Project update

Project title (Acronym):	Bringing Insect Farming to the Next Level – Promoting sustainable insect farming and preserving in Cambodia and Thailand to increase shelf life and obtain innovative foodstuffs based on local resources in order to counteract malnutrition, particularly of mothers and children
Geographical focus:	Cambodia, Germany, Thailand
Call reference:	Innovative approaches to processing local food in Sub-Saharan Africa and Southeast Asia, which contribute to improved nutrition and reduce qualitative and quantitative losses
Cooperating partners:	TiHo: Institute for Food Quality and Food Safety, Hannover University of Veterinary Medicine (Institut für Lebensmittelqualität und -sicherheit, Stiftung Tierärztliche Hochschule Hannover) RUA: Faculty of Veterinary Medicine, Royal University of Agriculture (សាកលវិទ្យាល័យភូមិន្ទកសិកម) LDC: Centre for Livestock and Agricultural Development (មជ្ឈមណ្ឌលអភិវឌ្ឍន៍ការចិញ្ចឹមសត្វ និងកសិកម្ម) KMITL: Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง) MUT: Faculty of Veterinary Medicine, Mahanakorn University of Technology (มหาวิทยาลัยเทคโนโลยีมหานคร)
Duration:	36 months
Budget:	643.522,02 €

Aim of the project:

Thailand and Cambodia are both affected by malnutrition of children and mothers, be it by the by the sheer number of persons suffering from it (Thailand), be it by the high percentage of the general population (Cambodia). While consuming insects (entomophagy) has a long tradition in these countries and is relatively widespread, this tradition involves gathering from the wild and subsequent preparation and consumption of the fresh or frozen insects. On one hand, if food insects, because of their nutritional benefits, are to play a major role in providing food for mankind, farming rather than collecting from the wild will be necessary. These techniques, already practiced in some parts of Thailand and Cambodia, have the potential to be used as minilivestock by families, as many insect species may be raised sustainably on agricultural side streams with less ecological impact as more typical livestock. On the other hand, rearing insects is prone to create surpluses in insect production, making preservation techniques necessary to ensure food safety by extending shelf life. These novel products may be produced for the family or sold at local markets creating an extra income.

IFNext attends these needs. The overall goal is to produce insects sustainably for the own consumption resp. to generate products that can be sold on the market and that actually meet the expectations of farmers and consumers alike.

For that, starter kits for insects (sometimes including building adaptions) will be developed and distributed to the participating 40 Southeast Asian families. Regarding insect species, the consortium agreed on one species which will be reared by all, i.e. Mediterranean field cricket (*Gryllus bimaculatus*) to compare results. Besides, each consortium member will also attend another species of national interest: Thailand will work with the silkworm (*Bombyx mori*),

Cambodia with the Jamaican field cricket (*Gryllus assimils*), and Germany with the mealworm (*Tenebrio molitor*) – rearing in the latter country will take place at the institute's insectarium. Along with the kits, participating families will be briefed in terms of insect production and accompanied by the local consortium partners.

During the project, these kits will be put to the test, evaluated and modified in case of need in order to suit local conditions, following the farmers' feedbacks.

In order to develop accepted insect product types, national surveys will be performed in which participants can choose among different types, (e.g. fermented, smoked, home-canned or as deep-fried crackers) and can also make own suggestions. The preferred techniques will be developed and evaluated by the consortium in terms of food safety and sustainable practicability under tropical conditions.

For the raw, cooked, and preserved insects, sensorial, compositional, and microbiological parameters will be selected, determined, and evaluated, so that local public health agencies will be able to assess the quality of these products in the future. This assessment will be done on species level, as it is known that these quality parameters are affected by species and rearing system, among others.

To assess the acceptance (and thus practicability) of the project, farmers and consumers will be interviewed in relation to their experiences and expectations with rearing, processing, and consuming these insects resp. their products. Again, this evaluation is done on national level and seeks to pinpoint the (a) safest and (b) most accepted product.

Germany was asked to coordinate the project. Within the consortium, the coordinator is *primus inter pares*, and decisions will be made democratically. Results will be published in many ways, both in scientific, peer-reviewed journals in English and in popular magazines and digital media, in these cases also in Thai, Khmer, and German.

Results:

Key statements and policy advice:

Animal rearing

- Breeding systems for crickets, silkworms and mealworms for small farms have been established. They enable the farmers to breed insects cheaply and to sell the harvest partly to feed their families and partly as a commodity on local markets.
- Silkworms are traditionally kept on frames. The participating cooperative receives silk moth eggs from the government, which become larvae in a community hatchery, which are distributed to the farmers after 10 days, who look after the animals until they pupate. For production, performance parameters have been created that are used to evaluate each run. One cycle takes about 4 weeks.
- In Asia, crickets are held in basins of approx. 2 x 1.5 x 1.5 m on metal frames. The equipment includes egg boxes that enlarge the walking surface, food and water sources,

as well as containers for laying eggs (in the case of breeding colonies). The humidity is ensured by plant material (banana leaves, rice straw sprayed with water). Some farmers, supply drinking water in a plastic pipe system with holes on the top; Cloth cuts act as a "wick" (Fig. 1) and one cycle takes about 10 weeks.

- In Germany, a system based on the Asian model was developed ("IF-Next-TiHo-Krabbelkist"), which is based on 52 litres plastic boxes. The device consists of egg cardboards, bowls for the food and a cut-open plastic bottle, in which a household towel acts as a "wick" for water (Fig. 2). This gives the crickets continuous access to drinking water without the risk of drowning. One cycle takes about 10 weeks.
- Mealworms are kept in commercially available stairs. The equipment consists of wheat bran, green fodder and some egg cardboard. One cycle takes about 8 weeks.
- The feeding of the silkworm consists of mulberry leaves and cannot be changed because the species is monophagous. Crickets and mealworms are omnivorous, but in the project they are supplied with concentrate feed for poultry and green fodder. The concentrates are actually the true cost factor, as the green fodder is either collected and fed on site, as in Asia (including plants that are invasive) or, as in Germany, from vegetable and fruit cuts from the cafeteria or a supermarket. Both food sources are free. In Cambodia, combinations of cassava top plants and cassava root flours have also been experimented with, and one combination seems very promising.
- The growth curves of crickets and mealworms in Germany were characterized. Three different patterns were recognized for crickets that affect the performance of the passage.
- As a by-product of insect breeding, "frass" refers to the sum of faeces, food and moulting residues and any animals that have died. For every 250 g of crickets harvested, there is an average of 530 g of frass.
- As expected, the insect species had a high influence on the breeding.
- In Cambodia, neighbors of the participating farmers have now adopted the IF-Next breeding system. The participating farmers have signed a contract with the concentrate supplier, where they get a discount on their feed purchases, and the supplier acts as a middleman for their crickets.

Animal health

- The farms were repeatedly attacked by flies and phoretic mites that enter the farms with the green fodder. They can be successfully combated by traps and special hygiene management.
- In Thailand, suspicious deaths were molecularly examined for the occurrence of the *cricket iridovirus*; The technique corresponded to the specifications from the literature, but the samples were negative.

Analytics

- Standard sets for checking the microbial and chemical-compositional properties have been established.
- From a microbiological point of view, the classic pathogens such as *E. coli, Staphylococcus aureus*, salmonellae, and listeriae were not detected. Nevertheless, as expected, high bacterial counts occurred in raw insects, which, however, can be effectively reduced by cooking. It remains to be seen whether this sterility will also persist in dried flours.
- From a chemical point of view, there were, as expected, high protein contents (between 50 and 70%, all chemical information on dry matter basis) and interesting amino acid

profiles. Nitriles (in the cassava feed trial), heavy metals and mycotoxins were not detected.
- The individual results varied not only according to the species, but also with the feeding.
- Frass is characterized by high bacterial counts, but also high protein (up to 23%) and ash values (up to 20%) and thus a valuable by-product, e.g. as a fertilizer.

Culinary
- As part of a questionnaire, consumer habits and preferences were queried in all three participating countries. A variety of innovative insect-based products were presented as potential novel foods, and insect meal was the favorite choice everywhere.
- Initial experiments are working with insect homogenates (including flours) as the basis for spicy crackers or noodles.

Consumption habits
- The analysis of the questionnaire with regard to consumption habits resulted in a complex, country-specific picture. Insect consumption is still not very widespread in Germany, although the benefits are well known. Insects are often eaten in Cambodia, but people are not certain about the benefits. Insects are less commonly eaten in Thailand and the benefits are largely unknown.
- There are also differences in gender, age and lifestyle in rural and urban areas.
- In Thailand, the home and residence province were also queried. Here, too, a complex picture emerged, which shows that insect consumption is practiced and assessed differently from region to region.

Key statements and policy advice:

- Farming beneficial insects in small farms is a valuable addition to any agricultural practice. The success depends on how well locally (and cheaply) available elements for rearing and breeding (species, building material, feed) can be used. Constant contact with the farmers is also necessary in order to be able to react quickly to problems.

- Traditional treatment and processing must be re-evaluated for its efficiency under today's conditions in order to be able to continue to produce safe food. This is all the more true for novel products such as insect flours.

- In Asia, too, there are different proportions of the population who do not traditionally eat insects. With the use of homogenisates, access to insects is made easier for those who disdain them because of their appearance.

- The system developed within the framework of IFNext is universally applicable if it is adapted to the respective local conditions. In this respect, follow-up work in other regions with a similar climate is just as conceivable as the adaptation of the breeding of other arthropods, which are also commercially successful, in the same climate as Thailand or Cambodia.

Fig. 1: View into a cricket container in Thailand; the blue plastic rectangles are the drinking water dispensers. Photo: Grabowski

Fig. 2: Water bottle of the IFNext-TiHo Krabbelkist Photo: Trögel.