

Researchers rope in recycler flies to ensure food security

Team develops blueprint to integrate waste management and sustainable food production

Cheryl Tan

Imagine a future where food waste is converted into nutrients for food production, all in a work of magic by the ubiquitous black soldier fly. This is exactly the vision that an interdisciplinary team of researchers hopes to realise, as it develops a blueprint to integrate food waste management and sustainable food production in urban settings like Singapore.

Assistant Professor Nalini Puniamoorthy from the National University of Singapore's Department of Biological Sciences, who is leading the project, told *The Straits Times* that Singapore faces a twofold challenge in its journey to food security, as the issue is not only with reducing food waste, but also with increasing food production in a sustainable way. Nearly 700,000 tonnes of food waste is incinerated on a yearly basis, while efforts to grow Singapore's own local produce are very

heavily dependent on imported agricultural inputs such as mineral fertiliser and animal feed that increase the cost of local food production and could have an adverse impact on the environment, Prof Nalini said. "So we're trying to marry (solutions to) these problems... and we think it is feasible by trying to take advantage of what nature already does, and that is to use these flies that are nature's very own recyclers," she said. As larvae, black soldier flies are able to consume up to four times their body weight in food waste daily, converting the waste into a by-product known as frass - which can be used to substitute or

supplement commercial fertilisers in agriculture. The larvae, being rich in protein and fats, can be used in animal feed formulations for poultry and aquaculture diets. The project, which Prof Nalini led with Professor Stephen Cairns from the Singapore-ETH Centre's Future Cities Lab Global programme, is done in collaboration with researchers from the Nanyang Technological University (NTU) and ETH Zurich. The three-year project is funded by the National Research Foundation, under its Campus for Research Excellence and Technological Enterprise programme. Prof Cairns said: "Designing fully circular food systems for high-den-

sity cities like Singapore requires experimentation at different scales. "Larger centralised black soldier fly larvae processing facilities could be integrated with food production areas to reduce waste at source, and further downstream at hotels and wholesale retailers, while compact decentralised facilities could be linked to restaurants, hawker centres and urban farms. Even smaller, mobile units might cover more ground in residential areas, community farms, and construction and harbour sites," he added. Singapore is the first country in Asia that is studying the possibility of rolling out black soldier fly facilities

on a national scale, though such integrated food ecosystems are more established in European suburban and agricultural towns, said Prof Nalini. She added that the "large-scale endeavour" will also bring Singapore closer to its 30 by 30 goal of increasing the capability and capacity of growing 30 per cent of its food needs locally by 2030. The project, which began this month, will span five interrelated themes, each covered by experts in insect rearing, urban design, sustainability, as well as food safety and nutrition. "What I envision in my rose-coloured glasses is that even when kids go to school, they will know how to separate their food waste after eating in the canteen, which will be given to the school garden for growing vegetables. "And when they go back home, they see food waste, they're able to tell their parents that they're wasting food... Education goes hand in hand with application, and I think we can effect the change if we're able to show that (this entire system) will work," she added. tansuwen@sph.com.sg

Building a sustainable food system with black soldier flies

The humble black soldier fly could be the missing piece in solving Singapore's growing food waste problem and helping the country achieve sustainable food production. Here are the five key areas that researchers in Singapore are looking into.



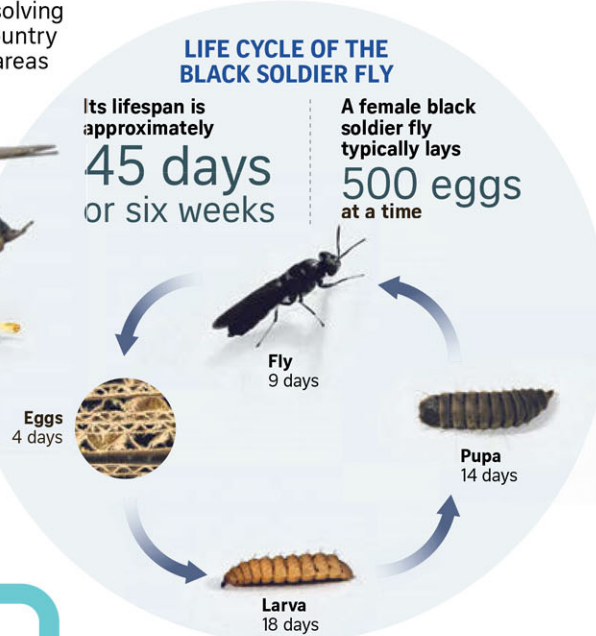
1 INSECT ENGINEERING

- Optimising and selecting specific reproductive traits so that the black soldier flies can mate in small urban spaces
- Testing how effectively the larvae can break down diverse food waste sources using machine learning



2 ENVIRONMENTAL IMPACT ON AQUACULTURE AND AGRICULTURE

- Researchers will study the carbon emissions and energy consumption of using larvae and frass in local aquaculture and agriculture production.
- Currently, fishmeal is often used as feed in aquaculture farms, which is unsustainable in the long run due to overfishing.
- Agricultural inputs, such as mineral fertilisers, are usually imported. The study will look at whether localised production can help to reduce environmental footprints.



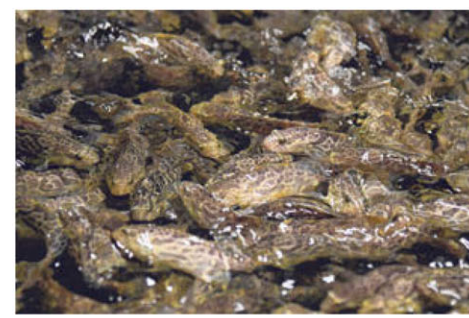
3 FOOD NUTRITION AND SAFETY

- In replacing fish meal with black soldier fly larvae in aquaculture, tests will be done to determine the impact on the growth rate and taste of the fish (right), as well as other biochemical aspects.
- The fertilisers will be tested on plants such as leafy greens (left) in partnership with plant biologists and urban farms.
- Researchers will monitor and assess potential contaminants such as pathogenic microorganisms in local food waste to ensure safety.



4 INDUSTRIAL PARTNERSHIPS AND COMMUNITY INVOLVEMENT

- Singapore can be seen as a "living laboratory" in urban design to integrate black soldier fly bioconversion facilities in the community.
 - Researchers will study how comfortable people are with living in close proximity and interacting with black soldier fly facilities.
 - This will determine where the facilities will be located in future, for example, nestled among urban centres or in agricultural zones.
- 5 LIVING WITH BLACK SOLDIER FLY FACILITIES**
- Sustainability@Tampines Park (above) was the first initiative launched in December 2020 to test the feasibility of a community-run black soldier fly facility. Residents donate their food waste and are rewarded with leafy greens from a vertical farm and tilapia from an aquaculture farm.
 - The team is working with a few industry partners to deal with different types of industrial food waste. Some examples include spent barley grains from the beer-brewing industry and soya waste known as okara.



TEXT: CHERYL TAN SOURCES: NALINI PUNIAMOORTHY, FUTURE CITIES LAB GLOBAL PHOTOS: JASON QUAH, NG SOR LUAN, MARK CHEONG, KEVIN LIM, TIFFANY LUM STRAITS TIMES GRAPHICS