Scaling regenerative black soldier fly farming innovations with vegetable push-pull cropping systems for One Health in Rural Kenya, Rwanda and Uganda 2023 PhD Projects

Project Number	PhD Project Title	Project Summary	Location of project	Qualifications and experience required
1	Optimization of black soldier fly growth and quality of frass fertilizers using locally available organic substrates	In sub-Saharan Africa, over 125 million tonnes of organic wastes are produced annually. Converting these organic wastes from a circular economy perspective would create affordable opportunities for income generation through increased crop and animal production by smallholder farmers. In recent years, black soldier fly (BSF) larvae have been demonstrated to efficiently convert organic wastes into high-quality essential nutrients. This technology has attracted global interest in the face of rising prices of animal feedstuff, waste accumulating and soil degradation. The main by-products of the bioconversion of wastes by BSF is protein-rich animal feed and organic fertilizer known as frass fertilizer, which have been shown to boost animal productivity, and soil health and crop yield, respectively. The BSF larval performance and quality of frass fertilizer produced largely depend on the type and quality of waste streams used for BSF rearing. This PhD study will aim at optimising the BSF bioconversion process to generate better-quality insect-protein and frass fertilizer with well-balanced nutrients, using readily available waste streams. The PhD project will determine waste combinations for the production of high BSF larval yield and frass fertilizer with higher nitrogen, phosphorous and potassium concentrations. Furthermore, frass fertilizer effects on the growth, yield, and nutrient use efficiency of key vegetable and cereal crops grown in different soil types will be assessed. The physical-chemical properties, and abundance and diversity of bacterial and fungi of soils amended with BSF frass fertilizer will be established. The exploitation of BSF and its by-products (frass fertilizer) has the potential to create affordable opportunity for revenue generation by entrepreneurs and smallholder farmers in low income countries	Uganda	- MSc. Applied Entomology, Environmental Sciences, Soil Science, Integrated soil fertility management, Agronomy, Biochemistry or related program. - Experience in BSF farming and organic fertilizer technology is an added advantage.
2	Identification and validation of vegetable-Integrated push-pull systems in diverse ecologies of East Africa	With the changing climate, booming population and increased demand for land, there have been growing calls for sustainable intensification of food production systems using innovations that maximize productivity on existing land without adverse environmental and social impacts. The agroecological push-pull cropping system, originally designed for the control of cereal crop pests, provides several important below and above ground ecosystem services that improve cereal productivity. The push-pull cropping system is currently being diversified with high value vegetables through vegetable integrated push-pull (VIPP). This diversification of push-pull with micronutrient-rich vegetables can enhance not only farmer incomes but also nutritional security for rural households. The pest control and soil quality improvement properties of the push-pull system also contributes to pest resilience of intercropped vegetables by enhancing their production and quality. Long-term use of organic amendments/composts in cropping systems, have been shown to enhance soil fertility, soil carbon sequestration, and contribute to greater retention of soil moisture and nutrients to improve yield. Despite the potential and urgent need for sustainable intensification of the push-pull with high value vegetables and other organic amendments, little is known about how attributes associated with it are compatible with farmer selected vegetables for integration in diverse agroecologies and at various spatial scales. This multidisciplinary PhD project will therefore evaluate both synergies and tradeoffs within vegetable-integrated push-pull cropping systems amended with organic	*icipe*, Nairobi, Kenya	- BSc. in biology, agriculture, or crop protection. MSc. in entomology, crop protection, agronomy, biochemistry/molecular biology, ecology, or related discipline. - Demonstrated ability to publish in high quality peer-reviewed scientific journal - Good communication skills and proficiency in English (both oral and written). - The Master's degree must have been completed less than ten years ago at the time of application. - Previous experience with field experimental set up will be an added advantage.

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		black soldier fly frass fertilizers in diverse agroecologies of East Africa for development of context-specific interventions that protect against crop damage whilst enhancing productivity for food and nutritional security.		
3	Systemic modelling of pest, disease, and soil fertility management strategies in vegetable integrated push-pull systems	The vegetable integrated push-pull technology (VIPPT) is a novel agroecological cropping system that mitigates various insect pests, parasitic weeds, and soil fertility constraints. Systemically, it integrates eco-agro-pastoral systems that encompass numerous dynamic interactions between crop production, livestock production and environmental quality for human wellbeing. Further intensification of the VIPPT includes integration with locally produced black soldier fly (BSF) innovations such as organic fertilizer for enhanced productivity and sustainability. BSF recycles organic wastes into economically valuable products such as nutrient-rich protein feeds for poultry and fishes, and organic insect-based frass fertilizers for improving crop productivity. Therefore, both the VIPPT and BSF farming innovations have the potential to contribute to 'One Health' as an integrated and unifying approach. A proper analysis of a such integrated system requires knowledge of multi-trophic interactions and respective feedbacks. However, existing approaches largely focus on individual system determinants and components which neglects the interactions that exist between components of system thereby precluding a full understanding of the dynamics involved in the system that lack robustness. The current project will develop system thinking and system dynamics models to assess the systems-level integration of the VIPPT and BSF within the context of a circular economy framework and evaluate the diverse 'One Health' benefits of the interventions to sustainably balance and optimize the health of people, animals, plants, and ecosystems. The candidate will develop systemic models that holistically integrate determinants associated with the full pathway BSF farming and its integration with VIPPT cropping systems on 'One Health' in smallholder farming systems.	*icipe*, Nairobi, Kenya	- Must have MSc in Physics, Economics, statistics, Computer Science, Mathematics, or related discipline with good skill in system design and system thinking approaches. - Should have a strong foundation in quantitative analysis, experience and in developing and using dynamics models using VENSIM or STELLA platforms. - Experience in mathematical modelling of plant pests or diseases, and in spatial and/or temporal statistics is considered a plus. - S/He must demonstrate ability to publish in high quality peer-reviewed scientific journal - The Master's degree must have been completed less than ten years ago at the time of application.
4	Assessing the factors influencing One health impacts of VIPP and BSF innovations in East Africa	One Health (OH) is a unifying approach addressing multi-disciplinary problems related to optimal health of humans, plants, animals, and the environment. Thus OH, is multisectoral and transdisciplinary and has significant implications on smallholder farmers given their over reliance on animal and crop health for optimal production that meets the demand for food and meat products. The vegetable integrated push-pull technology (VIPPT) is one such method that relies on environmentally benign methods for pest control and maintenance of soil health to meet food and nutritional needs of over 80% of the smallholder farmers. The advent of black soldier fly (BSF) farming provides a new dimension to sustainable intensification of farming related to waste recycling, insect-composted organic fertilizer production, organic soil amendments, and livestock feed through an inclusive rural circular economy. The current multidisciplinary project will evaluate/track key indicators of the 4 one health pillars (plant, human, animal and environmental) and determine factors influencing its impact among farmers integrating VIPPT with BSF innovations for the development of a more sustainable food systems within the regional framework.	*icipe* Mbita Point, Kenya	- Must have MSc in Agriculture, Entomology or Integrative Biology and Ecology - Experience with socioeconomic assessments. - Good communication skills and proficiency in English (both oral and written). - Good command of academic/scientific writing- The Master's degree must have been completed less than ten years ago at the time of application.