SUSTAINABLE
LAND MANAGEMENT

NEW APPROACHES IN RICE CULTIVATION

(Source: J. Settele)

(Source: S. Hotes)

Grasshoppers can have both beneficial and detrimental effects on rice ecosystems.

Half of the world's population lives on rice. However, rice is not cultivated ecologically and sustainably everywhere: it is normally grown with the application of mineral fertilizers and often sprayed to control weeds, pests and diseases. In Vietnam and the Philippines, Asian and German scientists are now searching for more sustainable ways to manage rice ecosystems.

The Brown Planthopper (BPH) reaches a length of only a few millimetres. But the damage caused by this and other species of plant- and leafhoppers in Asian rice fields is immense. But what can be done to control these pests? Entomologist Professor Stefan Vidal from Göttingen University is investigating how natural enemies contribute to the control of planthopper abundance.

»Rice is a staple food crop: half of the world population lives on it.«

Vidal is conducting his research in Philippine rice landscapes. Here, as in all rice environments, so-called parasitoids are a core group of natural enemies, which include tiny mymarid wasps with a size of just 2 millimetres and which are specialized on rice planthoppers as hosts. They lay their eggs inside the planthopper eggs, which, themselves, are attached to the tissue of the rice stems. When

(Source: J. Settele)

Tilling of a paddy field north of Hanoi, Vietnam.

the parasitoid larvae hatch they will feed on the hopper eggs. Vidal's hypothesis is that higher numbers of these wasps will result in fewer planthoppers damaging the rice plants.

Sustainable rice cultivation

Vidal is researching within the project LEGATO, which stands for »Land use intensity and Ecological enGineering – Assessment Tools for risks and Opportunities in irrigated rice-based production systems«. The project will have received a total of 7.5 million Euros in funding from the Federal German Ministry of Education and Research by February 2016. The main aim of the project, coordinated by agricultural ecologist PD Dr. Josef Settele from the Helmholtz Centre for Environmental Research (UFZ), is to find answers to how the rice ecosystems in Southeast Asia can be managed and developed sustainably.

This is a matter of some importance: »Rice is a staple food crop: half of the world's population lives on it«, says Settele. The LEGATO scientists are conducting their research across seven study regions on Luzon Island in the Philippines and in North and South Vietnam. The team of experts brought together by Settele from 22 research institutions in seven countries seeks to analyse how rice cultivation influences the surrounding landscape and ecological as well as human community and vice versa. They are focusing on ecological engineering, i. e. »the shaping and monitoring of ecosystems

Batad, a UNESCO World Heritage Site in Northern Luzon, Philippines, is one of the areas studied in the LEGATO project.

with the aim of increasing the productivity of rice cultivation while maintaining or even improving sustainability«, as stated by Dr. Kong Luen Heong of the International Rice Research Institute (IRRI, Philippines).

Mymarid wasps kill planthoppers

As part of this research Heong is also investigating how humans can improve the habitat for the natural enemies of the rice planthoppers. One ecological engineering approach that the LEGATO scientists are pursuing is to analyse how flowering plants on the bunds between the rice fields and within vegetation surrounding rice areas attract insects. These insects include the mymarid wasps (which kill the planthoppers but potentially also help to pollinate plants) and wild bees, which are generally important pollinators. The latter are the subject of a further working group led by Dr. Catrin Westphal from Göttingen University. The agricultural ecologist is investigating the diversity of bee species in the study areas. »Bees are an important functional group which can indicate the intensity of agricultural land use, like pesticide application, in the rice production systems«, she says. The occurrence of wild bees decreases with increasing intensity of rice cultivation. On the other hand diverse and flower-rich habitats have a positive effect on bee numbers. Initial studies suggest that the bees thrive best in extensively farmed areas with mixed crops offering diverse and complexly structured habitats: »The highest numbers of bee species occur where banana plants,

Forests above the rice terraces guarantee more continuous water supply and very high biodiversity (Luzon, Philippines).

palms and shrubs are found in very close proximity to blossom-rich undergrowth«. The nectar gatherers are important, not only as indicators of an intact landscape but also because they provide a vital service for the local farmers. »The bees pollinate tomatoes, cucumbers and zucchini. Without them it would not be possible to grow vegetables,« says Westphal.

»The bees need weeds and shrubs because they breed in the hollow stems.«

The weed-rich embankments between the rice fields also attract bees and wasps. Botanist Sabine Großmann is making a detailed study of the plants in and alongside the rice fields as part of LEGATO. She hypothesises that species-rich vegetation helps to keep hopper numbers down. »The bees need weeds and shrubs because they breed in the hollow stems«, says Großmann, a PhD student at UFZ. If these structures are not present, conditions are difficult for the wasps. The rice fields in the Philippines and Vietnam are very diverse; the diversity of structures and the intensity of land use vary greatly from one region to another. This is apparent for example from the farmers' use of insecticides to control hoppers and other pests:

»In the mountains of the Philippines, where people grow rice for their own consumption, there is no

Farmer Interview in Nueva Ecija province, Central Luzon, Philippines.

money for pesticides«, says Großmann. In the plains of Vietnam on the other hand, where rice is cultivated over much larger areas and which is to be sold, people are quicker to resort to the use of toxic sprays. However, they frequently choose the wrong time of year to do so: »In earlier times farmers in Vietnam's Tien Gang Province used to spray. Then all the insects died off, but the hoppers were the quickest to recover afterwards«, says Dr. Ho Van Chien of the Southern Regional Plant Protection Centre (Long Dinh, Tien Giang, Vietnam). »But in the meantime the lesson has been learned and through Ecological Engineering we do not apply insecticides any longer and consequently maintain biodiversity and its biocontrol services«.

»Our main concern is to make use of the rice farmers' knowledge.«

This affects the hopper populations less severely than other species, as some individual specimens always survive. The result: »Large populations of the hoppers quickly develop and cause even greater damage to the rice«, says Heong. One of the aims of the project is therefore to show the farmers that it is possible to dispense with pesticides and instead to tackle rice pests by natural means. Project coordinator Settele sees communication as an important priority for the LEGATO project. »Our main concern is to make use of the knowledge of

Traditional rice varieties: the grains are separated from the panicles immediately before cooking (Bangaan, Philippines).

the rice farmers in Vietnam and the Philippines and to make them communicate among and between each other«, he says. The two nations are united by the effects of globalization. »Young people no longer want to work in the rice fields. Many are moving away because the work is very laborious and they hope to be able to earn more in the towns«, says Professor Monina Escalada of the Visayas State University (VSU, Philippines), who is studying socio-cultural conditions within LEGATO.

Old traditions are being lost

Tourists are gradually discovering the picturesque rice terraces on Luzon Island. This brings money into the region, but it is contributing to an increase of the average cost of living for the local population. Overall, recent socio-economic developments and trends are the reason that rice growing is no longer sufficient as prior source of income. Most farmer families diversify their income base by non-agricultural activities. The specified knowledge of the older farmers will be lost, if there is no-one left to take over their work. »Social structures have been developed on the basis of rice production under very difficult circumstances. Recently, with changing lifestyle preferences of the younger people, and a significant shortage of qualified manpower in the rice terraces, the transmission of knowledge and traditions is intermitted or eventually being lost«, explains Vera Tekken from Greifswald University. For this reason strategies are needed to safeguard the farmers' income from rice growing and to stabilize yields.

(Source: S. Hotes)

Today's rice market is dominated by a multitude of mostly high-yielding varieties.

In order to build up a relationship of trust, Escalada and Tekken are interviewing the rice farmers, asking them for specific problems related to rice production, under inclusion of socio-cultural and social aspects. This not only takes up a considerable amount of time but also requires sensitivity.

»Many farmers are disconcerted by the fact that Europeans want to give them advice on how to deal with their own crops«, Tekken explains. She is convinced that the effort is worthwhile: »We don't want the farmers to turn to pesticides at the first opportunity to somehow deal with increasing problems and yield losses caused by pests, but rather for them to really consider ecological engineering as a useful tool.«

Uncertain future

Jimmy Cabbigat is one of the rice farmers in the Philippines. Cabbigat is aware of the importance of the LEGATO project: »Our forefathers laid out the rice terraces in order to survive. Now we have to consider how we can preserve the terraces for the future.« So the project aims to show the farmers practical options for maintaining rice cultivation in the uplands and taking best advantage of the terraces. For this reason Settele and the main project economist Dr. Joachim H. Spangenberg want to bring the farmers together with agricultural advisors, planners and those driving tourism. The rice farmers on the plains on the other hand are already working their land in a more commercial way, and with them

(Source: J. Settele)

Meeting of stakeholders and social scientists from the LEGATO project in Hingyon (Philippines).

the LEGATO scientists wish to discuss above all how to reduce their use of pesticides and fertilizers. »We want to prove that the rice farmers do not have to use expensive pesticides in order to make profits«, says Spangenberg. It is crucial that the whole

»One farmer on his own can achieve little, if he alone stops using pesticides, while the others continue to spray.«

village implements these findings. »One farmer on his own can achieve little, if he alone stops using pesticides, while the others continue to spray their crops. Then the hoppers will simply move onto his land«, states IRRI entomologist Dr. Finbarr Horgan. But before their findings can be implemented, the scientists have to answer many fundamental questions for which very little data exists as yet, such as: How does the landscape affect the dynamics of the rice farming and the organisms that live there? What are the effects of climate and land-use change on the ecosystems and the services that they provide?

One of the substances which has been little studied until now and for which many connections remain unclear is silicon. Rice is known to be one of the few plant species which can absorb quite large quantities of silicon and store it as silicon dioxide. For rice silicon can be a limiting factor. »If the soil is fertilized with silicon, yields are increased«, reports UFZ

Rice planting in Bangaan (Philippines) – another World Heritage Site studied in the LEGATO project.

scientist Professor Doris Vetterlein. The rice plants are also less susceptible to attacks by pests and better able to withstand dry periods, and their stems are more robust with a more erect leaf canopy. It is presumed that this improves light absorption by the plants so that their photosynthetic rate is higher. »In addition to all this, silicon plays an important role in fixing carbon in the soil«, says Vetterlein.

»If the soil is fertilized with silicon, yields increase«.

For this reason greater attention is now focusing on the element in the debate on climate change. Vetterlein is working with Professor of Soil Science Reinhold Jahn from Halle-Wittenberg University, Associate Professor Nguyen Van Sinh from the Vietnam Academy of Science and Technology and other colleagues to conduct fundamental research into silicon in the LEGATO study areas. The team wants to find out how much silicon is present in the soil, how it is absorbed by the rice plants and what happens to the silicon after harvesting when the rice plants are burned or left to rot in the fields. »If silicon should indeed prove to be a limiting factor, then the farmers would have to try to preserve as much of it in the system as possible«, concludes Jahn. Of course the local farmers are very interested in the findings of the LEGATO scientists. But there is also a transfer of knowledge in the opposite direction. Settele favours the research approach known as co-design in which the rice farmers are encouraged to contribute their own ideas. They complained for example that the so-called Golden Apple Snail is devouring the young rice plants. So LEGATO scientists Dr. Manfred Türke and Professor Wolfgang Weisser from the University of Technology in Munich are now investigating this problem. »Without the input of the local farmers we would not have been looking into this in more detail«, says Settele.

Production systems that are being investigated in the region are: agricultural systems (extensive) tourism, rice

LEGATO

www.legato-project.net

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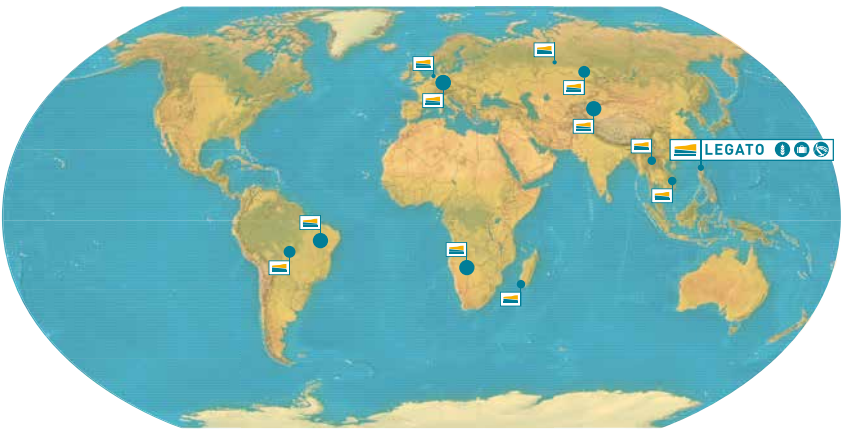
Funding: 7.5 million Euros

Funding period: March 2011 to February 2016



»LEGATO« is one of twelve regional projects funded by the Funding Measure »Sustainable Land Management« (Module A) provided by the Project Management Agency (PT-DLR) on behalf of the German Federal Ministry of Education and Research (BMBF).

Science Portrait 6 is published in the context of the Funding Measure »Sustainable Land Management« of the German Federal Ministry of Education and Research (BMBF).
www.sustainable-landmanagement.net

Publisher:
Scientific Support, Coordination and synthesis (GLUES)
Helmholtz Centre for Environmental Research – UFZ
Department of Computational Landscape Ecology
Permoserstraße 15 | 04318 Leipzig

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Layout: Metronom | Agentur für Kommunikation und Design GmbH, Leipzig

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Federal Ministry of Education and Research
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