



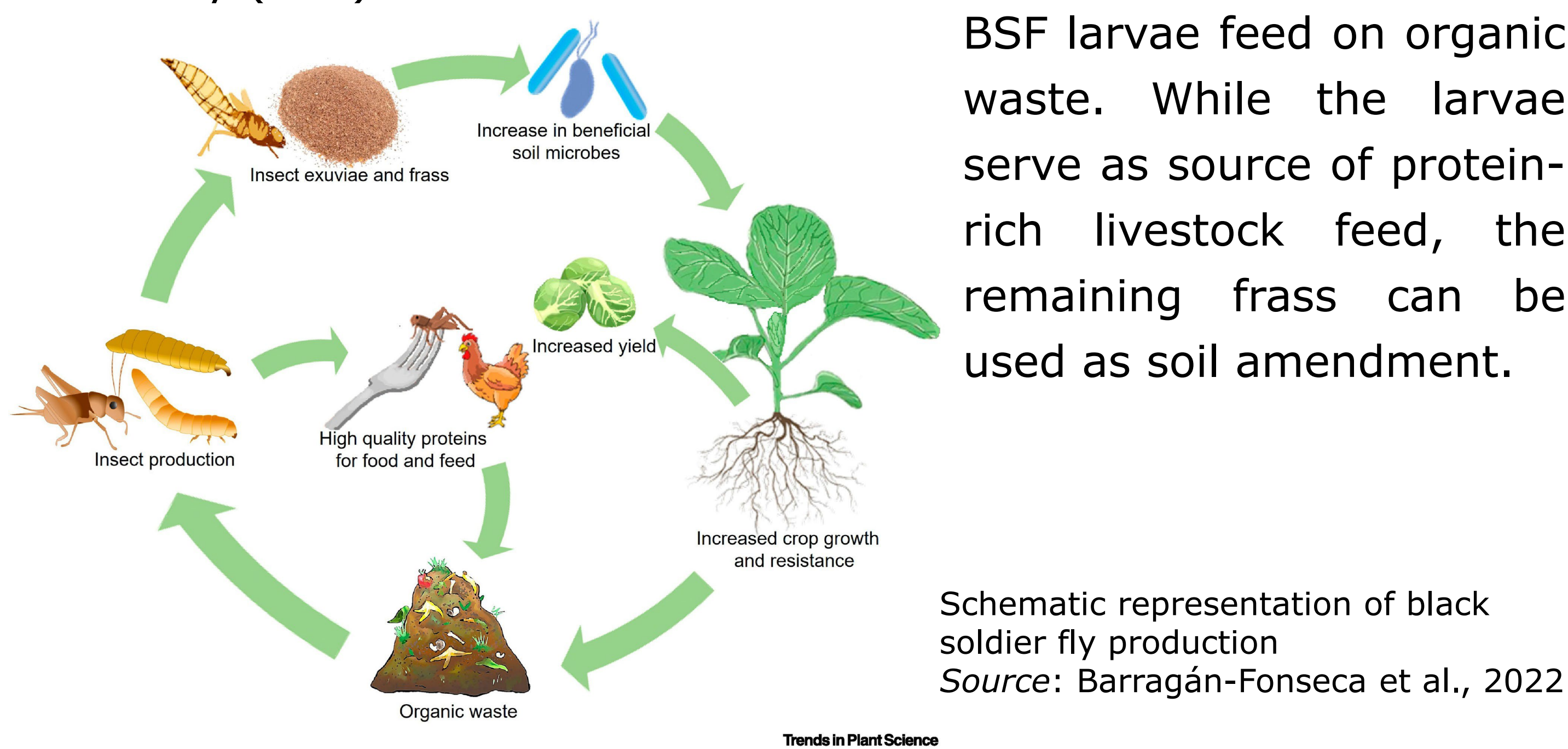
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Valuing waste streams for sustainable food systems: towards a digital twin

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Background

Attention for the use of organic inputs in agriculture in Uganda is growing. However, availability of biomass is limited due to poor crop yields and limited availability of good quality, yet underutilized waste streams. One waste stream with potential for improved use is wet coffee pulp from coffee washing stations. And one potential application to add value to this waste stream is the use of black soldier fly (BSF) larvae.

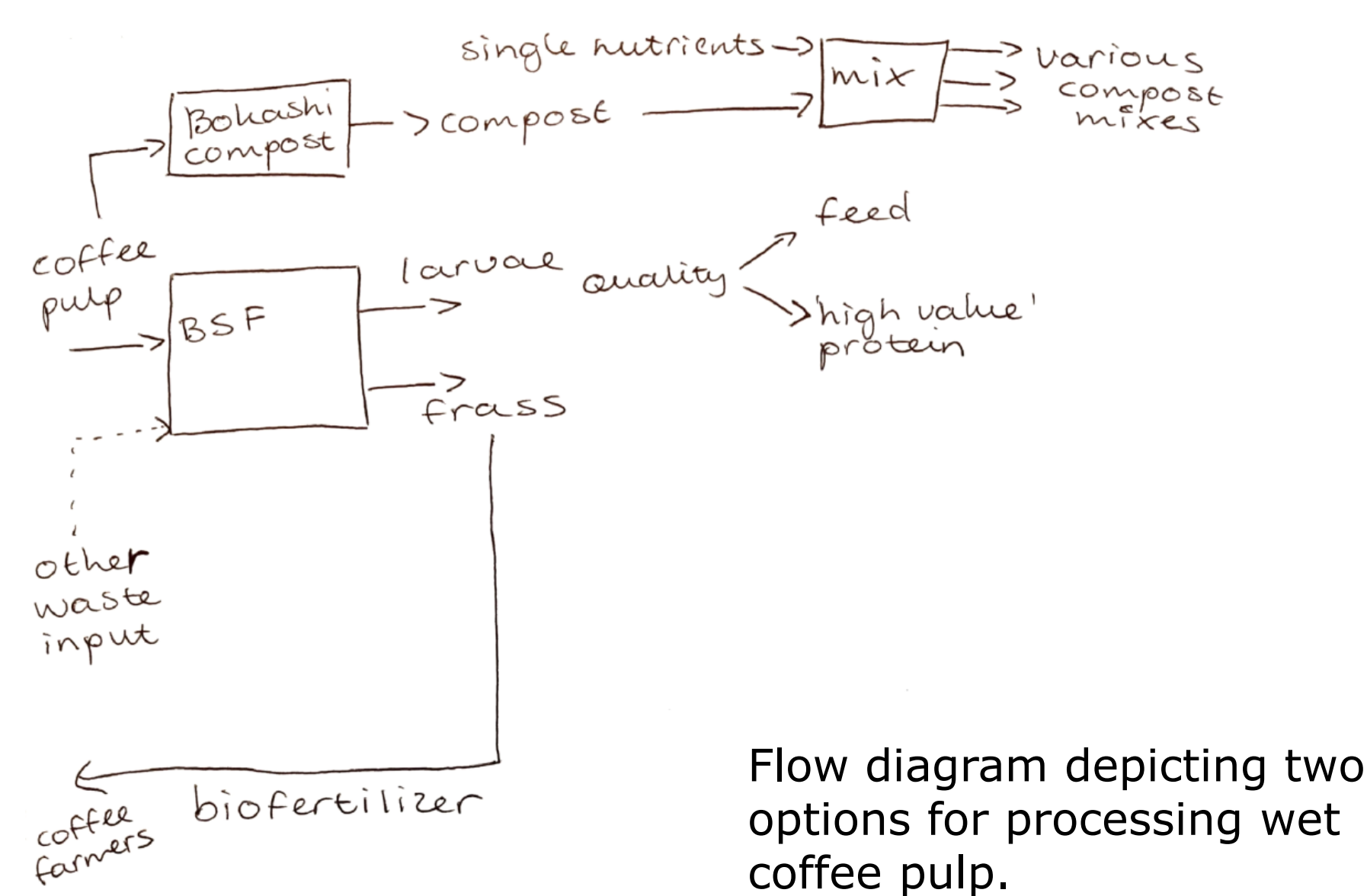


BSF larvae feed on organic waste. While the larvae serve as source of protein-rich livestock feed, the remaining frass can be used as soil amendment.

Schematic representation of black soldier fly production
Source: Barragán-Fonseca et al., 2022

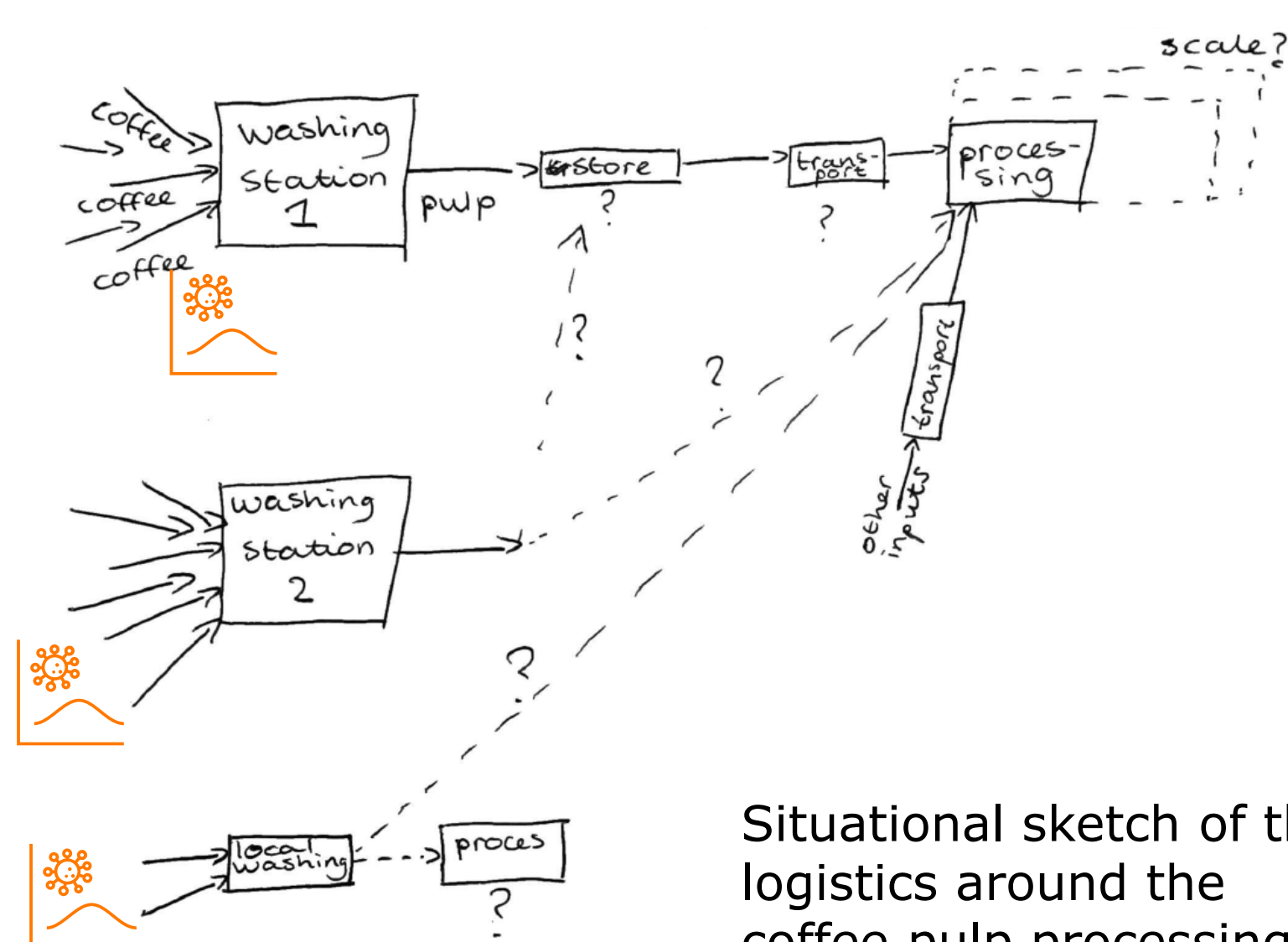
Research questions

1. To what extent are additional waste streams needed to optimize the BSF production process?
2. How does feedstock composition affect nutrient composition of the BSF frass?
3. How the BSF process compares with other forms of composting of coffee waste in terms of costs and benefits?



Flow diagram depicting two options for processing wet coffee pulp.

4. How are scale and valorisation performance influenced by (seasonal) waste availability?
5. How small can we go with processing while still being efficient?
6. What are optimal locations for the valorisation?



Situational sketch of the logistics around the coffee pulp processing.



Wet coffee pulp at a washing station in Uganda.



Crates with black soldier fly larvae at PROTEEN

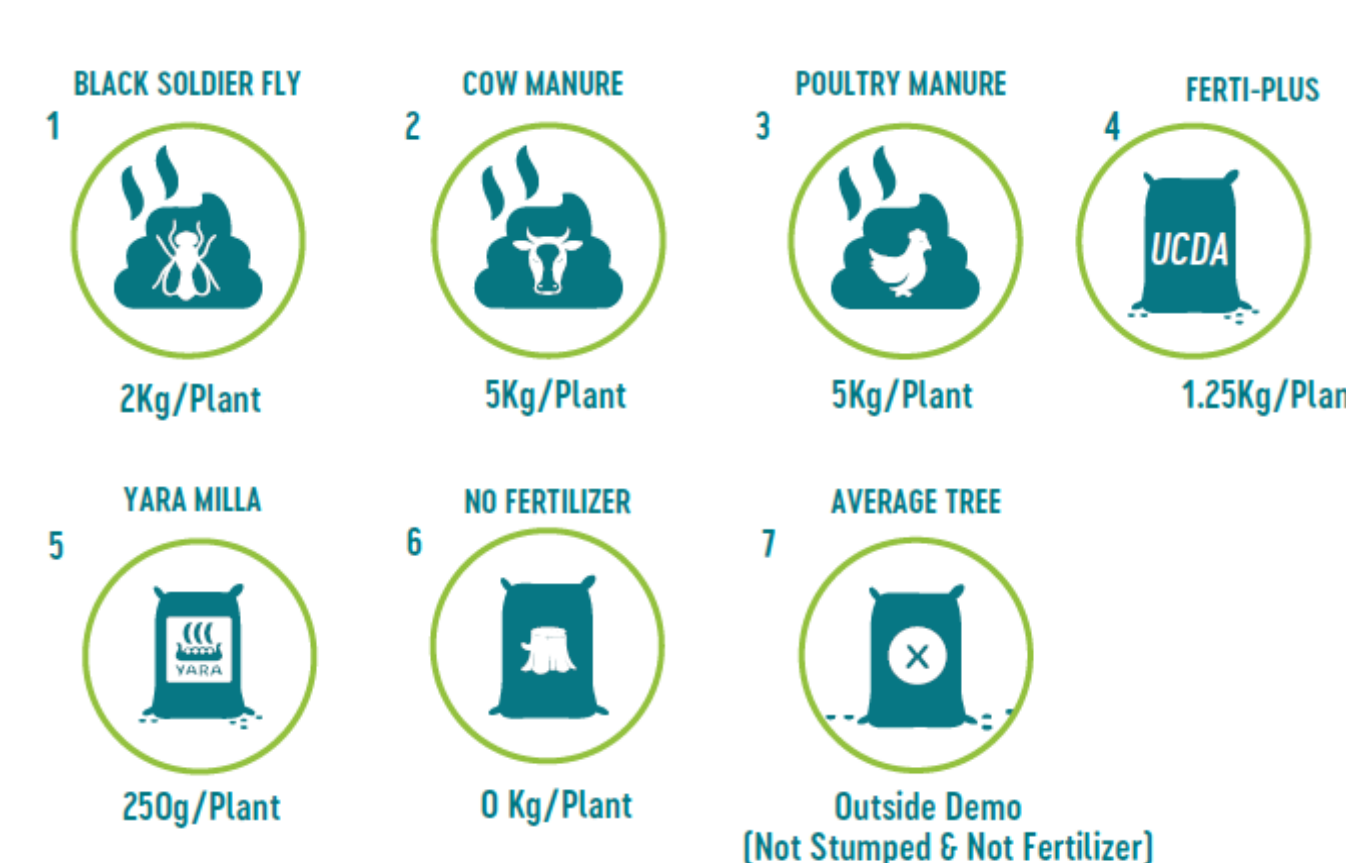


Bags with bio-fertilizer (BSF frass)

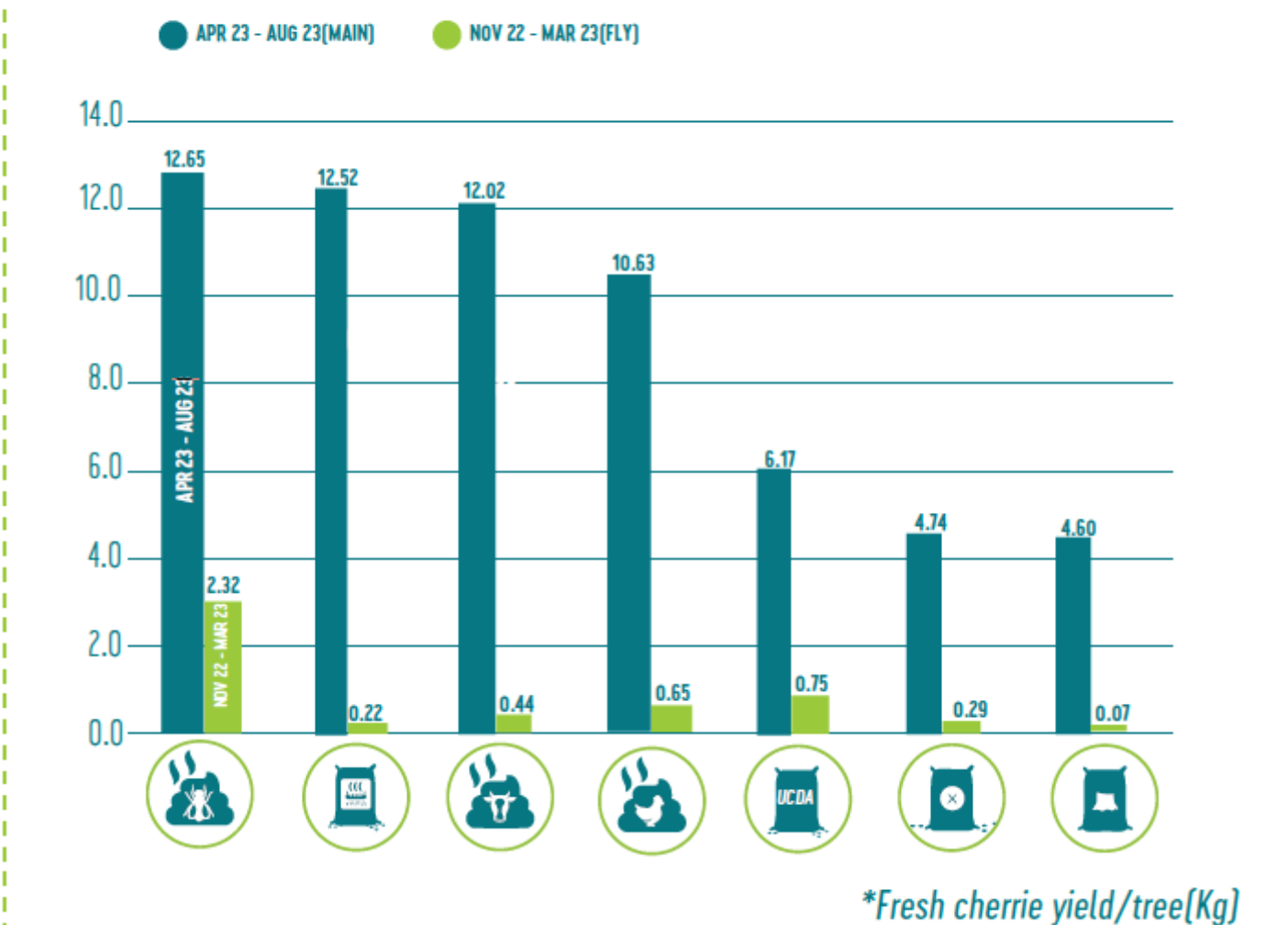
Problem statement

Initial tests show the feasibility of producing BSF on coffee waste with favourable outputs of insect protein and quality of the frass.

WHAT ARE WE COMPARING?



SEASON HARVEST ESTIMATES



*Application rate is per season

*Fresh cherrie yield/tree(Kg)

UGACOF trial results comparing BSF and other inputs on coffee yield (July 2022)

The optimisation of the BSF production process and its logistical organisation require advanced decision models. Yet, availability and desirability of real-time data to warrant the development of a digital twin is uncertain. The aim of this project is to study whether a digital twin may contribute to further optimization of waste stream valorisation in SSA and, if yes, how?

Data collection and analysis

- Two WUR student internships in Uganda in January-March 2023
 1. to identify how inputs (feedstock, costs, labour) and outputs (quantity, quality) of BSF and other forms of composing compare
 2. to evaluate how waste composition influences BSF frass quality
- Initial outcomes will be used to refine model and do 2nd round of data collection
- A junior researcher will join the team for further model development in mid 2023

Expected results

In a scenario evaluation we will develop models to support decisions related to:

- Seasonal availability and sourcing of additional waste streams
- Quality versus costs of bio-fertilizer output
- Consistency in relation to (seasonal) availability of additional waste streams
- Logistics (where to place facilities, central or decentral model, which processing is best placed where)

The study will conclude with perspectives, constraints and requirements related to the potential development of a digital twin



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<https://www.wur.nl/en/project/valuing-waste-streams-towards-a-digital-twin.htm>

Reference

Barragán-Fonseca, Nurfikari, A., Van de Zande, E., Wantulla, M., Van Loon, J., De Boer, W. and Dicke, M. (2022), Insect frass and exuviae to promote plant growth and health. Trends in Plant Science, Vol. 27, No. 7. <https://doi.org/10.1016/j.tplants.2022.01.007>