthcoming) revealed that Black soldier fly (BSF), Hermetia illucens, has a transformative force and a potential to offer solutions to many of the challenges facing Agri-Food systems.

Prospects for Agri-Food systems Transformation

BSF presents a transformative advancement for sustainable Agri-Food systems, addressing a multitude of environmental challenges across waste management, composting, aquaculture, and agriculture (Figure 1). Aligned with the principles of the circular economy, BSF efficiently converts organic waste into valuable resources, including protein-rich larvae with a diverse nutrient profile, oil, nutrient-rich frass, biodiesel, biofilm/plastic (Chia et al., 2021; Jalil et al., 2023).

This frass holds significant potential as an organic fertilizer, promoting crop growth and quality, soil health and contributing to sustainable agricultural practices (Klammsteiner et al. 2020; Abiya et al., 2022;). The eco-friendly nature of BSF technology anticipates a reduction in greenhouse gas emissions, conservation of resources and biodiversity (Mertenat et al., 2019).

Further, the versatility of BSF feed allows for tailored formulations to cater to the specific needs of different animals, further enhancing resource use efficiency. For example, research had shown that young turkeys fed with live larvae displayed improved feed intake efficiency, lower conversion ratios, and reduced pecking behavior (Veldkamp & van Niekerk, 2018). Guinea fowl diets supplemented with the larvae displayed increased feed intake compared to control groups (Wallace et al., 2018). Laying hens fed diets with larvae supplementation as a replacement for fish meal produced heavier eggs with increased yolk weight (Zhao et al., 2022). Pigs fed with larvae displayed higher carcass weights but slightly lower dressed percentages (Chia et al., 2021). Similarly, dairy

cows supplemented with larvae feed displayed higher daily milk production. Beyond these immediate applications, BSF technology opens exciting avenues (Figure 1 and 2) for the development of innovative insect-based products and can contribute to economic growth and job creation.transformative force and a potential to offer solutions to many of the challenges facing Agri-Food systems.

Business and market prospects

Black soldier fly (BSF) technology is buzzing with business potential, offering a sustainable solution to multiple challenges. Figure 2 highlights diverse products and markets ready to be unlocked. Beyond the farm, BSF magic extends to fertilizer, bioplastics, biopesticides, biofuel, and even insect-based cosmetics and pharmaceuticals. BSF market is poised for explosive growth, creating exciting opportunities for entrepreneurs and investors alike. However, a lot of these opportunities remained untapped. With growing environmental awareness and rising demand for sustainable alternatives, there is the need for innovative R&D and funding support to optimize the products that BSF technology can offer.

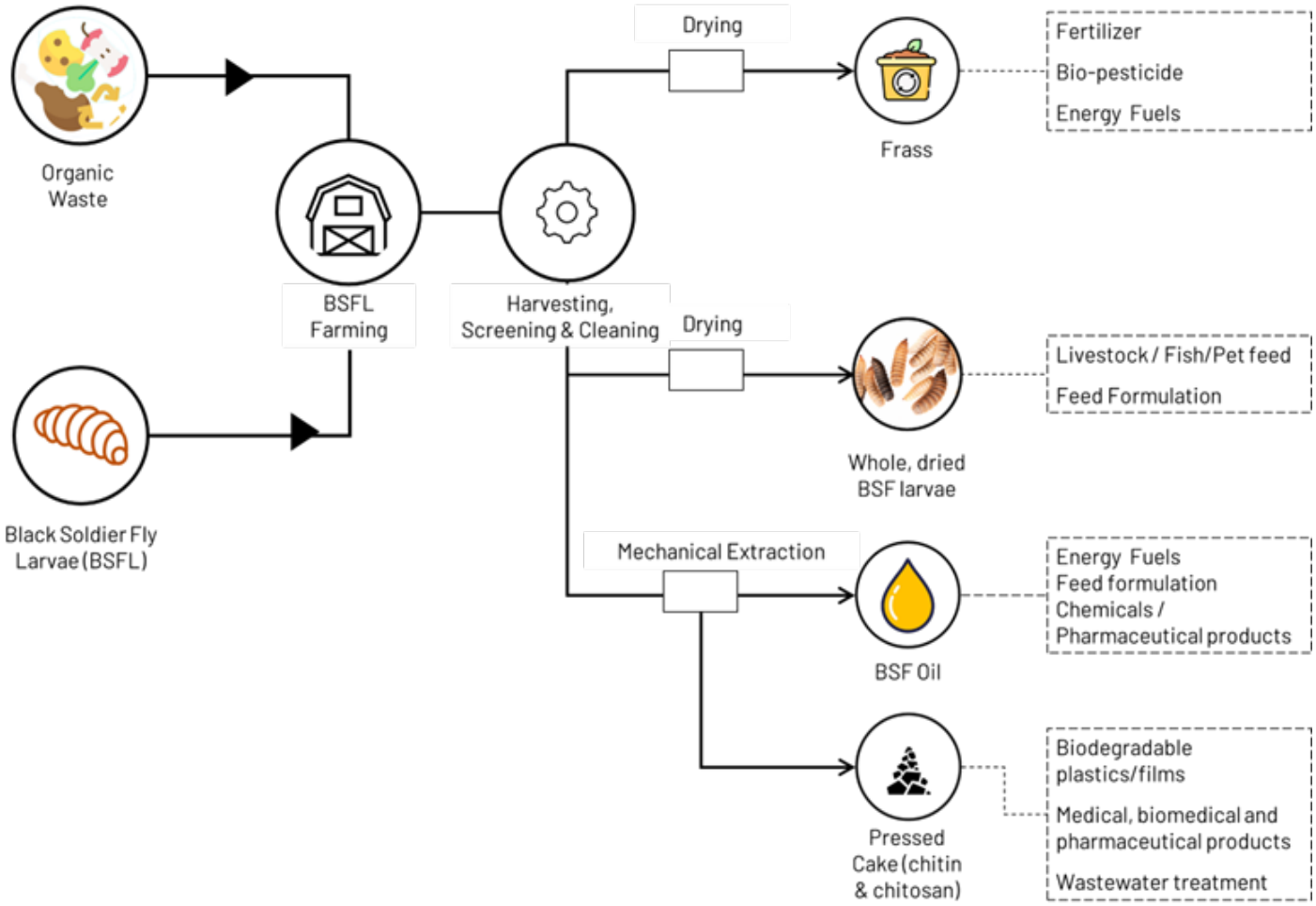

Figure 1. Process stages of BSFL technology, byproducts and potential applications
Source: Adopted from Adamtey et al. (forthcoming)

Regarding safety concerns, the integration of BSF technology into the food chain faces challenges, with the presence of pathogens and heavy metals in the larvae's substrate raising concerns (Biancarosa et al., 2018). Despite conflicting reports, the antimicrobial properties of BSF larvae, potentially mitigating risks. Regulatory recommendations advocate for the treatment of BSF frass before use. This presents a valuable solution, particularly within organic farming systems where synthetic products are prohibited, and in agroecological and Nature positive agriculture where environmental agricultural sustainability is paramount.

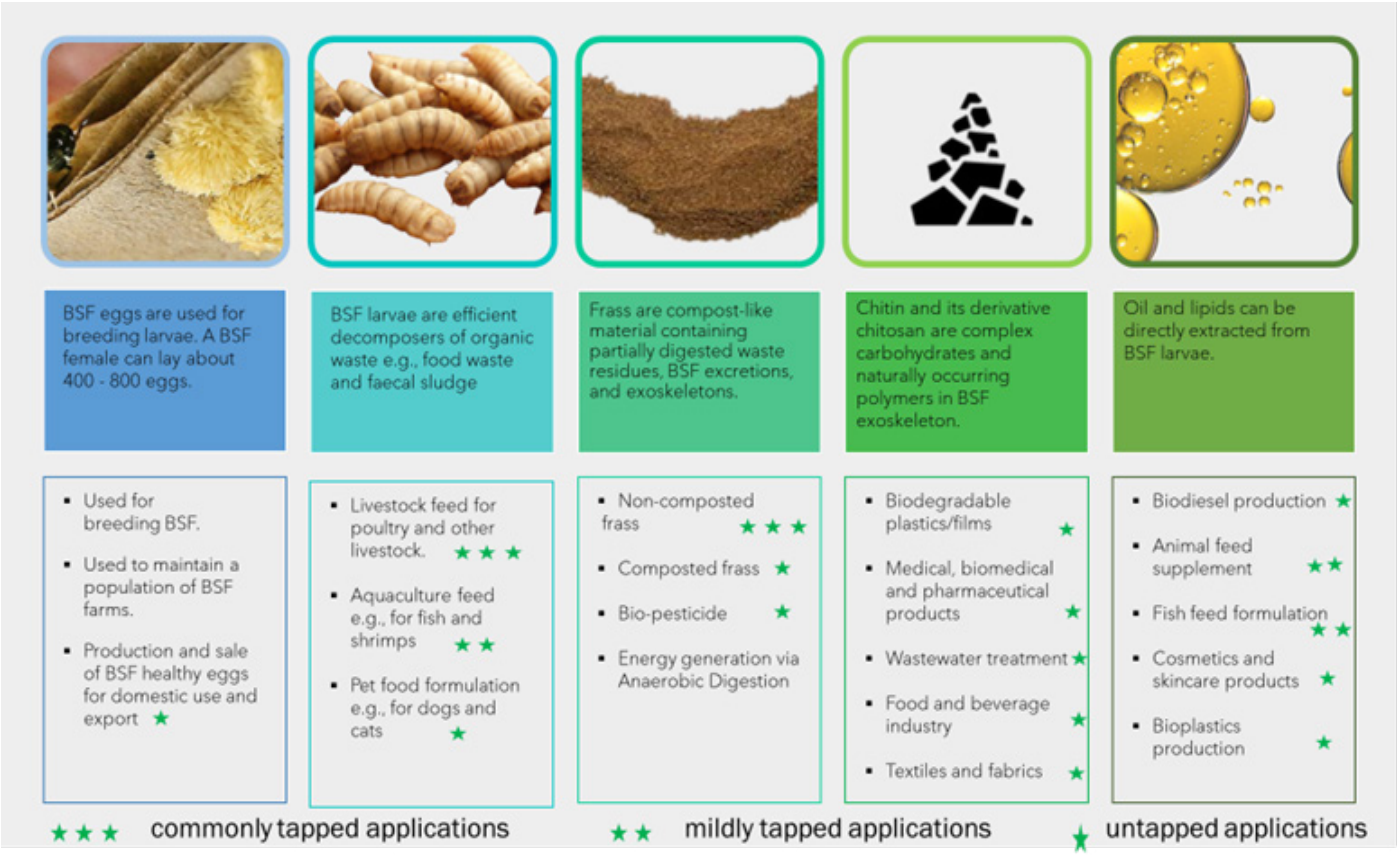

Figure 2. Black soldier fly larvae technology-potential business and market opportunities

Source: Adopted from Adamtey et al. (forthcoming)

Conclusion and Recommendations

The BSF technology emerges as a pivotal instrument for fostering a circular economy within the agrifood context, efficiently transforming organic waste into valuable resources, including protein meal, oil, chitin, bioplastic film, and fertilizer. While BSF technology holds significant promise for revolutionizing Agri-Food Systems, careful consideration of safety concerns, regulatory compliance, and continued investment in research and development (R&D) is vital for its successful integration.

To capitalize on the considerable opportunities presented by BSF technology and promote the expansion of relevant enterprises with accompanying job creation, strategic considerations should encompass investments in R&D for improved BSF rearing techniques, scaling up production facilities to meet the anticipated increase in demand through infrastructure development and automation, and prioritizing the emphasis on sustainability and nutritional benefits to bolster market penetration and credibility.

Collaboration with waste management entities, farmers, and businesses for the establishment of integrated supply chains, alongside community-focused training programs, could offer substantial aid in workforce development and job creation, particularly within rural areas.

Further reading material

Noah Adamtey, Elijah Baidu, Tosin Somorin, Olufunke Cofie (forth coming). BSF and Agri-food system Transformation: A Scoping Review on Trends, Gaps, and Scaling Opportunities (Submitted to Journal of Sustainable production and consumption).

Practical sessions with BSF trainees (*photo*: Ankrah/IITA).

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BSF larvae emerged into flies at YAWAT ranch (*photo*: Ankrah/IITA).

Separation of larvae (*photo*: Ankrah/IITA).

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Acknowledgements

This work was carried under the CGIAR Initiative on West and Central African Food Systems Transformation (TAFS-WCA), which is grateful for the support of the CGIAR Trust Fund contributors.

CGIAR Initiative on West and Central African Food Systems Transformation

The CGIAR Initiative on West and Central African Food Systems Transformation aims to improve nutrition, incomes, and food security within the context of climate change in West and Central Africa through nutritious, climate-adapted, and market-driven food systems.

Citation: Adamtey, N.; Cofie, O.; Atampugre, G. 2023. *Black soldier fly technology transforming agri-food systems*. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Initiative on West and Central African Food Systems Transformation. 6p.

Disclaimer: This work was prepared as an output of the CGIAR Initiative on TAFS-WCA and has not been independently peer reviewed. Responsibility for opinions expressed and any possible errors lies with the authors and not the institutions involved.

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Published: December 2023