

Research and innovation

The Global Forum on Agricultural Research (GFAR) brings together all those working to strengthen and transform agricultural research for development around the world. As part of this role, GFAR is working with New Agriculturist to showcase and raise awareness of important initiatives and their outcomes, to update and inspire others.



Ecosystem services

Recognition of the wider value of ecosystem services in agricultural systems is growing rapidly and agricultural research and innovation systems are increasingly incorporating the significance of ecosystem benefits directly into their work. In this edition, GFAR highlights some inspiring initiatives in this area around the world, to help inform, connect and develop new actions that further enhance ecosystem services in agriculture.

Letting nature manage its battles

Advice for managing rice pests, such as planthoppers, has taken on a simple message: let nature have its way in your fields. In a statement calling for support on pesticide regulation and for a ban of the use of specific insecticides in rice that contribute to planthopper outbreaks, the International Rice Research Institute has offered alternative practices to better manage pests.

Ecosystem services in support of a greener revolution in Africa

Malawi's subsidy programme for fertiliser and improved maize seed has been heralded as a triumph. But to test the hypothesis that crop diversity would offer improved ecosystem services and enhanced food security, a group of researchers initiated a country-wide trial, comparing monocultural maize production with a more diversified system.

Realising the benefits of enhanced agrobiodiversity

The 2008 food price crisis provided dramatic evidence for the fragility of both agricultural production and the wider food economy in many developing countries. To stabilise and improve productivity and yields, a group of stakeholders have called for a wide array of underutilised crops to be retained and promoted.

Letting nature manage its battles

Advice for managing rice pests, such as planthoppers, has taken on a simple message: let nature have its way in your fields. In essence, leave alone the 'friendlies' such as spiders, predatory bugs, and parasitic wasps, and you will increase your crop's chances against planthopper outbreaks. But as straightforward as the message is, doing away with time-old practices dependent on assurance from insecticides is not.

In a statement calling for support on pesticide regulation and for a ban of the use of specific insecticides in rice that contribute to planthopper outbreaks, the International Rice Research Institute (IRRI) has offered alternative practices to better manage pests, and has called on its partners to join its concerted efforts to change mind-sets.



Planting different types of flowering plants alongside rice can help encourage predators and parasitoids that prey on pests
©IRRI/KL Heong

Asia bears hopper brunt

The message comes as rice losses from planthopper outbreaks spread across Asia. In 2010, the pest destroyed more than 25,000 hectares of rice in Indonesia and about 1.1 million tons of paddy rice with an export potential of US\$275 million were lost in Thailand. In 2009, an estimated 300,000 hectares were heavily infested in China and Vietnam, of which more than 6,500 hectares suffered complete crop failure.

The hopper problem, which persisted in Vietnam from 2005 to 2007, prompted the country to suspend rice exports in 2007, to protect the domestic supply. However, this caused volatility in rice prices globally, prompting warnings from the World Bank that millions would be pushed further down the poverty line.

Ecosystem breakdown

Planthopper outbreaks are primarily caused by a breakdown of biological control functions in the rice landscape, what is known as 'ecosystem resilience'. IRRI entomologist Dr KL Heong points out that a rice field, left on its own without interference from chemicals, has its own 'foot soldiers' that provide protection from pest outbreaks.



Spiders help increase crop's chances against planthopper outbreaks
©IRRI/KL Heong

A rice field is a patchwork of rich diversity in which spiders, aquatic bugs, parasitic wasps, and predatory bugs thrive. An irrigated rice ecosystem in the Philippines, for example, is home to nearly 700 organisms, most of which are natural enemies of the pest and friendly to rice. Each has a role in a delicate balance of inter-relationships, making the landscape environmentally sustainable.

"Biodiversity is about balancing the positives and the negatives," says Dr Heong. "It is about roles, interactions, and stability. Without natural enemies, planthoppers multiply and can overrun a rice field, causing an outbreak." Natural enemies keep the pest population in check but the whole system starts to fall off-balance the moment chemicals are applied. However, no amount of solid, environmentally

sustainable practice will work unless farmers are weaned from the belief that they need to use chemicals to control pests.

Yet, pesticides are marketed as consumer goods, using emotional appeals and even giveaways, effectively putting reason on the back burner. Dr Heong believes that pesticide use must be knowledge-based in order to preserve the natural balance in the rice ecosystem and so prevent outbreaks.

A crucial step against chemicals

Following reports of damage in 11 provinces in Thailand, which affected 104,000 hectares, the country's Minister of Agriculture and Cooperatives, Theera Wongsamut, announced a US\$12.8 million initiative to stop the use of two outbreak-causing insecticides - cypermethrin and abamectin - in Thai rice crops. IRRI director general Dr Robert Zeigler applauded this action. "It is of international significance that Thailand should undertake this initiative because, as the world's largest exporter of rice, it is recognized as a global leader in the rice industry," he said.

In its action plan to solve the hopper problem sustainably, IRRI has proposed the restoration of biodiversity in

rice fields, as well as building ecological resilience. Specifically, IRRI recommends ecological engineering approaches that introduce landscape elements such as flowers and other plants to promote buildup and to sustain a healthy population of natural enemies of planthoppers.

IRRI also recommends the use of resistant varieties, or a combination of varieties, that are tolerant of the local or invading planthopper populations. However, to prevent the hoppers from developing resistance, farmers are advised against using the same variety for more than two years. Synchronous planting and fallow periods of one month in between successive crops of rice, as well as crop diversification schemes, are also included in IRRI recommendations.

To support farmers in their new approach, IRRI is calling on its partners in national governments and the private sector to regulate the marketing and improve the use of insecticides. The call is to change the classification of pesticides as consumer goods to being regulated materials, and to ban or restrict the use in rice of broad-spectrum pesticides that contain active ingredients known to contribute to planthopper outbreaks, including cypermethrin, deltamethrin, abamectin, and chlorpyrifos.

Certifying and training pesticide retailers is also recommended to prevent sales of fake, banned, or unapproved products, and to foster the promotion of integrated pest management and proper pesticide use.

Links

- Letting nature manage its battles
(<http://irri.org/knowledge/publications/rice-today/features/features-asia/letting-nature-manage-its-battles>)



Regulating the marketing and use of pesticides will help farmers manage pests more effectively
©IRRI/KL Heong

Ecosystem services in support of a greener revolution in Africa

In Malawi, a subsidy programme for nitrogen fertiliser and improved maize seed has been heralded as a triumph for input intensification of rain-fed cereals. Over 1 million farmers have benefitted annually since 2006, with increased maize yields doing much to address food insecurity in the country. But the team, which undertook the field research on which Malawi's current programme, is based also recognised that crop diversity would be sacrificed by a system entirely based on maize. In response, two members of that team initiated a country-wide trial, to compare monocultural maize production with a more diversified system. In particular, the research team wanted to test the hypothesis that a diversified system would offer improved ecosystem services, and that these would contribute to enhanced food security among a broad base of Malawi's rural poor.



Increased maize yields are helping to address food insecurity in Malawi
©Sieglinde Snapp

This trial developed into a five year programme of participatory research at sites in northern and southern Malawi, which was then expanded into a country-wide study involving around 1,000 farmers. Farmers assessed various systems against the standard improved maize seed/fertiliser package promoted through the subsidy programme. They also helped in developing the diversified model, to improve its applicability at household level. Ecosystem services that were monitored in the study were chosen for their relevance to smallholder farmer livelihoods. They included direct farm outputs such as grain and protein yield, and profitability, as well as supporting services such as plant cover, soil organic carbon, and fertiliser efficiency.

Promoting diversity

To introduce diversity, legumes were selected on several key criteria. They needed to be vigorous producers of nitrogen-enriched roots and leaves and should produce some edible grain, so as not to compromise household food security. They also needed to live longer than the four months typical of annuals. *Mucuna pruriens* and pigeon pea (*Cajanus cajan*) were two examples, which the research team termed 'semi-perennial' legumes (SP-legumes). Pigeon pea was already grown as a shrubby cereal intercrop in large areas of southern Malawi, where farmers appreciate its slow growth early in the season and deep rooting, which ensure minimal competition when grown as an intercrop with maize. It has high nitrogen-fixing capacity and produces modest amounts of grain on degraded sites.

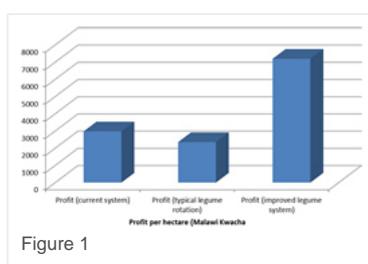


Figure 1

Data from earlier evaluations showed that, under smallholder conditions, grain yields were improved and fertiliser use was profitable with the small amounts of fertiliser available under the subsidy programme. But, by improving biodiversity through the incorporation of legumes into the system, fertiliser use efficiency rose sharply, thus markedly reducing the level of subsidy needed to ensure national food security. Legume rotation systems could produce equivalent quantities of grain with half the amount of fertiliser, and on a more stable basis (yield variability reduced from 22 per cent to 13 per cent) compared to monoculture. Further studies found that when an increased fertiliser cost was

taken into account - reflecting a global increase in fertiliser costs since 2008 - the diversified maize/legume system offered an even stronger value/cost ratio compared to monoculture.

In Figure 1, the profitability of three potential farming systems is compared. In the 'current system', the standard subsidised maize/fertiliser package is shown. If the farmer chooses to bring diversity in through rotating with a legume in the conventional manner, profit falls sharply. But, due to the combined effects of fertiliser use efficiency (the farmer gets more grain for less fertiliser) and an additional crop from the same piece of land in the same year, profit doubles under the improved legume system.

Consistent results

Farmer surveys indicated consistent technology rankings across experiments, despite the diversity of years, locations and participants involved. About half of participating farmers rated the SP-rotation system as first (41-56 per cent), around one-third chose an alternative groundnut/maize rotation and just 6-8 per cent chose monoculture maize. When technologies were assessed in terms of specific benefits and costs, nutritional benefits of legume diversification were particularly valued by female farmers. Overall, rankings of technologies remained generally consistent across the different sites and types of experimentation.

This is the first evidence in Africa that crop diversification can be effective at a countrywide scale, and that shrubby, grain legumes could transform the economic viability of fertiliser subsidy policies, and support key ecosystem services from agriculture. Plant cover has increased from around four months to ten months, and fertiliser use efficiency by about 200 per cent. Some 8,000 farmers at the northern Malawi site are now adopting the improved legume system.



Farmers and outreach workers will need to become familiar with the new intercropping systems
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National plans

The Malawi Government has recently launched the Green Belt Initiative, a national programme in agricultural transformation; improved cropping systems, including use of legumes, are a major focus. There are, however, important implementation issues. Legume seed is expensive to multiply and is less profitable for seed producers than hybrid seeds such as many of the improved maize varieties. But Malawi has several emerging seed companies that are actively seeking a niche and could, with proper support and advice, enter this market.

Farmers and outreach workers will need to become familiar with the new systems, and there will be a need for ongoing enhancement and development. But the data from the farm trials have been carefully peer reviewed, and provide robust evidence that an improved legume/maize rotation offers a sustainable way for Malawi to maintain its impressive progress in food production, through a system which - unlike the current subsidy programme - will be less likely to cause reductions of expenditure in other key areas such as education and health.

Written by SS Snapp, MJ Blackie, and GY Kanyama-Phiri

Realising the benefits of enhanced agrobiodiversity

The catastrophic failure of grain harvests in 2008 and subsequent price hikes for rice and wheat provided dramatic evidence for the fragility of both agricultural production and the wider food economy in many developing countries. Long-term food and livelihood security can be achieved, but if productivity and yields are to be stabilised and improved, a two-pronged approach is essential. In particular, a wide array of underutilised crops must be retained and promoted, in order to diversify agro-ecosystems and optimise the productivity and ecological benefits of crop rotation.



Underutilised crops must be retained and promoted
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As far as food is concerned, the bulk of the calories in the world's diet will continue to come from a few major staple crops. These will, nevertheless, need to be continually improved to maintain long term productivity, within the limitations of a sustainable agroecology. However, other food and livelihood security plants - which range from grains and pulses, fodder and fibre plants, root and tuber crops, fruits and vegetables to an array of non-timber forest products (NTFP) - must increasingly be used to provide a balanced diet, protect the farm ecosystem, and provide protection from internal and external market disruptions, especially in developing countries.

These 'development opportunity' plants and crops have great untapped potential to support smallholder farmers and rural communities through improved food and nutrition security, as well as income. Many are well adapted to extreme climatic conditions or to high pest and disease pressure, offering resilience to both biotic and abiotic stresses and providing harvestable yields where major crops may fail. Preserving and drawing on such valuable genetic resources is imperative if we are to address present and future environmental challenges.

Global initiative for diversity

In January 2011, a collective movement was formed at a stakeholder meeting to promote collaborative action to strengthen the role and value of agrobiodiversity in the context of development. Provisionally termed the Development Opportunity Crops Network (DOCNet), members and prospective members include UN organisations and international research networks and institutions, together with NGOs and representatives of civil society. The initiative is supported by the secretariats of the Global Forum on Agricultural Research (GFAR) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)*.

The DOCNet initiative builds on the momentum for sustainable use of plant genetic resources arising from regional frameworks like the Agricultural Biodiversity Initiative for Africa (ABIA) formulated by FARA, the Suwon Agrobiodiversity Framework by APAARI, ongoing initiatives by AARINENA and FORAGRO and the Bali meeting of the ITPGRFA Governing Board (March 2011).



Underutilised plants and crops have great untapped potential to improve food security
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Focussing initially on crops and plant-based NTFPs, a thorough review of published literature has helped identify key gaps in knowledge and documentation concerning the potential of underused agricultural biodiversity. Initiative members have highlighted several cross-cutting issues, such as the genetic improvement of underutilised plants, strengthening of seed systems and curriculum development. Within these topics, opportunities for collective actions are now being identified, building on successful activities of partner organisations and their complementary geographical and technical strengths.

Documenting diversity

One case study for collaborative development of a landscape-level sustainable production system in Lin'an county, China, has revealed that crop diversification results improved economic status of the rural population and reduced dependence on state support (INBAR, 2011). NTFPs, in particular bamboo and hickory nuts, have become valued alternative sources of income. Collaborative planning and innovation allows rural people not only to engage in forestry and forest management, but also to participate in processing, business management and marketing of NTFPs. As a result, per capita GDP in Lin'an has increased more than 15 fold in 20 years, from US\$400 in 1990 to US\$6,500 in 2009.

This case study, along with several others including mungbean in Asia and maca in Peru, were included as

part of a presentation about the DOCNet Initiative at the Science Forum 2011 of the CGIAR's Independent Science and Partnership Council (Hoogendoorn *et al.*, 2011). Preparation for this presentation enabled the group to include representation from many stakeholder groups. To facilitate sharing of information, the Initiative used a number of tools, including a document 'repository' on Google Docs, a discussion forum on LinkedIn, brief opinion surveys with Survey Monkey, together with more standard email exchanges and reviews of draft documents. A follow up stakeholder meeting will be held in January 2012. One goal of the 2012 workshop will be to draft a peer-reviewed publication based on the paper presented in Beijing. A Position Paper, based on case studies of development opportunities through research and development on underutilised crops, will also be prepared as well as prioritising the 'collective actions' put forward in that paper.

Influencing policy

In the coming months, a key challenge for the Initiative will be to design strategies which go beyond current research efforts in crop improvement, in order to promote sustainable use of 'opportunity' crops and products in a more holistic way.

Discussion has been stimulated about the value of diversified farming systems, not least their capacity to maintain sustainable ecosystem functions, provide nutritious and locally available food at affordable prices and support rural and urban poor people to participate in the market place. However, more targeted research is necessary to further focus global policy attention on the benefits of diverse and locally adapted agro-ecosystems, and their potential both to improve productivity and move millions of people out of poverty.



Discussion has been stimulated about the value of diversified farming systems
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* The Initiative includes at the moment: GlobalHort, INBAR, Crops for the Future (CFF), Plant Resources of Tropical Africa (PROTA), the Platform for Agrobiodiversity Research (PAR), AVRDC - The World Vegetable Center, PROLIINOVA, GFAR, AARINENA, APAARI, FARA, ITPGRFA, and the Crop Diversification for Improved Livelihoods Team within FAO-AGPM

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