



## **Ecological Engineering – a strategy to restore biodiversity and ecosystem services for pest management in rice production**

KL Heong

“We conclude that (pest management) in tropical irrigated rice **should be based on the contention that insecticides are not needed** rather than that they are, and that “pests” should be critically re-assessed and proven guilty before insecticide use is contemplated.” This was the conclusion made in 1994 by the late Professor Michael Way after an extensive review of the role of biodiversity in rice pest management. It paved the way for the development of strategies to enhance biodiversity and ecosystem services as the basis for sustainable pest management and the development of ecological engineering.

Rice ecosystems are inhabited by hundreds of arthropod species. These perform various ecological functions such as herbivory (feeding on the rice plants), predation, parasitization, pollination, decomposition, and nutrient cycling. Those that feed on rice plants as herbivores are often labeled as “pests”. However fewer than 10 species are of significance as pests that can cause yield losses if they occur in sufficiently large numbers. These pests are in turn subjected to attack by predators and parasitoids, and thus are kept in check. This intricate food web of relationships among the rice plants, the pests and the rich biodiversity of natural enemy species constantly strives to reach the equilibrium that prevents abnormal developments in pest species.

### **What is ecological engineering?**

Ecological engineering is an approach to restore or enhance biodiversity in the rice landscape, both of floral and faunal species, so that resources for natural enemies, such as shelter and food, are enhanced. Defined as “the design of human society with its natural environment for the benefit of both”, ecological engineering is a conscious set of human activities based on quantitative and theoretical ecology with the aim of gaining benefits for both. At the same time deliberate actions will still be needed to avoid the destruction of the biodiversity of natural enemies and detritivores through careful landscape designing and a judicious use of pesticides.

### **Conservation of habitats in the rice landscapes**

In rice landscape, bunds and non-rice habitats with perennial plants, trees and shrubs occupy a substantial proportion. Some are populated with fruit trees, some planted with vegetables but, very often, farmers treat other areas as waste land and spray them with herbicides, mistakenly thinking that they harbor pests. In fact, such perennial habitats are homes for natural enemies. For instance, in the Philippines and Thailand, rice bunds with *Brachiaria* grasses are the homes of two species of cricket that are ferocious predators of pest eggs laid on leaves. Many spider species also depend on these grassy habitats.

### **Growing nectar-rich flowering plants on bunds to provide food and shelter**

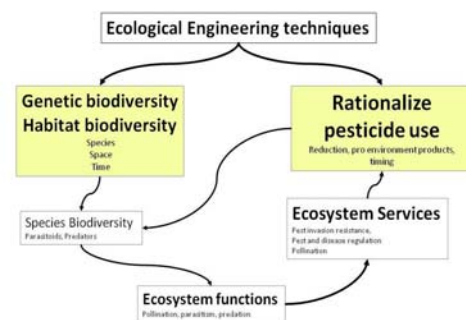
In addition to conserving specific natural habitats, ecological engineering methods can be used to augment biodiversity by the planting of nectar-rich flowering plants on the bunds. These flowers provide nectar for bees and other species that can enhance the pollination of fruit crops in the rice landscapes. In addition, the nectar is also a food resource for many hymenopteran parasitoids, especially those that regulate rice pest species, such as planthoppers, leafhoppers, stem borers, and leaf folders. Ecological engineering fields in Vietnam with bunds enriched with nectar rich flowers had significantly a higher parasitism and predation of planthopper eggs that are deeply embedded in the rice tissues.

Farmers in these villages had stopped using insecticides and are harvesting similar or higher yields but with substantial increases in profits from the reduced insecticide use.

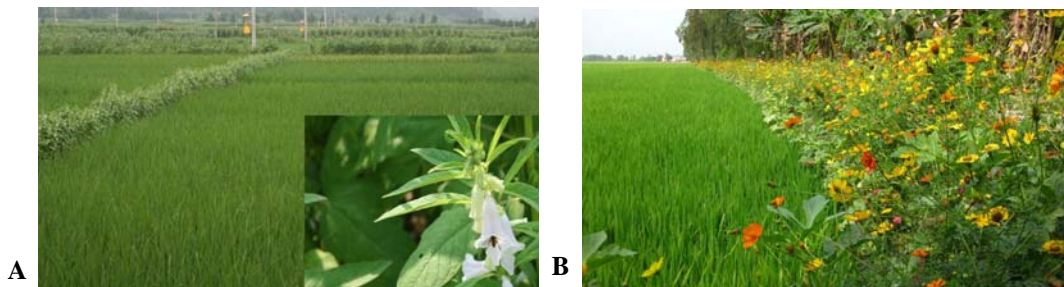
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In Jin Hua, China, hybrid-rice fields surrounded by sesame and nectar-rich flowering plants with no insecticides applied had significantly higher densities of arthropod parasitoids and predators as well as frogs. Again, yields in these fields were the same as in rice fields without ecological engineering and sprayed three times.



**A.** Rice fields surrounded by sesame. **B.** Rice field with nectar-rich flowering plants on the bunds. – KL Heong

### *Refraining from using insecticides in the early crop stage*

An important component of ecological engineering is to use insecticide only when absolutely necessary and as the last resort. Insecticides are by design biocides and thus have indiscriminate action on all living organisms. Those that are more vulnerable to being killed in an insecticide-sprayed field are the organisms that have a small size, soft bodies, and high mobility. Ironically, pest species tend to be larger and less mobile and are thus less vulnerable to the sprays. In addition, farmers' spray equipment has poor delivery systems and thus most of droplets land up in the water. Since rice is an ephemeral habitat, all species that live in it are migrants, both pests and natural enemies. At the early stages of the crop, species of both pests and natural enemies move in to inhabit it. The bunds that are richly endowed with floral species and homes of natural enemies become the sources of the predators, such as spiders and crickets. They feed on the initial inhabitants, the detritivores, such as midges and flies, in the rice aquatic system before the pests arrive. Also in the aquatic system are predators, such as microvelids, that act like "sharks" against the invading pests. In rice fields where early-season insecticide sprays are used, these organisms and the services they provide are destroyed. Invading pests then "escape" natural control and are able to reproduce exponentially into damaging numbers. The early-season insecticide sprays generally used to kill leaf-feeding insects do more harm than good as these insects seldom cause yield losses because of compensation abilities of the rice plant. The sprays destroy the ecosystem services that would protect the rice crop from pests multiplying exponentially.

### About the author



K.L. Heong is a specialist in insect ecology, biodiversity, and integrated pest management. He has focused his work to help rice farmers to increase biodiversity, reduce unnecessary insecticide use, and conserve naturally occurring biological control services in rice fields. He is presently working at IRRI and is based in Los Baños, the Philippines.

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### Challenges in implementing ecological engineering

Predators and parasitoids of pest species are important regulators of pest populations. The common insecticides used in routine early season sprays are usually highly toxic to these predators and parasitoids and thus destroy the ecosystem services they would provide. Pests that invade these fields thus become unregulated and develop into damaging numbers. Inherently, rice fields are richly endowed with predator and parasitoid biodiversity. With nectar-rich flowers, their populations and the regulatory services they provide are further enhanced. The big challenge is to motivate the millions of farmers to adopt these concepts, stop their routine spraying, and enrich rice field bunds with nectar-rich flowers. Since parasitization is not an easy concept for farmers to grasp and the parasitoids are too tiny to be observed, one approach is to use bees as an indicator species for the farmers to observe. Besides most parasitoids of rice pests are from the order hymenoptera which have rather similar characteristics. Farmers can be motivated to observe and conserve "bees and their relatives" and refrain from spraying insecticides harmful to them. At the same time, there is a need for improvements in the ethics of insecticide marketing so that it conforms with the FAO Code of Conduct on the distribution and use of pesticides. Advertising and incentives incite misuse among farmers. In many developing countries, unlike in developed countries, pesticides are still being sold as fast-moving-consumer-goods (FMCG) and this tends to enhance overuse and misuse.

### Further Reading

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