GREEiNSECT study trip:

Cricket production in North-Eastern Thailand

February 22nd-26th 2015

Back: 1.Alan Yen, 2. Philistine Tieli, 3. Jackie Oloo, 4. Charles Odira, 5. John Kinyuru, 6. xx 7.Lach Thea , 8. Paul Vantomme, 9. Choon Chamnan, 10.xx, 11. Paul Vantomme, 12. Sutham Sribunrueng, 13. Petch Wongtam, 14. Annette Bruun Jensen, 15. Yupa Hanboonsong, 16. Søren Bøye Olsen, 17. Nanna Roos, 18. David Kamukama, 19. Gabriela Maciel Vergara, 20. Godfrey Bwogi. 21. Farmer. Front: 1. Kennedy Pambo, 2. Mary Orinda, 3. Dorothy Muguru, 4. Victor Owino, 5. Evans Nyakeri, 6. Roberto Flore , 7. Afton Halloran, 8. Paiboon Kammoolanat, 9. Farmer, 10.Natasja Gianotten , 11. Tasanee Jamjanya

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Background

Khon Kaen University (KKU) has conducted research and offered extension services and training in farming of crickets for human consumption since 1998. The sector has grown rapidly and currently there are more than 20,000 registered insect farmers in Thailand, mostly in North-Eastern Thailand with Khon Kaen as the center. A complete value-chain has developed over the years - from producers to food processing companies. At KKU, the research and development activities were pioneered by Dr. Tasanee Jamjanya and Dr. Yupa Hanboonsong, leading the development of the present production system that have since been adapted by farmers. Dr. Yupa Hanboonsong is an international partner in GREEiNSECT. She supports GREEiNSECTs Kenyan partners by providing opportunities to learn from the established cricket farming sector in Thailand. The GREEiNSECT study trip was therefore organized for the project partners and Ph.D. students in Kenya and University of Copenhagen. In Kenya, GREEiNSECT has collaborated closely with the project Flying Food (FF). FF aims to disseminate cricket production to small-scale farmers in Kenya and Uganda with support from private stakeholders and public funds in the Netherlands. The FF partners from Kenya and Uganda were invited to participate in the GREEiNSECT study trip to gain mutual and optimal benefits from this unique learning opportunity. The FAO also participated as an international partner, and representatives from the Rome office (Paul Vantomme) and the regional office in Bangkok (Patrick Durst) were present. Dr. Alan Yen from La Trobe University, Australia and Chief Editor of the new Journal of Insects as Food and Food joined the study group as a resource person. Roberto Flore from Nordic Food Lab, University of Copenhagen participated as a resource person in insects in modern gastronomy.

The programme for the tour was organized by KKU together with the GREEiNSECT management. The programme included on-site visits and activities that were a part of the value-chain such as cricket farmers, cricket traders and markets. Entrepreneurs developing business models for cricket products oriented towards export markets were also included in the programme.

Acknowledgement

On behalf of the participants of the GREEiNSECT study tour, I wish to thank Drs. Yupa Hanboonsong and Tasanee Jamjanya for warmly welcoming the team in Thailand. From their personal involvement and engagement in developing a cricket rearing sector in Khon Kaen, they shared their insightful and invaluable experience as well as their knowledge. They have played such an important role as a significant source of inspiration for the developing edible insect sector in Kenya. Their commitment serves as a model for how we can transfer science into action.

Nanna Roos
GREEINSECT Principal Investigator
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Photos in this report were taken by: Nanna Roos, Afton Halloran, Paul Vantomme, Alan Yen, Søren Boje Olsen, Annette Bruun Jensen

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Participants

A total of 28 participants were signed up for the study tour. Two GREEiNSECT participants and one additional participant had to cancel their participation due to complications in their visa applications.
List of participants:

Name (Last/First)	Affiliation	Nationality	Position
Afton Halloran	GREEiNSECT/ UCPH	Canada	PhD Fellow (Department of Nutrition, Exercise and Sports,(NEXS), University of Copenhagen)
Annette Bruun Jensen	GREEiNSECT/ UCPH	Denmark	Department of Plant and Environmental Sciences (PLEN), University of Copenhagen
Dorothy Muguru	GREEiNSECT/ TUK	Kenya	PhD Fellow (Technical University of Kenya)
Evans Nyakeri	GREEiNSECT/ JUOOST	Kenya	PhD Fellow (Jaramogi Oginga Odinga University of Science and Technology (JUOOST)
Gabriela Maciel Vergara	GREEiNSECT/AgTrain UCPH	Mexico	PhD Fellow (Department of Plant and Environmental Sciences (PLEN), University of Copenhagen)
John Kinyuru	GREEiNSECT/ JKUAT	Kenya	Jomo Kenyatta University of Agriculture and Technology
Mary Orinda	GREEiNSECT/ JUOOST	Kenya	PhD Fellow (Jaramogi Oginga Odinga University of Science and Technology (JUOOST)
Mohammed H Alemu (cancelled due to visa complications)	GREEiNSECT/ UCPH	Ethiopia	PhD Fellow (Institute for Food and Ressource Economics (IFRO), University of Copenhagen)
Monica Ayieko	GREEiNSECT/ JUOOST	Kenya	Jaramogi Oginga Odinga University of Science and Technology (JUOOST)
Sunday Ekesi (cancelled due to visa complications)	GREEiNSECT/ Icipe	Nigeria	International Centre for Insect Pathology and Ecology (icipe)
Komi Fiaboe (cancelled due to visa complications)	INSFEED/ Icipe	Togo	INSFEED Coodinator, International Centre for Insect Pathology and Ecology (icipe)
Victor Owino	GREEiNSECT/ TUK	Kenya	Technical University of Kenya (TUK)
Paul Vantomme	GREEiNSECT/ FAO Rome	Belgium	Food and Agriculture Organization of the United Nations (FAO), Rome
Nanna Roos	GREEiNSECT/ UCPH	Denmark	Department of Nutrition, Exercise and Sports (NEXS), University of Copenhagen
Søren Bøye Olsen	GREEiNSECT/ UCPH	Denmark	Institute for Food and Resource Economics (IFRO), University of Copenhagen
Chhoun Chamnan	GREEiNSECT/ Cambodia	Cambodia	Department of Fisheries Post-Harvest Technologies and Quality Control, Ministry of Agr., Fish., and Forestry, Cambodia
Yupa Hanboonsong	GREEiNSECT/ KKU	Thailand	Khon Kaen University

Charles Odira	Flying Foods	Kenya	Mixa Food and Beverages
David Kamukama	Flying Foods	Uganda	Interchurch Organization for Development Cooperation
Godfrey Bwogi	Flying Foods	Uganda	Masaka District Local Government
Kennedy Pambo	Flying Foods	Kenya	PhD Fellow (Technical University of Kenya)
Natasja Gianotten	Flying Foods	Netherlands	Jagran
Philistine Tieli	Flying Foods	Kenya	Anglican Development Services – Nyanza
Jackie Oloo	Flying Foods	Kenya	Jaramogi Oginga Odinga University of Science and Technology
Patrick Durst	FAO-RAP	USA	Food and Agriculture Organization of the United Nations - Regional Office of Asia and the Pacific
Roberto Flore	Nordic Food Lab, Copenhagen	Italy	Head Chef, Nordic Food Lab
Lach Thea	Ministry of Agriculture, Fisheries and Forestry	Cambodia	Department of Fisheries Post-Harvest Technologies and Quality Control
Alan Yen	Department of Environment and primary industries	Australia	Department of Environment and Primary Industries

Programme

February 22 Arrival in Bangkok, group dinner

February 23 King Bhumipol's Sufficient Economy Demonstration Site
Invited visit at 'The Mae Fah Luang Foundation' (MFLF), a non-profit organization for rural development under Royal Patronage.
Invited visit to the FAO Regional Office of Asia and the Pacific
Transfer to Khon Kaen

February 24 Visit cricket farms in Nampong village.
Invited lunch with village leader and families. Round-up discussions
Visit King Cobra Village and return to Khon Kaen

February 25 Market and Processing
Visit Mahasalakam cricket trader, including a processing demonstration
Visit a farmer group of silkworm business
Kam Hai market (vendors selling a variety of insect products)

February 26 Entrepreneurship
Khon Kaen University Business Incubator: BI (Centre for Entrepreneurship)
Visit "Bann Kanom," shop making traditional Thai sweets under BI network
Presentation on OTOP (One Tambon, One Product), as well as the Sufficient Economy model
Visit the students Edible Insect Club: Cricket farm at Entomology Division, Khon Kaen University
End of tour

February 27 Flights home

Monday, February 23rd: Rural development in Thailand

The first day of the study tour was held in Bangkok. The programme covered visits to rural development activities supported by the Royal Family and a visit to the FAO Regional Office of Asia and the Pacific. The purpose of these activities was to get an introduction to some current and historical aspects of cricket farming in the context of rural development in Thailand.

Visit at The Royal Chitralada Project (King Bhumibol's Chitralada Palace)

The GREEiNSECT group participated in a guided tour to visit the demonstration facilities of the Royal development activities in various agricultural and industrial technologies. The visit provided an introduction to the cultural context of rural development in Thailand, which has been supported by Royal family over the course of many generations. Royal support for improving livelihoods in villages and rural areas has resulted in thousands of development projects in the country and engagement in rural development. The demonstration site do not yet include cricket farming technologies.

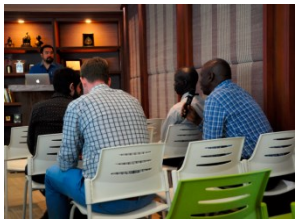



1-2. GREEiNSECT group at The Royal Chitralade Project. 3. Among the demonstration projects was dairy production. An early development aid project in the 1960s sponsored by Denmark introduced dairy production in Thailand. 4. Demonstration of mushroom production

Visit to Mae Fah Luang Foundation

Following the tour at the Royal Palace, the group was invited for lunch at the Mae Fah Luang Foundation, a development organization under Royal Patronage.





1. Dr. Kanok and Dr. Yuoa Hanbongsoong. 2-3. Mr. M.L. Dispanadda Diskul present the mission and activities of Mae Luang Faóundation

The visit was hosted by Dr. Kanok, Advisor - Ministry of Agriculture and Cooperatives, and Deputy Chief Executive Officer M.L. Dispanadda Diskul presented the history, mission and activities of the organization. Mae Fah Luang Foundation's development approach was presented for inspiration and as an introduction to the Thai culture and history for rural development. Mae Fah Luang Foundation was founded on the vision of providing people with sustainable livelihoods. It was first developed in 1988 through the work of the Doi Tung Development Project in Chiang Rai, following the initiatives of HM King Bhumibol and HRH the Princess Mother to tackle poverty and lack of opportunity for rural people with an emphasis on people-centric development assistance sensitive to socio-geographical contexts. The development projects integrate health, livelihood, and

education to effectively solve complex development issues. Through decades of work, this development approach by the Mae Fah Luang Foundation has evolved and has been implemented in several domestic and international extension projects. Along with the outreach projects, the Foundation promotes the practical experiences through the "Living University" where individuals and organizations from various sectors visit to learn about the development approach and apply to their problems and locations. A small project including cricket farming is currently being implemented in Northern Thailand.

Visit to the FAO regional office for Asia and the Pacific

The GREEiNSECT group was invited to the FAO Regional Office for Asia and the Pacific in Bangkok. Assistant Director-general and regional representative Dr. Hiruyuki Konuma welcomed the group and presented the mission of FAO in the region. Senior officer Patrick Durst spoke about the long-term involvement of FAO in documenting the importance of edible insects in South-East Asia, and the FAO's support to develop cricket farming in Thailand and Laos PDR.

Dr. Hiruyuki Konuma warmly welcomed the GREEiNSECT group to the FAO regional office and shared the mission and actions taken to support food security in the countries in the region.

The group had the opportunity to discuss and share views about the future potential of insect farming for food security.

After the end of the programme of Day 1, the group transferred to Khon Kaen.




1. Transfer from Bangkok to Khon Kaen. 2. Dorothy Muguru and Mary Orinda. 3. Gabriela Vergara and Jackie Oloo. 3. Annette B Jensen and Natasja Gianotte.

Tuesday, February 24th: Cricket farming in Khon Kaen

The group visited cricket farmers operating in Khon Kaen Province. Our guides and hosts: Dr. Yupa Hanboonsong and Dr. Tasanee supported by Khon Kaen University students. Location: Baan Saento village, Nampong District, Khon Kaen Province

Drs. Yupa Hanboonsong and Tasanee Jamjanya shared their experience from 20 years of developing and disseminating cricket farming to farmers in the region. Assisted by KKU students to guide the GREEiNSECT group.

The village of Baan Saento is located in Khon Kaen province, approximately 40 km from Khon Kaen University. About half of the households in the village have a total of 100 cricket pens. Cricket farming in this village began seven years ago.

Farmer 1

1. A farmer, more than 80 years old, shared his knowledge and experience. 2. The rearing facility

One of the farmers owning and managing a cricket farm was over 80 years old. He has took up cricket farming to become economically independent of his family. The low investment and short production cycle suited his life situation. The workload from managing the crickets was light and easy for him. Cricket farming was conducted in a facility built as an extension on the main house (photo above). Two species, *Acheta domesticus* and *Gryllus bimaculatus*, were reared alternately as recommended by Khon Kaen University. The farmer preferred to farm *Gryllus bimaculatus* because of the shorter production cycle and higher price, but alternated to prevent diseases.

Housing and rearing facility

Two cages (pens) size 3 x 2 x 0.5 m. The cages were made of concrete. The sides of pens were covered by netting material. The top of the cage was covered by netting to prevent predators, for aeration, and prevent crickets from escaping. The netting material on the top of the cages was supported by wooden bars. A strip of plastic material inside the upper edge of the concrete pens to prevent crickets from crawling out (red material

in the photo above). The two pens were sheltered under a simple housing construction with a roof made of normal iron sheets, and ceiling and sides to be covered by normal mosquito netting.




1. Farmer 1 pens; 2. Mature *Gryllus bimaculutas;* 3. Ovipositioning in egg bowls. 4. The GREEiNSECT group collects information

Management

At the time of the visit, the farmer was rearing field crickets (*Gryllus bimaculatus*). The crickets had reached maturity and on the day of the visit egg laying bowls were placed in the pens.

- Egg trays used as hideouts covered most of the bottoms of the pens with only narrow passages between (see photo).
- The farmer used flat plastic plates for drinking water and feed. Feeding and watering trays were placed on top of the egg trays (see photo).
- Egg trays placed on wooden strips allowed droppings to fall to the ground. Farmer used 600 egg tray hideouts per cage/ pen (approximately 100 egg trays/m^2)
- On the day of the visit, 15 egg bowls were placed in along the side of the pen (smaller bowls as seen in the photo above). The egg laying substrate contained coconut ash, fibres and rice husk ash.
- Mature crickets were allowed to lay eggs for only one day before they are harvested for the market because females with eggs are tastier and weigh more, so only sufficient eggs for a new cycle were collected.
- The farmer estimated that 15 egg bowls would produce 50 kg of adult crickets.
- Eggs take 7-9 days to hatch. The Period from hatching to maturity/ harvesting is 35- 38 days (*Gryllus bimaculatus*)
- Rearing was done under the prevailing weather conditions. The time of the visit occurred during the cold season, and productivity was below peak season.
- Predators (of crickets and the feed) were kept away by covering the housing with side netted walls, and covering the pens with nets.

Feeding and watering:

- The farmer fed 21% protein commercial chicken or cricket feed during the first 21 days of nymphs ('pin heads'), then switched to 14 % protein chicken or cricket feed for the remaining period until a week before harvest.
- A week before harvesting the feed was changed to pumpkin in order to clean the gut and improve taste.
- The feeding and watering frequency increased as the crickets grew. Nymphs were fed a maximum of once a day and their water was changed few times per week. When harvesting approached, feed and clean water was provided morning and evening.

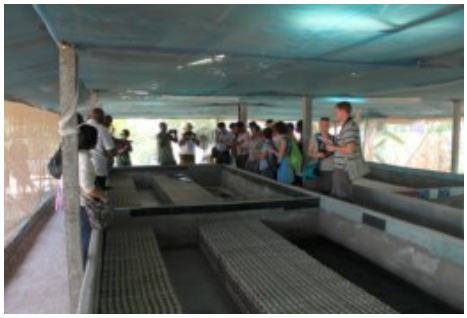
Economy:

- Cost of feed for a production cycle was 2,000 Baht (20 bags of feed, 30 kg/bag – total 600 kg). During the previous cycle, the farmer sold the crickets for 50,000 Baht (500 US$)
- Cleaning was done only once at the end of the cycle. Waste from the crickets droped to the bottom of the pen through the egg trays. Chalk/ lime was applied between rearing cycles for cleaning
- After harvest, the egg trays are removed, cleaned and dried in the sun and renewed if damaged. The trays can be reused for several production cycles.

Farmer 2 – Paiboon Kannolanat

Cricket farmer Paiboon Kannolanat

The farmer had taken up cricket farming as a secondary activity to agriculture because it requires little work and the investment and sale be simple. He found the workload easy and less difficult than farming. The investment was quickly returned, and the economy of a production cycle was simple. He knew how much feed he needs to buy and approximately how much he can earn. His construction was larger than farmer 1 (8 larger pens measuring 3 x 5 x 0.5 m in two rows).



1. The larger pens at farm 2 were not covered by nets. The ceiling and wall were netted to prevent predators from invading. 2. Pens were recently stocked with eggs, covered with polyethylene material. Two rows of egg trays in place. A third to be positioned after hatching.

At the time of the visit, the site had recently been harvested. The total harvest for all six pens was 300 kg of *Gryllus bimaculutus*. In the hot season, the harvest was reported as 500 kg. He reared some house crickets (*Acheta domesticus)* in a newly started production cycle. Crickets were at two stages of development: eggs and nymphs (pin heads). Eggs were spread on the floor and covered by polyethene paper for warmth.

Housing and rearing facilities

The house was enclosed with netting with verandah covered extensions covered with side nets. The roof was made of normal iron sheets and the cages made of concrete material. The top of the cages were not covered by mosquito netting. The top edge of each cage was lined with a slippery material to prevent crickets from escaping.

Management

Acheta domesticus were placed in the pens. The photo below shows how the egg legging material from the egg bowls with eggs was spread on the bottom of the pen and covered lightly by a black polyethylene material to secure stable temperature and humidity to hatch.

- Egg trays served as hideouts. Farmer used 1500 egg tray hideouts per pen (100/m^2). The trays were placed in rows with space between (see photo). Egg trays are used to the end of the cycle after which they are removed, cleaned and dried. Damaged egg trays are replaced by with new ones. Each tray can be reused for several cycles.
- The eggs hatched within 11-14 days and 25 egg bowls were used for one pen. The farmer expected to harvest 130 kg of crickets per pen.

In 3 pens, the eggs were stocked some days earlier and already hatched to nymphs. The nymphs were fed chicken starter feed on a sheet of plastic material on top of the egg trays. The water was provided in standard chicken dispensers. At this stage, very little management was needed. The water dispensers were only refilled weekly and fed when needed.

1. Substrate with eggs for hatching, covered by a piece of plastic cloth for keeping a stable temperature and humidity. 2. Substrate with egg. There is no formal way to count eggs in egg bowls. It is based on experience to judge the density and quality of eggs.

The stocking density in the pens was solely determined by the number of egg bowls applied. When questioned how he knew if the density was correct, the farmer explained that the number of egg bowls was sufficient for the pen. If he had an impression of overstocking when the crickets grew, he could remove some by hand. There were no formalized estimate of the numbers of cricket successfully hatched in a pen. A common estimate that the farmers make is that an egg bowl contains 1000 eggs. The farmers build up their own experience with how many egg bowls to use per pen.

1. 1500 egg trays in a pen. 2. Feeding nymphs/pin heads. 3. Water dispenser with nylon cloth to prevent drowning.



1-2. The smooth non-sticky material around the upper edge to prevent crickets (nymph to adults) from escaping. 3. Different non-sticky material used on the edges of the pens.

When questioned about what was the major constraint to beginning cricket farming, the farmer clearly stated that access to high-quality eggs was essential. Inbreeding was a problem, so it was not possible to continue to self-supply the egg bowls by transferring from production cycle to production cycle. In the village, they were able to exchange egg bowls between cricket farmers. Cricket farmers, therefore, were dependent on being close to other producers and to be in a community with a willingness to cooperate.

Feeding and watering:

- Feeding on 21% protein chicken feed for first 21 days of nymphs, shifting to 14 % protein chicken feed for the remaining period. The farmer did not report problems in switching from the high to low protein feed.
- Feeding containers for nymphs were pieces of sacks cut in pieces of approximate 40 x 40 cm. The feed was placed on the piece of cloth (see photo).
- The farmer used chicken water suspensors lined with nylon cloth material. Water was changed every two weeks for pinheads and daily or weekly for adults depending on the quantity of droppings/dirt in the water. The practice of using nylon cloth in the water dispensers is no longer recommended by Khon Kaen University because it was observed to cause harmful bacterial growth when not regularly changed and cleaned. It was previously suggested as a means of preventing the nymphs from drowning. This farmer has continued the practice and says that it works well in his production.
- One week before harvesting, the farmer changed the feed to pumpkin to clean the gut and the improve taste.

Production and economy

- The egg laying substrate used was a mixture of coconut ash, fibres and rice husk ash. This composition was based on experience. The farmer used 25 egg bowls per cage (5/m^2), a little less (20) in the cold season, and up to 40 bowls in the peak hot season. This stocking intensity of 25 bowls is expected to translate to 130 kg of adult crickets at maturity (appr. 5,2 kg cricket per egg bowl).
- The harvest from all pens was between 300- 500 kgs of adults per cycle according to season
- The period from hatching to maturity/ harvesting is between 35- 38 days. Rearing is done under the prevailing conditions of temperature and humidity.
- After each harvest, the pens are emptied for waste/droppings and completely cleaned. During the production period no cleaning or removal of waste was carried out.
- The farmer used 60 bags of feed each weighing 30 kg for a production cycle. The feed was composed of 21% protein.
- Mature crickets were allowed to lay eggs for only one day before they were harvested for market. Then more eggs were retained in order to increase the weight of the crickets to be sold as well as quality since eggs are perceived as tasty.

- The previous cycle earned 70,000 bhat for a harvest of 300 kg. This exceeds the common price for crickets of 100-120 bath/kg, and the noted earning may cover two or overlapping cycles.

Farmer 3 Petch Wongtam



1. The village leader Mr Petch Wongtam owned the farm and also used it as demonstration site for other farmers. 2-3. The GREEiNSECT team was warmly welcomed. The welcome sign acknowledged the 15 nationalities represented in the group.

Production facilities

The rearing facility was similar to farmer 2, with concrete pens in two rows in a housing unit composed of a hard roof and covered by a ceiling and walls of mosquito netting. The facility was placed in the center of the village and the farmer also opened his farm for demonstration to new insect farmers. The success in insect farming was dependant on a certain density of farmers that were willing to support each other by sharing experiences and also to exchange eggs for avoiding inbreeding. The pens were stocked with *Gryllus bimaculutus* in hatching and growth stages.

Housing and rearing facilities

- This housing unit was the largest of all of the farms that we were able to visit. It was netted in a similar way to the other farms. The housing roof was made of normal iron sheets. Floor cemented with rough concrete.
- The pens were made of concrete material. The top of the cages were not covered by mosquito netting. The edge of each cage was lined with a slippery material to prevent cricket escape.
- Egg trays were used as hideouts. Egg trays were used to the end of the cycle then after they are removed, cleaned and dried.
- Predators were kept away by side-netted walls.
- Between production cycles, the pens were cleaned with chalk/ lime. No pesticides or other chemicals were reported to be used.


1. Farmer 3 facility. 2. Feed cricket feed 21% (starter) and 21% (grow out)



1. Feeding tray. Top of a green plate: a small piece of wood to allow the small crickets to enter tray as 'stairs'. The farmer was concerned that the young crickets learn to enter the feeding tray. 2. Waste (frass) collected from the pens after the end of a production cycle was used as fertilizer. 3. Waste used for fertilizing bananas. The farmer experience was that it was very suited as fertilizer for his bananas.

Management

- Similar to the other farmers visited he was feed the crickets 21% protein chicken feed for first 21 days of larvae, and 14 % protein chicken feed for the remaining period.
- A week before harvesting, the feed changed to pumpkin in order to clean the gut and improve taste.
- The farmer used flat poultry drinkers lined with nylon cloth material. The water is changed every two weeks for nymphs/pinheads and daily or weekly for adults depending on the quantity.
- Feeding containers were flat plastic bowls. The farmer placed small wooden sticks as a bridge to feeding bowl and hiding tray. This encouraged the crickets to learn to eat from the feeding trays.
- Adults were allowed to lay eggs for only one day before they were harvested for the market.

Economy

- The farmer collected 3-4 bags of droppings per cage which he sold at 50 baht per bag each weighing 30 kg
- The period from hatching to maturity/harvesting was 35- 38 days. Rearing was done under the prevailing conditions of temperature and humidity.
- The farmer reported that he earned 70,000 bhat for all pens in the previous production cycle.

Farmer 4

A female farmer rearing a smaller facility. Sided by Prof. Dr. Yupa Hanboongsong, KKU.

Housing and rearing facilities

- The housing was made of wooden posts and roofing made of corrugated iron. The ceiling was covered with plastic sheets. The pens were smaller than those on the other visited farms - 2 x 3.5 m (7 m2 per pen).

- The pens could be covered by a net that could be rolled to the side of the pen for inspection and feeding (blue material on photo). Similar to other pens, a line of smooth material efficiently prevented the crickets from escaping the pen. This technology appears to be efficient as none of the farmers mentioned any problem of loss of crickets due to escape.
- There pens were equipped with egg trays similar to the other farms visited.

Management

The pens were stocked with *Gryllus bimaculatus.* The crickets were mature as demonstrated by a high pitched sound from the crickets. Notably, the pens were completely free of smell, also at this stage of the high density of mature crickets. Egg bowls were placed in pens during the following night for eight hours to harvest eggs for next cycle. The crickets would only lay eggs when bowls are in place, not in the egg trays. The farmers only let the crickets lay enough eggs for a new cycle. After removing the egg laying bowls a few hours later, the crickets retained an amount of eggs which increased both the weight and the quality of the harvest. A cricket full of eggs is appreciated for good taste.
- In this facility, the feeding places consisted of pieces of sacks bordered with wooden sticks. Water was provided in both chicken dispensers and flat plates. Feeding and watering was both on the floor of the pen and on top of the egg trays. The farmer explained that this was better because some crickets would stay on the floor and others feed on the top.



1-3. Mature field crickets (*Gryllus bimaculatus*). Feeding and watering on trays as well as in chicken dispensers and some feeding directly on the floor. Farmers explained that some crickets would feed on the floor and others in the trays. By securing good access to feed they would grow better.

Summary points cricket rearing

The folllowing summary points are based on the observations and information gathered during the visits to the farmers and the following meeting with the village families. The village invited the group for a delicious lunch with traditional dishes and hosted a plenum discussion where the GREEiNSECT visitors could ask follow-up questions.

Management

- The crickets were reared on rotational basis rotating between house cricket and *Gryllus bimaculatus* to reduce diseases and avoid inbreeding. However, farmers expressed they preferred *Gryllus bimaculatus* due to faster growth and better market price.
- The market consisted of 30 buyers/middlemen who came to the village when called upon by a farmer who was ready to harvest.

- The price was set by the buyers and determined by supply and demand.
- Farmers were not scared of new farmers entering the market as the demand is still high. The village now has 67 cricket farmers. They express that they are not in a strong enough position to bargain for higher prices from the buyers.
- The farmers are dependent on that there are many farmers concentrated in the village. The farmers exchange experiences with farming, and most importantly, they can exchange eggs to refresh production and avoid inbreeding. They have observed that the crickets get smaller if not refreshed by the exchange of eggs.
- At the site where the lunch and meeting was held, a container with crickets (*Gryllus bimaculatus*) was kept with crickets found and collected in the wild. These were used for renewing the gene pool. An exact description of how the decision and procedure for renewing the cricket population was not available.
- There was a clear seasonal variation in production and the farmers adjust the production. During summer, crickets grow faster than in winter, due to low temperature during the winter.

Common mistakes by new farmers

During the plenum discussion different common mistakes were brought up:
- Keeping good hygiene in the pens was essential to avoiding diseases and poor growth. Careful cleaning between production cycles is essential. Frequent reuse of the netting used to cover the pens was a common problem that could become a source of infection.
- The breeding problem was mentioned as a general problem. Exchange of eggs with others/ buying from others is necessary for successful production. If the population was not refreshed the farmers observed reduced growth within a number of generations (not stated how many).
- Open housing was better than closed housing because it ensures proper aeration and an easy working environment. Covering with nets was essential to avoid predators.
- However the housing design was based on the space available and therefore the farmers visited by the group had different facilities.




1. Plenary discussion facilitated by Dr. Yupa. 2-3. Lunch prepared and hosted by village members, a cheering occasion for inspiring interaction and learning about the village community.

Possible areas of improvement:

- The farmers considered the possibilities for market expansion in the future and if the market can be diversified through product development and the possibility for international markets.
- Feed is the major expense in the present management. Some farmers experimented with local feed sources and it was expressed that local production of feed at a low cost would be a major advantage.

Important for good management:
- Keeping the pens clean was reported by all farmers to be important. The pens needed to be cleaned carefully between production cycles. Any improvement in management practices that can reduce risk of diseases and poor environment was welcomed.
- Keeping the drinking water clean was very important. Farmers used different watering containers and had different experiences. If a farmer experiences problems with productivity, then the water quality should be carefully inspected.
- Rotation between the two species was considered important, but the farmers would prefer *Gryllus bimaculatus* because of faster growth and better price. Alternative species could be advantageous in the future.
- The gender of the cricket population is dependent on the prevailing environmental rearing conditions. Favorable conditions promote the emergence of females and unfavorable conditions favour males. Since females are preferred both for egg laying and because crickets with eggs are considered tasty and preferred, the farmers are motivated to keep a healthy growth environment. Overpopulation of males can be used as an indication of that something in the management and production environment can be improved.
- Predators of crickets: Farmers experienced problems with lizards, ants and snakes. Covering either the house or the pens – or both – is essential.

Summary points in economy and livelihood

Why is cricket farming more successful than many other introduced agricultural productions?
- Farmers express that it is easy to do and more profitable. The investment and sale of the crickets was simple. It was mentioned several times that it is was very simple to keep track on inputs and income. Production cycles are short, so investment is quickly returned. The production can be discontinued for a period of other activities, for example harvest or important celebrations, and then quickly reestablished by stocking and initiating a new production cycle. Each production cycle is a closed economic cycle.
- Cricket farming is not labour intensive and can be done along with other activities. Cricket farming is typically an additional activity for additional income, or conducted by elderly people so that they are not dependent on family support. People, for example, returning from work in Bangkok without access to cultivated land can easily take up cricket farming if they have access to just a small space near a house.

The cricket market from farmers perspectives
- Crickets mainly feed on commercial feeds for most of the rearing period and weaned on green or yellow vegetables (pumpkin, pumpkin leaves, cassava leaves and fruit) in the last few weeks to clean the gut, alleviate any bad smell and improve the taste. The vegetable residues used for cricket feed must be free of insecticides.
- Feed was the highest cost. To reduce production costs, local feed formulation based on local feed ingredients is being considered, and some farmers in the plenum discussion indicated that they were in the process of a formulation.
- The cricket market is a chain production where some do production (farmers), others marketing, some packaging. Farmers expressed that control over more of this chain would improve their earning.
- Marketing strategies needed: The farmers hoped for creating awareness and promotion in youth and school children to secure the future expansion of the market and to make room for more farmers without compromising the price that the farmers received. They already experienced slightly decreasing prices.

- They hoped for new markets, packaging and product development to reach new consumers in the future.

How does cricket farming impact on the farmers lifestyles in the village?

- The farmers and villagers expressed that cricket farming has not substantially changed their food consumption habits. Crickets are mainly considered a form of snack (this is a perception and not supported by data on consumption).
- The farmers unambiguously reported that cricket farming has generated more income for the families. In particular, it is mentioned that it can lessen the dependence of elderly parents on their children because elderly with a small house and without cultivated land can farm crickets. The low investment and short production cycle (fast return of investment) was considered attractive. It was mentioned several times that the simplicity in the investment and return made it easy to start and to make an income. The general impression was that the introduction of cricket farming has contributed to improve his livelihood. Other economic factors cannot be left out from this perceived gain from cricket farming.
- Prospects of farming other insect species:

The farmers expressed that they considered if other insects could be reared, for example,grasshoppers that are collected from the wild. KKU has not promoted grasshopper/locust rearing because of risk of turning into pests in the case that they escaped.

The farmers also expressed that rearing bamboo worms could contribute to a new income source. Bamboo worm were attractive because they were regarded as 'beautiful', 'clean' and to have good taste and farmers, therefore, considered them as a future possibility.

Wednesday, February 25th: Insect processing and trade

Cricket wholesale and trading – processing site

To get an insight into the next step of the value-chain following the primary producers, the group was invited to a middleman enterprise by business owner and cricket trader Mr. Kun Pichip. The site was located in Maka village, Kantaravichai district, Machasaraleham province. The owner kindly hosted the group, demonstrated his processing of crickets for trade and shared his experience and view on the cricket sector now and in the future.

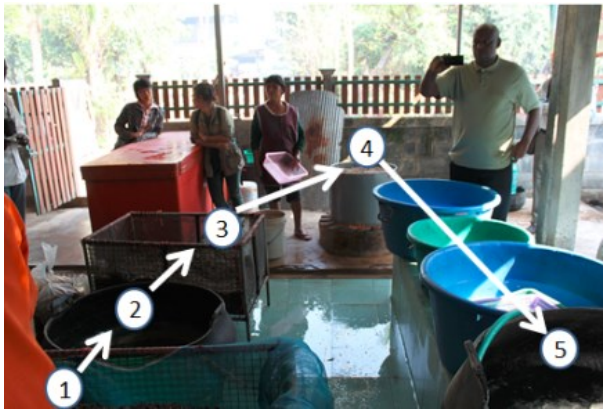
The GREEiNSECT team arrived when a batch of freshly harvested cricket had just arrived at the collection center to be processed for further trade and distribution. The group was warmly welcomed by the owner Mr. Kun Pichip. Mr. Picip had 20 years' experience in the business. His supplies came from his network of 200 cricket farmers, mostly in the district nearby the village. A single farmer could deliver crickets as far away as 300 km. The trader demonstrated and explained the steps of cricket processing for trade:



1.-3. Mr. Kun Pichip welcomed the GREEiNSECT team. The facility is an open house with no walls and covered by a roof. A walk-infreeer was installed next to the facility with capacity of freezing 5-6 tons of cricket.

When the crickets were mature and ready for harvest, the farmers contacted Mr. Kun Pichip and announced the day they would harvest their farm. The harvest was conducted early in the morning by removing egg trays, collecting the crickets and packing the live crickets into 5 kg bags and placing the bags on ice. The harvest was conducted very early in the morning so the crickets could be delivered and further distributed the same day. The farmers then transported the freshly harvested crickets to the collection center, cooled them on ice for killing and preserving. The processing began immediately after the farmer delivered the crickets. At the day of the visit, the staff were waiting for the GREEiNSECT group to leave and were eager to start to deliver to their customers in time.

First, a staff member weighed the cricket in the bags delivered and paid the farmer. The owner bought the cricket from the farmer at a price matching the market price of the day. We arrived a morning when he had received cricket harvested from 6 – 8 farmers who delivered a total of 600 kg house cricket and 400 kg from field crickets (total 1 ton). He explained that this delivery was low because of the cold season and that he normally would receive around 1.5 ton.



The cleaning process from (1) freshly arrived crickets cooled on ice; to (2) rinsing in cold water followed by draining (3); then transfer to hot/boiling water (4); and finally rinsing and cooling in 4 batches of water.

1. Fresh crickets after weighing. 2. First rinsing in cold water. 3. Heating/boiling for 5 minutes. 4-5. Cooling and rinsing in cold water four times.

The water for boiling was heated by a gas burner. The temperature was not monitored. The boiled crickets were cleaned again by shifting them four times between water containers filled with cold water. Finally, they were drained and repacked into 5 kg bags, iced and prepared for delivery. The weight of the crickets would slightly increase after the rinsing process due to some retention of water.

1. Cleaned fresh crickets weighed in 5 kg bags for trading. The crickets are sold with a net gain of 10 bath/kg. 2-3. Freezing house with capacity for storing 5-6 tons of crickets at -20°C.

Market

The trader had two categories of customers:

- The first are the local buyers who buy in smaller quantities to distribute to others at the end of the supply chain (eg. food sellers at the local food center stalls, on road sides and sometimes on bikes).
- The second category is middlemen buying larger quantities for import to Laos PDR where the demand is high.

On the day of the visit, the trader bought house crickets from some farmers for 90 Bhat/kg and sold them at 100 Bhat. For field crickets, he bought them at 110 Bhat/kg and sold at 120 Bhat/kg. The profit margin was 10 Bhat in each case (plus a slight surplus from the increase in weight due to the water retention from the cleaning). When we arrived, the trader already had five orders from local customers for a total 500kg of crickets. Crickets that were not sold in the morning of processing were stored in a freezer house at -20^0 C. The crickets were stored frozen for up to one year, without becoming spoiled. The trader experienced the great advantage of capacity of his freezer in times of shortages in supply and demand, and planed to build a second one in future. The storage capacity was about 5-6 tonnes. The cost of operating the cold storage was 7000 Bhat/month.

General aspects of cricket trade and market

Quality control: The trader has no certifications, and the business of trading crickets or other insects was not regulated. No microbiological tests were done to determine the microbial load on the product before distribution. The processing was based on experience and followed general practices for handling of food. Khon Kaen University is currently supporting the establishment of a quality control system.

Price fluctuation: During the hot and rainy season, the price of crickets was lower due to increased supply. Price for house crickets could go as low as 75 Bhat/kg while field crickets stayed a little higher. Years ago, the price of crickets was greater because there were fewer farmers. The price was between 120- 130 Bhat/kg. The demand was high throughout the year. The business of the cricket trader was limited by the supply and he hoped for a future with more farmers and higher supply. On the other hand, he was also worried that the market will be limited and the price will decrease with increased production. Now the demand for crickets remains high throughout the year, for local consumers as well as for middlemen bringing crickets to the market in Laos PDR.



1-2. Roasted and steamed crickets served as snack for the GREEiNSECT team. 3. Dr. Tasanee facilitated a discussion session. Mr. Kun Pichip shared his valuable experience and answered questions about his business.

Production: No extension services were given to the farmer by the trader. The trader visited the farmers he bought from regularly, for example once a year, to see that they kept the production clean and in good condition, and also to have a good relationship with them. On a daily basis he negotiated the price with the farmers and aimed to stay ahead of competition to ensure stable supply from a group of farmers regularly delivering crickets of good quality. He always pays the farmers in cash.
Parallel insect trades: It was observed that the trader also buys silk worms from China. This business was not explored further during the visit.

Silk rearing training center

The group visited a local silk rearing center located in Nong Ya Plong village; Manchakimi District; Khon Kaen. The visit was kindly hosted by centre leader, Mrs. Tonglerd Sonchan.



1. Facility for dying eri silk. 2. Silk processing site. 3. Eri silk production facility.

Silk is traditionally produced in the region and insect rearing is an established traditional practice. There are two silk producing species that reared in this village: A native variety of the species *Bombyx Mori* and the imported species from India *Eri (Samia cynthia ricini)*.




1. Rearing Eri larvae on cassava leaves. 2. Eri cocoons and moths. 3. Dyed Eri silk. 4. Silk cocoons (*Bombyx mori*) being extracted for silk (Roberto Flore).

At the time of our visit, *Bombyx Mori* silk was being processed and *Eri* silk larvae were being reared on cassava leaves.

Processing: After harvesting, the pupa cocoons are boiled to separate the silk from the pupa. This step is done manually. The pupa drops to the bottom of the boiling pot as the silk is gradually removed. One cocoon yields 600 meters of silk and 1kg of silk worms yield 300 cocoons. It takes two hours to completely remove the silk from cocoons on one boil. Once the silk is removed, it is dyed in different colours. The dies come from barks of various trees including mango tree and pradu (Rosewood). Fresh barks from these trees are boiled for one hour to produce the dyes. The local soil is also used to as a dye. After dyeing for two minutes, the silk is boiled for 30 minutes to remove the wax substance and then sun dried. The fabric made from silk (yarn) costs 1500 Bhat per meter and one person working 8 hours a day can make about 1 meter. *Bombyx Mori* silk is finer and better quality compared to Eri. The boiled pupae retained after removing the silk is appreciated for human consumption.

Kam Hai open food market

The group visited the local Kam Hai food market to experience how insects are traded a part of the traditional food market in the region. The insects found traded in the food stands on the evening of the visit were termites (*Termes sp*), giant waterbug (*Lethocerus indicus*), silk pupae (*Bombyx mori*), water beetle (*Cybister limbatus*) and field cricket (*Gryllus bimaculatus*).

1-3. Termites traded among other local foods in portions of mixed eggs, larvae and pupae. 4. Portions of crickets (dark upper left), silkworm pupae (light brown) among portions of small fish wrapped in bananaleaves.

1. Giant waterbug (*Lethocerus indicus*). 2-3. Field cricket from cricket farmer kept live in small pen for freshness. Fed pumpkin (orange pieces). The sales-pen has wheels and can be stored away at night. Crickets were harvested in portions and sold roasted. 4. Water beetles

One food stand traded live reared crickets. The crickets were kept in a small container so the consumer could see they were alive at the time of buying (photo above). The trader also sold roasted crickets ready to be eaten. Keeping the crickets alive at the stand allowed her to prepare only the amount expected to be sold and keep the stock fresh and alive for the following days. The crickets were fed pumpkin.

Thursday, February 26th: Enterpreneurship and business

Business Incubation at Khon Khaen University (KKU)

Dr. Yupa and Prof. Supachai Patumnakul presenting about Khon Kaen University Business Incubator

The group was invited to learn about the initiatives supported by Khon Kaen University to encourage and support the establishment of new businesses. An inspiring and informative presentation about the Khon Kaen University Business Incubator: BI (Centre for Entrepreneurship) was given by Assoc. Prof. Supachai Patumnakul, Vice President for Research and technology transfer, Khon Kaen University.

Business Incubation (BI) was an initiative by the KKU to bridge the gap of lack of research commercialization within the University, low entrepreneurial spirit among farmers, missing link between new business and technology and building of strength and sustainable economy of the country. It is supported by the Commission for Higher Education of Thailand. The first target is the 4th year students and the Alumni of the University. A business incubator is an office or unit that provides services, support guidance as well as promotion of new business based on technology, innovation, creation or knowledge. They have both 'hard' and 'soft' services. Hard services include: low cost office space, infrastructure and facilities, equipment and communication. Soft service include: pre-incubation services-individual screening, developing the product, business planning, mentoring/coaching, training to develop business skills, technology/technical expertise, counselling, market research, access to market, access to funding, legal advice, networking, finance and accounting services.
The University and the individual owns 50% of the intellectual property rights.
Aim: They groom 4th-year students and Alumni to become self-employed and be employers hence grooming business and thriving networks in Thailand.
BI supports ideas with the potential to reach a market. Prof. Supachai Patumnakul emphasised that the interest and skills of the individual, and willingness to hard work, is the key that leads to success and drives the business idea.

Cases from the Business Incubation BI network was presented:

Case 1: Bann Kanom shop- traditional Thai sweets

The shop has been running for three years. It started as a coffee shop and had to close down due to low sales. With help from BI, the owner re-evaluated the business case. He did a benchmark with local bakeries and decided to establish a bakery. Due to support from BI there were prospects to scale up and accelerate the business to open shops in other towns. Currently, he has a staffing capacity of 50 people. Promotion and marketing are a key to the success of the bakery and sweet shop. The proprietor also runs a mushroom and hydroponic vegetable garden at his home. What can be learned? Market assessment is very critical to know what the consumer wants and preferences.



1-3. The successful entrepreneur establishing a business with a bakery, shops, hydroponic vegetable production and fungus production welcomed the group and showed his commercial activities.

The entrepreneur noted that a successful entrepreneur should believe in his/her product, and if one market trial fails, try another market: for example this could be open air markets, schools, hotels etc. This can drive the demand and support the business growth.

Case 2: 'Eco Insect Farming' – cricket product for export market

One BI incubator developed the idea of producing cricket products and collaborated with a French business owner who redesigned the idea to produce cricket products for an export market in France.


1-2. Dr. Yupa and Mrs Sukrita Anutrakunchai. Mrs Sukrita works for Eco Insect Farming on development of cricket products for export. 3. Production facilities (located in North Thailand, from presentation). 4. Eco Farming products

The facility is located in North Thailand distant from Khon Kaen and not accessible to be visited physically by the GREEiNSECT group. The technical responsible Sukrita Anutrakunchai, a former student of Khon Kaen University, had kindly offered to come to Khon Kaen to present the business concept for the group.
'Eco Insect Farming' gets fresh products from selected farmers in Khon Kaen district. The farmers are selected for good hygiene and production management. All products from 'Eco Insect Farming' are traceable to these selected farms. The crickets are after harvest stored in a freezer at -20 degrees Celsius. For processing, the

crickets are washed five times and after dried in oven at 110 degrees for 6 hours. This is assumed to be long enough for proper dehydration and killing residual bacteria. The bacterial load has been assessed using standards for food hygiene, and meets general standards. The load is not monitored on all batches. Hydration is assumed sufficiently reduced after 6 hours and also not at present directly assessed in all batches. The dried crickets are processed to the main ingredient through several steps in a grinder to obtain fine grade powder. The producer makes impromptu visits to the farms to observe the rearing process for quality assurance and also farmer trust building.

The company aims to building up the production to meet the following regulations:

i) The factory standards meets the standards from Ministry of Industries in Thailand

ii) Production conditions can be approved by the Food and Drugs Administration, Thailand

iii) Microbial tests are performed to be approved by the Central Laboratory (reference laboratory) in Thailand . Samples from the fresh crickets received from farmers are tested.

iv) The microbial test should meet criteria for EU standard. Different markets have specific tests which the product undergoes before release to this market.

At factory level, processes for maintaining high quality and shelf life is implemented. Cricket powder -vacuum containers are used and filled with nitrogen to preserve high quality.

Market

The company is aiming for an export market. However, export to France is still under development due to barriers in the EU regulations for insect products.

At present, the company is exploring the domestic market for various products. The producer has developed a range of different products targeting Thai consumer groups. It is important that the products are branded and packaged attractively. There is, for example, a variety of flavored cricket crisps. The market is still under development, along with the expansion of the production.

1-2. Selection of products from Eco Insect Farming and a range of snack products from another company which have been developed targeting young people in Thailand by packaging attractive to this consumer group

1-2. The company has invested much in the development of new products, packaging and marketing to different consumer groups, especially young people. 3-4. A snack product mede from silk pupae with cheese flavour and complete nutritional information.

What can be learned from the cricket farming business?

Mrs. Sukrita emphasized the importance of consumer analysis and testing. It is important to target the current market for taste, product variety and presentation. Attractive packaging designs can be borrowed from other products, and thereby present the consumers for something familiar. Products should be packed and presented in different sizes according to consumer needs and the type of market. Preserving good quality and long shelf life is important (eg. use of tougher, colorful and nitrogen gas inter foiled package for freshness). The company is prepared for export. When realized, it must be ready to meet different standards for different export markets. It has been considered to divide the production line into two lines, one for export with one set of standards for monitoring from farmer to end-product, and one for the domestic market with a parallel supply chain with a different set of standards to be met.

Considerations related to GREEiNSECT and Flying Food: for cricket industry in Kenya and Uganda the question of how to work on the acceptance of crickets as a quality food through building up trust of consumers needs to be addressed. Working on communication strategies, e.g. development of attractive Information Education and Communication (IEC) materials for consumer knowledge and exposing consumers to products through 'field days' is an important and significant investment. Bench making is critical in any industry of complimentary or competitive products. For cricket market in Thailand, for example the white ants, "omena" and other edible insect value chains can be analysed to see what can be borrowed. Market testing should be regular and ensure the same quality. This builds the trust and a taste for the crickets too.

Khon Kaen University students 'Ento' club

Students from Khon Kaen University (Faculty of Agriculture) have formed the 'Ento' club with their own cricket farm, coached by Dr Yupa Hanboonsong. Students are mainly in their 3rd year, but also include some 2nd years. The student club kindly hosted the GREEiNSECT group for a demonstration and for a cheerful meeting with the enthusiastic students.

1-3. The Ento students warmly welcomed the GREEiNSECT group. The students are supervised and guided by Dr. Yupa in maintaining the cricket production

1-4. 'Ento' student club cricket rearing facilities. At the visit only the smaller round pens were cultivated while the larger pens were out of production due to the cold season.

The students run a production site at the university campus. The cricket rearing is done in concrete cylinders and pens similar to the pens used by farmers. The concrete cylinders were previously used by farmers but at present the rectangular pens appear to taken over as the most popular, at least around Khon Kaen.
For watering they used wet sand. Students do rearing, processing, packaging and selling themselves. Income can be used to cater for the recurrent project expense. In addition to cricket rearing, a pilot project on rearing giant waterbugs was in development.
What could be adopted in Kenya? The Ento club inspires the initiation of school programmes to improve knowledge and acceptance of cricket rearing. The short production cycle is suitable for school settings. Children are often motivated by getting new knowledge and changing eating habits. The rearing technology needs to be well developed and supervision by experienced resource person is important to assure experience of success.

1-3. An entomology student serves crickets reared in their own cages. The Ento clubs serve as a meeting point for students with interests in insect rearing and supports the next generation of entomologists engaged in insect farming.

Closing visit to Khon Kaen University

1-3. Visit at Khon Kaen University hosted by Dr. Nawarat Wara-aswapati Chareon. The globally unique work conducted on cricket farming by Drs. Yupa and Tasanee is proudly recognized by the university.

Vice President for International Affairs, Dr. Nawarat Wara-aswapati Charoen received the GREEINSECT group for an introduction to Khon Kaen University and share of perspectives on future relations. Khon Kaen University has 40.000 students, of which 600 are international students. Three main departments: Health, Science and Technology, Humanities and Social Sciences. Programs exist for exchanges of professors and students. The visit was an inspiring occasion for exchanging ideas between many nationalities for future relations between KKU and the GREEiNSECT research partners for example that programmes on module development for students taking the course on edible insects could be shared. The international relations could also create exchange programs for the edible insect rearing students and Khon Khaen University.

Closing remarks

The aim of the study tour was to stimulate the learning of how the well-established value-chain of cricket production in North Eastern Thailand has developed and is now functioning on commercial premises. The outcome of the tour fully met everyone's expectations and provided the teams of researchers and practitioners from GREEiNSECT and Flying Food, along with the international partners, with invaluable insight in broad aspects of the young cricket sector in Thailand. The learning from the field visits and from meeting with stakeholders and actors along the value chain have brought insight that will influence the future for the developing insect rearing sector in Kenya.

For more information about GREEiNSECT please contact the GREEiNSECT Principal Investigator, Dr. Nanna Roos - nro@nexs.ku.dk

Please visit the GREEiNSECT website here: www.greeinsect.ku.dk