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TAMING WILD WHEAT
Global wheat breeding research aims to increase yields to meet rising population-driven demand

PIGS AND SWEET POTATOES
Enhancing a traditional village-based food system in PNG and Papua province

SHOULDERING THE BURDEN
Vietnamese and Thai women are increasingly taking on the role of farm managers as economic pressures cause men to seek off-farm work

EDITORIAL

Cultivating good research

In its earliest form, agricultural research dates back to harnessing the production potential of crops and animals through rudimentary selection and breeding – the start of early civilisations. In modern times, agricultural research continues to underpin societal and economic growth by lifting food and fibre production. The right mix of proactive government policies and enthusiastic farmers has helped to lift production levels that have so far kept global food production in step with population growth. However, as populations continue to rise rapidly, substantial research is again needed to ensure food production continues to expand.

Although research is often conducted to meet the demands of national agricultural sectors competing for market share, there are also research centres that work on the international stage for public good.

The Australian Government has contributed to the funding of such centres, along with a range of multilateral organisations such as international development banks, United Nations development programs and international health and environmental initiatives.

Building research skills takes time. Since the late 1960s, the Consultative Group on International Agricultural Research (CGIAR) has led efforts to deliver this expertise. Australian investment in CGIAR and other non-aligned centres complements ACIAR's work that links effective international agricultural research with aid.

Since 1992, ACIAR has administered the Australian Government's contribution to the CGIAR and other research centres. ACIAR allocates about 20 per cent of its total appropriation – A$10 million a year – to fund international agricultural research centres (IARCs). This takes two forms: as non-project specific funding to support the work of IARCs with a comparative advantage in the Asia-Pacific region, and allocations to projects led by the centres. Projects involving IARCs cover the full range of agricultural research that ACIAR undertakes – economic/farming systems, cropping systems, natural resource management and livestock systems. IARCs are engaged to lead projects in cases where a bilateral project (involving an Australian institution as project leader and a partner country or countries) does not present the most effective means of delivery.

The structure of CGIAR and non-aligned centres focuses each centre on a particular area of agriculture, such as a specific crop (for example, the International Rice Research Institute), climatic region (International Centre for Agriculture in the Dry Areas), sector (Centre for International Forestry Research) or theme (International Food Policy Research Institute).

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Partners in Research for Development presents articles that summarise results from ACIAR-sponsored research projects, and puts ACIAR research initiatives into perspective.

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International collaboration

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Around ACIAR

A Cambodian villager harvests rice: the International Rice Research Institute and Australian researchers are aiming to create one-line hybrid rice varieties to help boost yields (page 8).

Front cover: Improved rice varieties, such as this one under development in Cambodia, help developing countries increase food security and build a more commercially competitive rice industry.

Back cover: a young Vietnamese boy at a durian market in the Mekong Delta, south of Ho Chi Minh City.

WHEAT BREEDING

HELPING THE WORLD TAME WILD WHEAT

A global wheat breeding research project with Australian participation could potentially increase wheat yields and help meet increasing population-driven demand. Brendon Cant reports

Groundbreaking research, using breeding strategies that complement conventional wheat breeding, has shown yield can be lifted by selecting certain physiological traits. Such increases, needed to satisfy an expected surge in demand over the next 25 years, cannot be obtained through conventional breeding. Wheat breeder Dr Matthew Reynolds, who headed an ACIAR-funded research project at the International Maize and Wheat Improvement Center (CIMMYT) in Mexico, says today's wheat appears to retain characteristics from its wild wheat ancestors, therefore leaving room for improvement.

"We are still taming wheat," he says. "Wild wheats used to grow in competition with other plants such as weeds, whereas today farmed wheats largely compete with themselves."

CSIRO Plant Industry, the Australian National University and the University of Queensland worked together on the project, which ran from 1999 to 2006.

Dr Reynolds says new breeding techniques are crucial to meet the expected increased demand. "Current rate of genetic progress from breeding will not meet predicted demand, especially in the developing world," he says.

Wheat is a staple food with 220 million hectares grown worldwide – half of it in developing countries. CIMMYT believes that worldwide demand for wheat will grow by about 1.3 per cent – and slightly more than this figure in developing countries.

Wheat breeding programs around the world, particularly during the 'Green Revolution' in the 1960s, made significant genetic gains in yield potential without the aid of physiological selection tools. But improvement in genetic yield potential since then has fallen to less than one per cent a year, too low to keep pace with future demand.

Dr Reynolds, who recently published a review on impacts of international wheat breeding with wheat breeder and Nobel Laureate Dr Norman Borlaug at CIMMYT*, says the Green Revolution, which helped feed the world, also reduced pressure on the environment.

CIMMYT research indicates that if the global cereal yields of 1950 had still existed in 1999, an extra 1.8 billion hectares of similar land would have been required. But the extra land would not have been available without deforestation and exploitation of marginal lands, least of all in Asia, where the population increased from 1.2 to 3.8 billion in that period.

Also, if natural ecosystems had been brought into agricultural production at the time, the environmental consequences would have been the loss of biodiversity, and the extinction of some plant and animal species. There was also the issue of unforeseen disease epidemics that could wipe out many of the world's crops, leaving a critical shortage of a staple food unless a way was found to improve resistance to disease.

For example, a major stem rust epidemic could cut world wheat production by at least 10 per cent within one or two years, cause huge economic loss and reduce the calorie intake of millions of people.

The research – 'Increasing yield potential in wheat: complementing conventional breeding by application of novel physiological and

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germplasm strategies' – was conducted in Mexico and Australia.

Dr Reynolds says identification of traits that limit yield through experimenting in field environments, or searching for better sources of those yield-limiting traits in genetic resource collections, could help lift yield. Traits could also be combined into good background cultivars and selected for increased yield, using integrative physiological traits such as canopy temperature.

To find these traits, researchers have been turning to wild wheats and ancestral grasses that contain the genetic origins of modern cultivated plants.

The team found that stomatal-aperture traits, such as leaf permeability and canopy temperature depression were useful for indirect selection for yield potential as well as yield under drought. Incorporating these traits into breeding and selection should increase progress by dollar spent.

The team also found spike fertility and biomass at flowering limited yield. "We have found germplasm with greater spike fertility and developed screening techniques, such as spectral reflectance, to screen for biomass at flowering," Dr Reynolds says. "Collaborations in the UK have also been established to determine the genetic basis of spike fertility in spring and winter crosses with large spike materials."

Dr Reynolds says a piece of chromosome associated with leaf rust, containing gene LR19, has been shown to be associated with increased spike fertility in wheat, but in this case only delivered higher yield under optimal conditions. Results from the trials could be followed

Wild ancestors, and also the seed of old landrace varieties that have self-sown in remote areas, have become an importance genetic resource as researchers seek out traits that will give modern wheat crops more environmental resilience.

Dr Matthew Reynolds

up in several ways, he says. Molecular markers could be developed for stomatal aperture-related traits and other yield-enhancing traits to provide additional tools for improving breeding efficiency.

The true biological yield potential of wheat in different environments, including marginal environments, based on physiological insights grained from the current work, could also be further exploited. And the capacity of national agricultural research systems (NARS) to fully implement the use of physiological selection criteria in breeding could be developed.

While one of the aims of the research was to help poorer countries gain greater yields for themselves and therefore not have to import expensive grain, there were also benefits to Australian wheat growers.

Dr Reynolds says the technologies being developed are equally applicable to collaborating countries and NARS breeding programs. Increasing yield potential in a high-yielding wheat is also good for wheats in low-yielding environments, and he says higher-yielding wheats in irrigated environments could be adapted to drier areas such as Australia.

The varieties with higher genetic yield potential, when combined with genetic disease resistance, were generally higher yielding under all levels of inputs, so farmers benefited, irrespective of how much fertiliser was used.

The technologies developed by the ACIAR project should also significantly improve the efficiency of early generation and advanced line selection. They should also provide a better knowledge base to develop more strategic crossing plans, by identifying yield-enhancing traits in new and conventional sources of germplasm.

Dr Reynolds' report states that shifting the wheat yield frontier will have an immediate impact on raising farm level yields and reducing unit production costs. This should mean greater domestic food security and more wheat available at a lower price, therefore benefiting poor consumers, rural and urban.

The report says if the research could improve the rate of increase in genetic yield gains by just one tenth, or from 1.0 per cent to 1.1 per cent a year, the annual output will reach 685 million tonnes a year by 2020.

The international wheat breeding research funded by ACIAR through international agricultural research centres (IARCs) such as CIMMYT means research is not duplicated and poor countries do not need to spend money developing their own technologies. IARCs provide continuity in agricultural development that would otherwise be uncertain for many less developed countries where economic, political, and social instability are commonplace.

While national wheat breeding programs in countries such as Argentina, India and China are stable, there is a high turnover of researchers and some may not even get regular funding.

The benefits and efficiency of the international collaborative platform are indisputable when considering the duplication otherwise needed to achieve the same impacts through unilateral or even bilateral programs.

One of the major challenges to improving food security in rural resource-poor communities is to develop cultivars tailored to specific local environments. While germplasm can be developed at a national and international level to incorporate generically useful traits, it is a major challenge for scientists with limited public sector resources to test the full range of genetic diversity generated by a breeding program under all possible environments.

* See 'Big bang from wheat breeding bucks', www.cimmyt.org ◂

Peanuts without poison

Minimising aflatoxin contamination offers significant health benefits in countries where peanuts are an important food, reports Rebecca Thyer

Indonesia has a big appetite for peanuts – producing more than 800,000 tonnes each year. But demand outstrips local supply, making Indonesia one of the world's largest peanut importers. Nearly all peanuts are consumed as food, especially among poorer communities, because they are a rich source of protein, oil and vitamins. However, an under-recognised problem associated with peanut consumption by humans is the risk of aflatoxin contamination.

Aflatoxin is one of the most powerful natural toxins known – causing cancer, suppressing immunity and interfering with nutrient uptake.

Dr Graeme Wright, from the Queensland Department of Primary Industries and Fisheries, says aflatoxin invades peanuts during production or soon after harvest and is more prevalent in peanuts exposed to end-of-season drought stress.

He recently led an ACIAR project into aflatoxin contamination in Australia and Indonesia. In collaboration with the Indonesian Legumes and Tuber Crops Research Institute in Malang, East Java and the Southeast Asian Ministers of Education Organization BIOTROP Institute in Bogor, West Java, the project aimed to minimise aflatoxin contamination in Indonesian and Australian peanuts through research, development and extension of appropriate on-farm and post-harvest management practices.

In Indonesia, large numbers of peanuts are produced in the drier eastern areas – East Java, Sulawesi and the East Nusa Tengara region – and are often exposed to the severe end-of-season drought stress that favours aflatoxin development.

For Australia's 60,000-tonne industry, aflatoxin risk is also closely related to drought stress. Although contamination has been a problem in the industry for nearly 20 years, it only recently became a major

In the foreground is an untreated plot in southern India; in the background are peanut plants treated with an insecticide.

Peanuts for a new age

NEW TECHNOLOGY MAY HELP INFORMATION ABOUT SUCCESSFUL PROJECTS TO INCREASE PEANUT PRODUCTION REACH TWO MILLION FARMERS, REPORT KELLIE PENFOLD AND REBECCA THYER

PARTNER COUNTRY: India PROJECTS: CS2/1994/050, CS1/1997/114 DESCRIPTION: The projects aimed to increase peanut yields by breeding more drought-tolerant genotypes and tackling white grub infestations
CONTACT: Dr Graeme Wright, 07 4160 0734, Graeme.Wright@dpi.qld.gov.au; Dr John Rogers, 07 3720 9065, john.rogers@rcac.net.au; www.rcac.net.au, www.etc-india.org or www.fdc.org.au

A major crop in many tropical and semi-tropical areas of the world, peanuts (also called groundnuts) rank in the top 10 of the world's most important food crops and are a major source of cooking oil and protein.

For example, in India about 14 million families farm 8.6 million hectares of peanuts, but it is estimated the crop may influence the livelihood of more than 100 million Indians.

Like Australian crops, Indian peanut yields are often severely retarded by a lack of water during crop growth. This arises from unpredictable rainfall, high evaporation and production on degraded and low water-holding soils.

The breeding of more drought-tolerant genotypes could provide a long-term option to increase productivity in drought-prone environments.

Through an ACIAR-funded project, Dr Graeme Wright of the Queensland Department of Primary Industry and Fisheries (QDPI&F), his peanut team and researchers from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) set out to improve the drought tolerance of peanuts using breeding approaches that draw on physiological traits.

Through this breeding approach, the team was able to select high-yielding genotypes with drought tolerance.

Dr Wright says the project was hugely successful, with drought-tolerant varieties now at very advanced stages in both Australia and India. "Their introduction should improve yields in both countries and lead to improved food security for India's rural communities," he says.

The economic benefits of this ACIAR project speak for themselves – if a quarter of Indian growers adopt a drought-tolerant variety, then within 10 years an economic benefit of about 71,970 Lakh Rupees (A$287 million) net present value will be felt. Drought-tolerant peanuts will also have major economic benefits for Australian growers.

However, drought is not the only destructive force facing peanut production. White grubs – the soil dwelling larvae of scarab beetles – feed on the roots of the peanut plant, killing seedlings and sometimes older plants, as well as reducing drought tolerance and final yields. They can also attack important crops such as sugar cane and millet.

In India, $800 million worth of peanut crop is

issue – primarily because of the introduction of heavy penalties by peanut buyers. Penalty payments are applied on delivery to loads with aflatoxin levels of between 8 and 400 or more parts per billion (ppb).

With risk management goals in mind, Dr Wright and the team set out on a fact-finding mission. They found that fresh peanuts in Indonesia's 'wet produce' markets were commonly contaminated to levels well above acceptable health risk levels (35ppb). About 45 per cent of samples taken contained more than 50ppb, 33 per cent had more than 300ppb and 22 per cent exceeded 1000ppb.

They also found that contamination was fairly limited soon after harvest but became more serious at the fresh market retailer. It was clear that post-harvest aflatoxin contamination was the cause of this build-up in the food chain, specifically inadequate drying and poor storage conditions associated with high atmospheric humidity. Subsequent research found that the risks of pre-harvest contamination were relatively small in most production situations.

The project also road tested a low-cost immuno affinity-based analytical system for determining aflatoxin in peanuts and provided training to Indonesians at the three collaborating institutions. Dr Wright says project results will help Indonesia determine future research directions to minimise aflatoxin and hopefully provide policy makers with useful data to implement appropriate regulatory programs to minimise aflatoxin in the peanut food chain. ◂

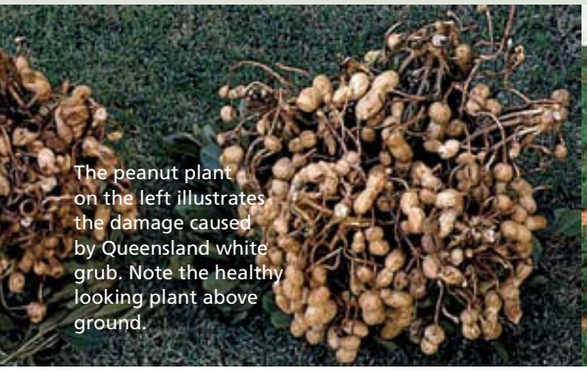
What is aflatoxin?

Aflatoxin is a carcinogenic, immune-suppressing and anti-nutritional contaminant. It is a major problem for human food and animal feed quality throughout the world. The toxin is about 25 times more harmful to people, causing liver diseases such as hepatitis and liver cancer. This is driving a push to decrease the levels of aflatoxin allowed in foods.

Trade of aflatoxin-prone commodities is already controlled and regulated. In countries with developed food safety systems, the consequences of aflatoxin are largely economic, affecting the price received for peanuts by farmers. However, in developing countries the price is mostly paid through the health of the population, since contamination by toxin is commonly ignored.

PARTNER COUNTRY: Indonesia
PROJECT: PHT/1997/017: Reducing Aflatoxin in Peanuts Using Agronomic Management and Bio-Control Strategies in Indonesia and Australia
DESCRIPTION: Aflatoxin contamination of peanuts is a major health risk for Indonesians, yet its risks can be better managed
CONTACT: Dr Graeme Wright, 07 4160 0734, Graeme.Wright@dpi.qld.gov.au

JOHN ROGERS



The peanut plant on the left illustrates the damage caused by Queensland white grub. Note the healthy looking plant above ground.

ACIAR white grub project leaders John Rogers, Anitha Reddy and Andrew Ward (standing seventh to ninth from left) meet with Mans Lanting from ETC India (sixth from left), local farmers and local NGOs to look at a peanut crop in southern India.

lost to white grub each year. Australia also suffers considerable losses of at least $0.5 million a year.

The biology of white grubs differs slightly between countries and in Australia, the plant can still look healthy while the crop underground is being damaged. Damage can only be assessed when digging a plant, rather than pulling it out. (When a harvester pulls out the plant, the damaged section is left in the ground.) In India, the grubs are more aggressive and can destroy whole sections of the crop.

Dr John Rogers led an ACIAR project between 1997 and 2002 on the management of white grubs in peanut cropping systems in Asia and Australia. "In Australia, white grubs do not pose a major threat to the peanut industry: aflatoxin does, and therefore gets top research and development priority," he says. "An insecticide to prevent white grubs in Australian peanuts is known, but it has never been commercially developed. However, it is about to go off-patent so one of the generic pesticide companies will hopefully pick it up."

The first task of Dr Rogers' project – run by QDPI&F with the University of Queensland, Rajasthan Agricultural University in India and ICRISAT – was to gain a better understanding of the biology of the pest.

"Early on we realised that the greatest potential for impact was in southern India, so we focused our efforts there," Dr Rogers says. "We were able to link up with the successful network established in farming communities by the ETC group, a Dutch aid agency which had NGOs already working with farmers at the grassroots level.

"We were able to distribute surveys, collect samples and conduct on-farm experiments through those NGOs. Once we established the levels of infestation, we were able to come up with recommendations on control.

"Many of the farmers knew they had a problem in their crops but they didn't know what it was. We produced a booklet with good photos in English and the three local languages called *Why are my groundnut plants dying?* It was a great success in helping farmers correctly identify white grub and other problems.

"Then we were able to recommend a low-cost chemical control program which suited these growers, who were very poor, with many in debt."

He hopes to see the information more widely distributed using India's new broadband infrastructure. Already 70 per cent of villages in India have access to broadband internet with 670,000 kilometres of cable laid. Plans are for every village to be online by the end of 2007 and to have their own ICT (information and communications technology) knowledge centre.

"I can imagine an Indian peanut grower being able to come into a telecentre and ask a question of NGOs or other farmers in southern India, or even directly to an Australian researcher via the internet and being able to get an answer," he says. "This could be backed up with CD-ROMs, presentations via the internet, farmer support programs on Doordashan (the Indian State TV network) and hardcopy publications to help them identify and manage problems in their crops.

"We've done all the research necessary to manage the problem, but much of that has stayed with the researchers. For a small expense, we can use this new technology to share this knowledge with more than two million farming families in India." ◂

The hybrid vigour of sexless rice

Researchers mount an ambitious project to create one-line hybrid rice varieties, reports Gio Braidotti

PARTNER COUNTRIES: Global PROJECTS: CIM/2002/106: Fertilisation-independent formation of embryo, endosperm and pericarp for apomictic hybrid rice; and CS1/1995/125: Molecular tools for achieving Apomixis in rice DESCRIPTION: IRRI and Australian researchers aim to create one-line hybrid rice varieties to help boost rice yields CONTACT: Dr John Bennett, j.bennett@cgiar.org

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A Cambodian villager harvesting rice: crop yields need to keep pace with population growth.

With more than half the world's population reliant on rice for food security, the International Rice Research Institute (IRRI) in the Philippines is facing a stark challenge in the 21st century. There is a need to ensure crop yields continue to keep pace with population growth at a time of growing scarcity of land suitable for cultivation.

Part of the food security equation is to continue to apply advanced breeding techniques to lift crop yields. However, the gains needed are daunting. One estimate predicts that by 2030 farmers will need to produce 60 per cent more rice than in 1995.

In recent times, yield improvements have been achieved by harnessing the vigour of first-generation hybrid seed. Chinese scientists bred the world's first rice hybrid in 1974, a significant achievement given that rice normally self-pollinates. The scientists achieved this by transferring the male sterility gene from wild rice to create the 'cytoplasmic genetic male-sterile' or CMS line.

When combined with two other lines, CMS allowed the development of 'three-line hybrid rice', which delivered a 15 to 20 per cent yield increase over high-yielding bred varieties. In 1995, China further refined the technique and developed two-line hybrid rice. The UN Food and Agriculture Organization (FAO) has estimated that with 15 million hectares under hybrid rice cultivation – about half of China's total rice area – national average rice yields increased from 3.5 to 6.2 tonnes a hectare.

However, producing three and two-line hybrid rice seed is technically complex, expensive and out of reach of the poorest growers because of the need to buy seed on a yearly basis to capture the yield benefit, says Dr Abed Chaudhury from CSIRO Plant Industry.

The experts agree that what growers need is a hybrid line whose seed – besides providing a food crop – can produce an embryo that is a clone of the first-generation hybrid plant. Being a clone it can maintain the hybrid vigour of its mother, delivering to the farmer the yield advantage minus the need to buy seed.

The technical name for one-line hybrid rice is apomictic rice. Apomixis is an asexual type of reproduction in which the plant embryo grows from egg cells without being fertilised by pollen. It can be used to lock in hybrid vigour or other desirable agronomic traits because it avoids aspects of the sexual reproduction process, such as meiotic recombination, that lead to genetic variation.

Transforming sexual plant species into apomictic forms is considered the ideal approach by many breeders, and in 1997 Australian researchers and IRRI undertook the mammoth task to make that dream a reality for rice by 2022.

Funded by ACIAR, the project is headed by IRRI's Dr John Bennett and Dr Abed Chaudhury.

"Apomixis is found in some 300 species of plants, including many that are close relatives of cereals, but there is no known relative of rice that is apomictic," Dr Bennett says. "That means the project involves building a synthetic version of apomixis using genetic engineering. If that can be achieved, then there is an outside chance that we can repeat the process through mutagenesis to produce a non-genetically modified (GM) variety."

Dr Bennett explains that normally in rice there are two fertilisation events, both of which need to be modified. One generates the embryo via fertilisation of the egg. The other involves fertilisation of a cell that produces the edible endosperm.

"The CSIRO team has made significant headway solving the problem of endosperm production in the absence of fertilisation," Dr Bennett says.

From work done with *Arabidopsis* (the model plant system for experimental genetics), the CSIRO team was able to identify – for the first time – the genes that control partial apomictic development, the so-called FIS (fertilisation-independent seed) genes.

"Because the FIS genes are present in rice and the rice genome has been sequenced, we could readily isolate FIS-class genes in rice," Dr Chaudhury says. "Since the genes function as suppressors of partial apomictic development in *Arabidopsis*, what we needed to do was switch these genes off in rice."

To achieve that goal, ACIAR-funded post-doctoral fellow Dr Ming Luo generated transgenic rice lines using a gene-silencing technique developed by CSIRO called RNAi (RNA interference).

"When you silence FIS-class genes, you remove the suppressors and then you observe both autonomous endosperm development and partial embryo development," Dr Chaudhury says.

The next frontier, according to Dr Bennett and Dr Chaudhury, is achieving full embryo production in the absence of fertilisation. "We have a lot of ideas about how to achieve it which we are testing at the moment," says Dr Chaudhury.

He remains optimistic that the ultimate target can be achieved and an increased rice production system can be made available to poor farmers.

"This is one of the most ambitious projects in plant biology," says Dr Chaudhury. "But the international community is once again becoming excited about the possibilities of apomixis and its ability to make seed production so much easier. Of course, once we can do it in rice, it opens the way for apomictic varieties of other cereals." ◂

Farm women shoulder the burden

In developing Asian countries women are left by their husbands for part of the year and must take on farm managerial duties, reports Jenni Metcalfe

PARTNER COUNTRIES: Australia, Thailand and Vietnam PROJECT: PLIA/2000/039: Impact of migration and/or off-farm employment on roles of women and appropriate technologies in Asian and Australian mixed farming systems DESCRIPTION: The project will assess the effects of off-farm employment on agricultural productivity, farm efficiency, welfare and the changing roles of women at the household, farm and local levels CONTACT: Thelma Paris, t.paris@cgiar.org

"My husband comes home once a year … so aside from the traditional tasks I used to do, I now have to take over the jobs that my husband did, such as preparing the nursery for rice seedlings, irrigating the fields, broadcasting fertiliser and spraying pesticides. After going to the market and finishing household chores, I visit our fields every day."

This was how Mrs Lien describes her life since she started running the family's irrigated farm in South Vietnam. Her husband works in a private shoe factory in Ho Chi Minh City. This leaves Mrs Lien to raise the family as well as single-handedly oversee the small farm's rice-growing.

In the northern Philippines, another woman whose husband is a seasonal migrant says: "If my husband is away, I supervise the farm's crop operations. My husband leaves after the land preparation to work as a carpenter in another province for at least four months. Now I have to check when the crop is ready and start hiring labourers to harvest it. I find it difficult to hire labourers because there is competition during these peak months."

In north-east Thailand there are similar stories of women left behind to take on new managerial responsibilities.

"Although my husband's remittances from construction work are a big help to us, particularly for my children's education, I have to manage the labourers for rice production and for crop care of the rubber plantation," says one Thai wife. "I make all the decisions on farm and household matters. When in doubt, I consult my husband via telephone."

Women changing roles from unpaid family worker to farm manager is becoming increasingly common in developing Asian countries. However, their lack of access to the information and resources they need for new crop and water management technologies can have a negative impact on the productivity and sustainability of local agriculture, says Dr Thelma Paris, a social scientist with the International Rice Research Institute (IRRI).

"Agricultural technologies, practices, policies and systems are based on the conventional assumption that farmers in developing countries are full-time male farmers," Dr Paris says.

She says that while agricultural projects deal mostly with introducing, validating and evaluating technologies to reduce poverty and improve livelihoods in developing countries, there is a need to understand drivers of change: "We need to examine the factors that constrain or support the adoption and diffusion of technologies."

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Dr Thelma Paris, a social scientist with the International Rice Research Institute (IRRI).

Dr Paris is leading an ACIAR project that is looking at social changes occurring in agriculture in Asia and Australia, and the changing role of women as a result of off-farm employment or migration.

The project is a collaboration between IRRI, Curtin University of Technology (Australia), Khon Kaen University (Thailand) and the Cuu Long Delta Rice Research Institute (Vietnam).

The team brings together a mix of social science skills, including gender specialisation, agricultural economics, sociology and extension.

Data and information collected from her surveys will be used to assess the effects of off-farm employment on agricultural productivity, farm efficiency, welfare and the changing roles of women at the household, farm and local levels.

"Economic pressures push members of farm households to seek off-farm work, leaving one partner to look after the farm," Dr Paris says. "This is also true of the dryland farming areas of Australia where the vast majority of farming families undertake off-farm work.

"The bottom line is that, while remittances are useful in helping families left behind, women must maintain productivity levels and deal with increased burdens and responsibilities.

"Our research should provide early warning of rapid changes that may be undermining the national and regional food security that we've worked so hard to achieve over the past several decades."

The results of the research so far show that the proportion of households with migrants (individuals away for more than three months who send their income back home) is higher in Thailand than in the Philippines and in Vietnam. A higher proportion of males migrate compared to females in Thailand and Vietnam, but the opposite is true in the Philippines, where most of the migration is international rather than domestic.

"My husband is away 20 to 30 consecutive days without communicating with me," says Mrs Tran Thi Dao, a 35-year-old mother of three from South Vietnam whose husband is a short-term migrant working as a labourer digging soil. "His earnings are spent on food (rice and meat), children's health care and school supplies."

Mrs Tran Thi Dao's husband became a migrant worker just one year after they married. However, her husband's off-farm income is not enough to

cover the farming costs – seed, fertiliser and pesticides – which are bought on credit with the hope that this can be paid back at harvesting time.

"When I have free time, I work as a hired labourer for additional income," Mrs Tran Thi Dao adds. "I feel so alone and lonely without my husband. I worry that no one will take care of my children if I get sick." She is also concerned that she knows little about rice diseases and has to depend on local pesticide dealers for advice.

Shouldering responsibility for the farm is also a burden for Mrs Lien. "I find it quite difficult to go to the field at night to monitor the water level to ensure that the rice grows well. Before I was too scared to go to the fields by myself but since I do not have any choice, I have learned to overcome my fears. I have to go to the field to let water into the rice fields and wait until the water level is sufficient. I wish my husband was here but I know we have to sacrifice so that we can put our children into school."

Women who live alone feel vulnerable and many have to rely on neighbours for protection.

The experiences of the women quoted are typical of some 800 farming households that the researchers have talked with in Thailand, Vietnam and the Philippines. To poor farming families in Asia, migration is a survival strategy where most of the off-farm income is spent on food, debt payments, children's education and farm inputs.

In Australia, results of similar focus group discussions showed that many women are engaged in off-farm work to supplement household income. At the same time, they also make significant contributions to on-farm work.

"We are currently having in-depth discussions with households to look in more detail at the unique personal, social and economic constraints faced by women who are heading up or managing farms, compared to those headed up by men," Dr Paris says. "We hope to identify policies, technologies, training and extension practices that might overcome these problems. This might include training courses in integrated pest management, the efficient use of water and nutrient management."

Local on-farm strategies and activities will be tested by 60 women who are heads of farms in selected villages in the Philippines, Thailand and Vietnam. The Australian project will focus on the capacity building of women farmers and may include training about supply chain marketing, new and emerging markets, information technology and leadership in agriculture.

"Understanding the impact of migration and off-farm work on farming is important in improving agricultural productivity and the well-being of farm families in all risky farming environments," Dr Paris says. ◂

Other project team members include Chaicharn Wongsanum at Khon Kaen University, Thailand, T Chi at Cu Ulong Delta Rice Research Institute and Joyce Luis at the Social Sciences Division, IRRI.

Watching the water ways

REALLOCATING WATER COULD HELP BOOST AGRICULTURAL PRODUCTION IN CHINA. REBECCA THYER REPORTS ON A PROJECT BUILDING THE NECESSARY POLICY FRAMEWORK

PARTNER COUNTRIES: China, Australia PROJECT: ADP/2000/120: Institutions and policies for improving water allocation and management in the Yellow River Basin, China DESCRIPTION: By creating the right policy framework, this project aims to help improve water use in China CONTACT: Anna Heaney, ABARE, Anna.Heaney@abare.gov.au

PHOTOLIBRARY.COM

Hukou Waterfall on the Yellow River.

China's booming economy and rapid population growth have increased industrial and urban sectors' demands for fresh water, placing increasing pressure on water resources that remain available for agriculture.

About two-thirds of China's cultivated land is in the Yellow River Basin, but it has less than a quarter of the nation's water resources. One possible answer to this disparity is to reallocate water to higher-value crops and more productive areas, which in turn would also increase the value of agricultural production by an estimated one billion Yuan (A$165 million) a year (almost a two per cent rise).

The benefits of water reallocation were uncovered through an ACIAR-funded modelling project led by the Australian Bureau of Agricultural and Resource Economics (ABARE), in collaboration with the Center for Chinese Agricultural Policy and the International Water Management Institute.

A project team member, ABARE's Anna Heaney, says water in China is state-owned and irrigation districts are granted a right to withdraw a fixed volume of water from a river or dam. This water is then distributed by canal to villages. Allocations are made administratively without differentiating between land type or crop sown.

"By concentrating on areas with better potential and diverting water to these areas, China could boost its agricultural returns," Ms Heaney says.

However, before those benefits can be realised, water property rights and exchange rules must be defined and evaluated, or those in water-exporting areas will suffer.

"Because farmers do not own the rights to the water, those in the poorer agricultural regions that give up their water will not receive the benefits from water sales," she says. "That's why compensation is important and it needs to be in place before China can realise the benefits of water reallocation."

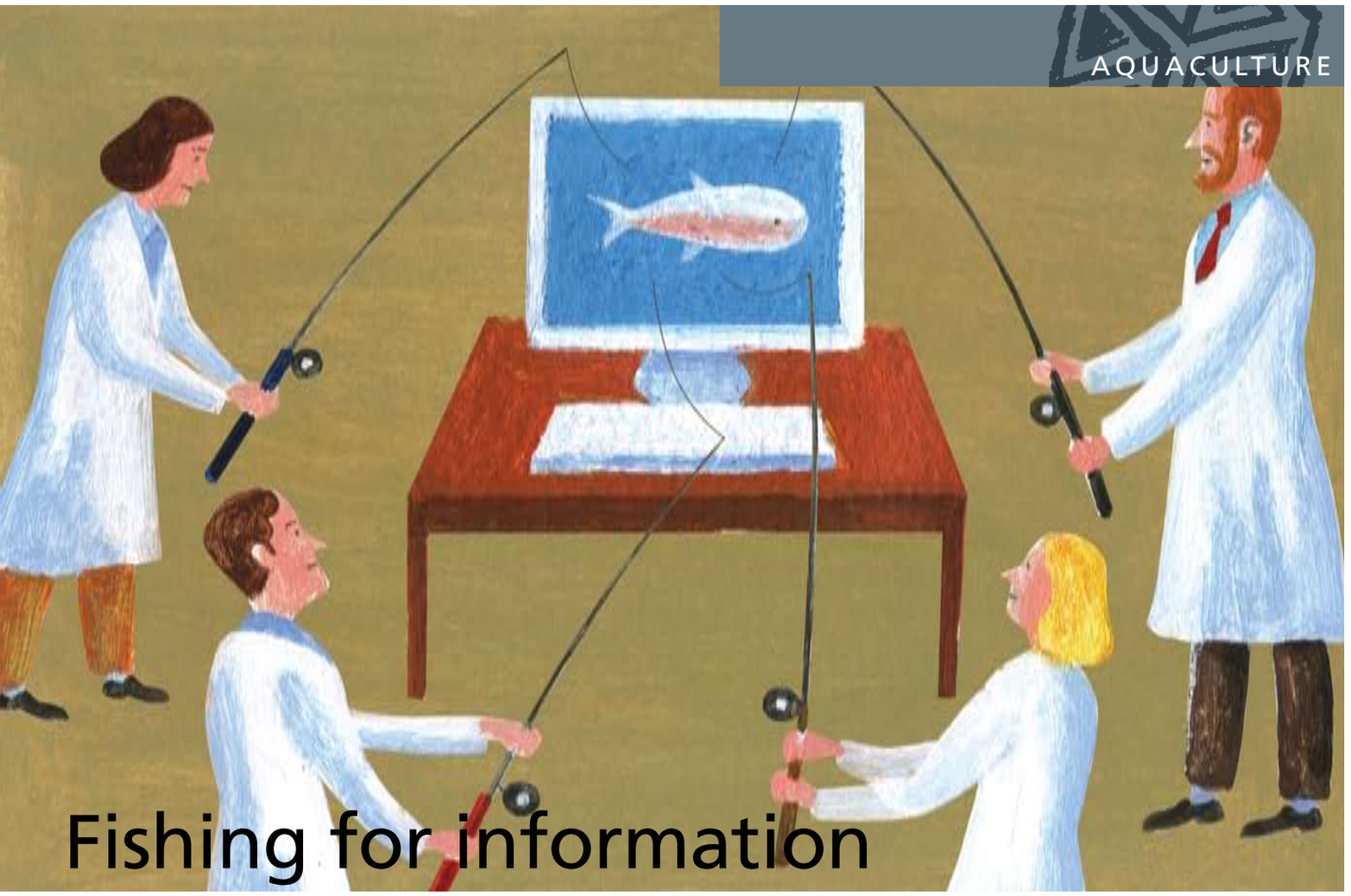
Providing incentives to save water and reallocating water resources to best meet competing demands are important aspects of both water and agricultural policy reform in China. "The drive to change water policy is already there," Ms Heaney says. "We're working to develop systems of water property rights and exchange rules to underpin the more efficient use of water resources in the Yellow River Basin."

If farmers in water-exporting regions held the property rights to transferred water, income from water sales could offset lost income from reduced agricultural production. Revenue from water sales could see those incomes rise substantially – income from water sales is estimated at 500 million Yuan a year.

But without compensation, the regions with the lowest incomes are likely to be affected most.

Ms Heaney says the team has looked at the benefits of reallocation from a provincial level. "We are now working out the benefits at a village and irrigation district scale, and looking into what kind of institutions are needed to do that."

Results from this analysis will be presented at the International Association of Agricultural Economists meeting in August 2006. ◂



Fishing for information

PAUL DICKENSON

The expanding global aquaculture industry offers a significant economic opportunity for many people in developing countries, but progress is often hampered by a lack of useful information, reports Rebecca Thyer

PARTNER COUNTRIES: Global PROJECT: FIS/2002/036: Development of the Aquaculture Compendium DESCRIPTION: Compiling useful information on aquaculture into a single resource CONTACT: Elizabeth Dodsworth, CABI, e.dodsworth@cabi.org

Aquaculture is one of the world's fastest-growing primary industries, especially in Asia, where more than 90 per cent of aquaculture production now takes place. Most of the growth is also happening in this region. However, the full potential of this increasingly important industry is often hampered by a lack of relevant, localised information. Many farmers also have difficulty accessing what information does exist, so providing people with available knowledge has been the focus of a recently completed ACIAR-funded project.

The project team, from the UK-based not-for-profit publisher CABI, compiled an *Aquaculture Compendium* based on its own innovative technology for knowledge management.

Essentially a search-based multimedia encyclopaedia, the compendium contains text, pictures, maps, databases, bibliographic data, diagnostic keys, taxonomic information and statistics, and is available on CD-ROM or via the internet – making it primarily a tool for extension officers and researchers.

CABI was approached by aid organisations in Australia and Asia to carry out the project, based on its well-known role in compiling information, particularly for researchers.

Project team member Dr Elizabeth Dodsworth, CABI's information for development director, says a lot of important information already existed: "Our job was to bring it all together and identify any gaps." The team commissioned material to fill those gaps and sought permission to reproduce existing material.

Dr Dodsworth says the information is intended for extension officers, practitioners and small business owners. Through their work it will be passed on to rural workers.

"Aquaculture has great potential to improve socioeconomic conditions and environmental sustainability worldwide. The compendium will help address information needs and ultimately contribute to improving the sustainable livelihoods of people dependent on aquatic resources."

Dr Martin Parr, who managed the *Aquaculture Compendium* editorial process, says a more comprehensive approach was taken to this work than for CABI's earlier compendium projects. "We took a different approach to this work. In addition to including pre-published information and numerous commissioned datasheets, we also commissioned a series of case studies with links to the R&D behind this work from institutions in Bangladesh, Vietnam and Thailand. We basically documented local practices and provided links to more information."

He says information was presented in this way to ensure maximum use of the material available.

"By providing relevant and interesting case studies, those working in aquaculture can immediately relate to problems or issues they might be facing," Dr Parr says.

Support for the newly released compendium has so far been very positive. Dr Dodsworth says it shows a big shift in developing countries towards aquaculture.

The compendium is available for purchase and will also be distributed through project partners, including ACIAR. ◂

For more information: www.cabicompendium.org/ac

THE BEST RECIPE FOR PIGS

Problem pigs: slow-growing and malnourished.

Dr Jusuf (left), a project sweet potato breeder, and an assistant check a crop's progress.

A project in Papua New Guinea and the Indonesian province of Papua is seeking to enhance a traditional village-based food production system, reports Roger Beckmann

Pigs have long played an important role in traditional New Guinea society, as valuable commodities and an important source of animal protein. Also important – both to villagers and pigs – are sweet potatoes. This vegetable together with pigs forms one of the fundamental village-based production systems.

In Papua New Guinea (PNG) and the Indonesian province of Papua, which makes up the western half of the island of New Guinea, the importance of pigs is increasing because they have the potential to be a source of income as well as meeting more immediate food needs. However, there are several problems with trying to expand the pig population. Traditional village pigs grow very slowly, their final weight is not great and their fertility is low. In terms of producing meat, the sweet potato/pigs system is very inefficient.

So the important question is how to improve production in a way that is sustainable, affordable, culturally acceptable and achievable within the context of remote Papuan villages.

To help find the answer, ACIAR has been funding a project to study all aspects of the sweet potato/pig production system in Papua. The project, managed by the CGIAR International Potato Center (CIP), falls into two broad parts – one connected with the nutritional value of the sweet potato and the other concerned with improving the husbandry and management of pig-raising.

Sweet potato is an important crop to the Dani people in Papua, but it seems little selective breeding to improve the plant has been carried out.

Sweet potatoes store starch and sugar in the edible underground tuber. The parts above ground – the vine and the leaves – are also edible, but they contain relatively little starch. Starch is a carbohydrate that when eaten becomes an energy source. Usually, carbohydrates are not in short supply in places where there is adequate rainfall, sunshine and soil for good plant growth. The nutrient that is most often limited in ecosystems and agricultural systems is protein. If the sweet potato plant contained more protein – and this would be mainly in the leaves and stems – then it would support faster pig growth. Of course, larger tubers with increased starch would also help, yielding more food for the time spent harvesting.

In earlier ACIAR-sponsored work, scientists studied sweet potato varieties and selection in Vietnam and material from that research will now be adapted to Papua. Another source of sweet potato knowledge comes from Indonesian scientists who developed new varieties of the plant for human consumption at the Research Institute for Legumes and Root Crops in Malang and the the CIP 's South-East Asia and Pacific office in Bogor.

Pig problems

To find out how to improve the village production system and why

AND SWEET POTATOES

Liem Mahalaya, project officer, the Dani project coordinator and villagers inspect new lalekens (small paddocks) planted with pasture.

Pigs feed on cooked sweet potato roots and vines, supplemented with forage grasses and banana trunks.

the animals grew so slowly, the team's scientists carried out a survey of pig health in Papua. The results showed that the pigs' problems extended beyond their diet.

Many of the animals were riddled with parasitic nematode worms, in fact almost every pig parasitic worm recorded in the literature was identified in the surveyed pigs. Worms were abundant in the intestine, but some species migrate around the animal and into the muscle (meat) and other organs. The scientists also found several pigs harbouring parasitic protozoa. Some of the nematode and protozoa species in the pigs could easily infect humans. In addition, the pigs were infested with mites and lice and local scientists have recorded diseases such as bacterial meningitis and pneumonia.

Together, the parasites and diseases constituted the principal reason for the slow growth of pigs, but infection was not the whole story. Some of the pigs were suffering from liver damage brought about by a class of chemicals called pyrrolizidine alkaloids. These occur in some of the plant species that grow naturally in the area.

The pigs were allowed to roam at will during the day and would browse on the toxic plants. The exact effects of the alkaloids are still not clear, and they may be responsible for the pigs' low fertility. Back in 1989, project team member Dr Colin Cargill, from the South Australian Research and Development Institute (SARDI) in Adelaide, and his co-workers noticed that if village sows in Tonga ate plants containing alkaloids they often died after giving birth.

A survey of local plants showed that several are non-toxic and high in protein. Some of these are grasses, but there are also tree species with protein-rich leaves. If pigs ate these plants rather than the leaves of the sweet potato, their dietary protein intake would increase, helping their growth rates.

Two fast-growing and relatively drought-resistant tree species are especially promising, not only as a protein source but as a good source of wood suitable for fence-building or for cooking fires. This is significant because other findings suggest that fences could play an important part in improving pig productivity.

Keeping them in

It was clear that confining pigs to areas where there are few, if any, toxic plants would help improve productivity. It could also help the parasite problem, as the animals' ability to acquire infection from elsewhere would be reduced. However, the important feature would be to prevent constant reinfection of worms between the pigs.

The typical system sees pigs kept within a family compound overnight and then let out in the morning. They roam free around the village, saving on food as the animals seek out material to eat.

Usually, domesticated pigs will not defecate in their own sleeping area overnight. Instead, they release their dung when first let out in

SWEET POTATO DIAGNOTES

A CD and internet resource for sweet potato crop management

ACIAR has recently released a new software product for sweet potato farmers, extensionists and researchers.

Sweet Potato DiagNotes contains an interactive diagnostic key allowing more than 80 problem-causing agents (diseases, insect pests, nematodes, nutritional disorders and environmental factors) to be identified from the symptoms and signs observed on the crop. For each problem, there is a detailed fact sheet providing photographs and information on identification, importance and management of the problem.

There are also fact sheets on other aspects of sweet potato production and soil fertility management.

This is the most comprehensive publication yet produced on sweet potato management and will provide a valuable reference tool for those working with this crop.

Sweet Potato DiagNotes is the product of a collaboration between the University of Queensland, the International Potato Center (CIP) and the Philippine Root Crop Research and Training Center (Philrootcrops), funded by ACIAR. The product has taken more than four years to develop and brought together the expertise of crop pathologists, entomologists, nutritionists and nematologists from around the world.

The interactive key utilises Lucid™ software, a University of Queensland product that has been extensively used for taxonomic keys. Its application in diagnostic keys (expert systems) is a more recent development and *Sweet Potato DiagNotes* breaks new ground in its scale and user-friendly features.

The product can be accessed free at www.lucidcentral.org/keys/sweetpotato or a CD can be ordered from ACIAR by emailing comms@aciar.gov.au. No charge will be made for Papua New Guinea users.

This is a new type of product for ACIAR and feedback from users is welcome. Please email feedback to both comms@aciar.gov.au and Dr Jane O'Sullivan at j.osullivan@uq.edu.au.

PARTNER COUNTRIES: Indonesia, Vietnam
PROJECT: AH/1998/054: Poverty alleviation and food security through improving the sweet potato-pig systems in Indonesia and Vietnam DESCRIPTION: The project set out to improve sweet potato-based production as a stable food and feed supply
CONTACT: Dr Colin Cargill, cargill.colin@saugov.sa.gov.au

Local veterinarian and project officer Liem Mahalaya prepares to tag pigs.

the morning in the same areas where children play and dogs roam. As a result, many pigs become infected with human or dog tapeworms, acquired from eating faeces, and children can acquire pig infections by playing in the dirt where the animals have defecated.

In collaboration with villagers, the scientists have suggested that pigs be let out into a specialised dunging area first. These areas would have stony ground on which the animals would defecate. The stony ground prevents pigs from eating earthworms, which are secondary hosts for some of the parasites. Periodically, these dunging areas would be cleaned out, the dung composted and later put on the fields for use in crop growth – however not where pigs would roam.

After their morning dunging, the pigs would be moved into fenced paddocks sown with high-protein plants and trees. Each pasture area would be used until about 50 per cent of the foliage had been eaten. Then the villagers would send the pigs to another area, allowing the initial pasture to recover. This rotational idea fits well with the traditional systems of agriculture familiar to villagers. Interestingly, villagers had previously used a similar system decades before, but Dutch missionaries encouraged them to let the pigs roam free in an attempt to save on the amount of food used to feed the animals.

Of course, the pigs still need supplementary feed and scientists are studying what should be included in this diet. Sweet potatoes are included, but they contain compounds known as trypsin inhibitors that inhibit the action of protein-digesting enzymes in the gut. These compounds can be inactivated by heat treatment. However, as cooking uses fuel, an alternative method is fermenting. Fermented silage containing a mixture of different, locally available food sources is the ideal.

With a good diet the pigs grow faster, and with treatment to remove parasites the situation is even better. The scientists demonstrated this to farmers. Untreated pigs in the village grew on average 30 grams per day. With treatment, parasite-free pigs fed on the usual village diet grew at 60gm a day. However, parasite-free pigs on an optimum diet (with good levels of high-quality protein) grew at the rate of 130 to 230gm per day. Achieving the best diet may require the addition of animal protein, as plant proteins can be deficient in certain amino acids. Scientists used available fish offal.

The work has stimulated great interest among the village farmers, who now discuss the issues amongst themselves as well as with the local scientists. An important part of the project has been to encourage participation, and it was the diet trials that caused excitement among the farmers.

Pig productivity will never equal that found in the developed world, due partly to the type of pig. Native pigs can only grow to a maximum weight of 80 or 100 kilograms. The types of pig commonly used in farming in Australia usually reach a weight of about 200kg, and frequently grow by about 600gm to 700gm a day.

But these figures are not what the team is aiming for at the moment. Instead, the scientists and the villagers are more than happy to improve their existing system and get the most out of what is already available. ◂

'WITH A GOOD DIET THE PIGS GROW FASTER, AND WITH TREATMENT TO REMOVE PARASITES THE SITUATION IS EVEN BETTER'

Exploring cassava's potential

Improving yields of staple crop cassava will help improve food security and also lead to more commercial opportunities, reports Janet Lawrence

PARTNER COUNTRIES: Indonesia, East Timor PROJECT: CIM/2003/066: Adoption of cassava in Indonesia and East Timor
DESCRIPTION: Cassava is the third most significant crop in Indonesia and East Timor, but yields are well below their potential CONTACT: Dr Reinhardt Howeler, ciat_bangkok@cgiar.org

As a staple food crop and the raw material for many industrial uses, the hardy root crop cassava has an important role in many parts of South-East Asia, particularly Indonesia and East Timor. Its tolerance of drought, poor soils, diseases and pests also add to its value in farming communities.

Although cassava is the third most significant crop in Indonesia and East Timor, yields are well below their potential.

Indonesia, for example, has gone from a net exporter to a net importer of cassava chips and starch in the past decade. Improved breeding lines grown in Indonesian trials have yielded up to 58 tonnes a hectare, yet the average yield for the country is only 14t/ha. In East Timor, trials have yielded around 40t/ha –10 times the local average of 4t/ha.

The challenge is to lift on-farm yields to the demonstrated potential so that food security can be established.

Dr Reinhardt Howeler, from the International Center for Tropical Agriculture (CIAT) regional office in Thailand, is leading the ACIAR project 'Enhancing the adoption of improved cassava production and utilisation systems in Indonesia and East Timor' to address the yield disparities.

The project draws on findings of an earlier ACIAR-supported 'Seeds of Life' project in East Timor, in which five Consultative Group on International Agricultural Research (CGIAR) centres supplied crop materials and expertise to identify better-yielding varieties of sweet potato, maize, rice, peanut and cassava. In this earlier project, CIAT supported the introduction of improved cassava varieties in East Timor, so it is well placed to help improve on-farm yields.

The new project is in the second year of its three-year life. Taking part are five research institutes and universities in Indonesia and a non-government organisation. In East Timor, both the National University and the Ministry of Agriculture are involved.

In Indonesia the project is building on previous collaborative cassava experiments and farmer participatory research (FPR) activities. In East Timor it is building on four years of participation in the Seeds of Life project.

Dr Howeler says: "We were fortunate that in both countries some demonstration plots were already in place, where farmers from the surrounding area could participate in the evaluation and selection of the varieties or technologies being tested, using their own criteria for selection. Some farmers are now conducting FPR variety trials on their own farms, which should enhance the adoption of new practices and increase farmers' yields and income."

Farmers in different regions have tested different varieties, chosen according to their end use.

In Lampung province, Indonesia, where cassava is used mainly for starch extraction, farmers selected for high yield as well as high starch content.

In Yogyakarta province, where cassava is grown for human consumption and some processing, farmers selected for yield and taste (sweetness).

At the two East Timor sites, where cassava is grown almost exclusively for food, farmers selected mainly for sweetness and texture, almost irrespective of yield or starch content.

Dr Howeler says it will be interesting to see if farmers' selection criteria change as, with a bigger harvest, they find other uses for cassava roots and leaves.

Meanwhile, in Lampung farmers have also visited a long-term fertiliser trial that has shown how potassium applications, and to a lesser extent nitrogen and phosphorus, can lift yields and improve soil conditions. In another development, feeding trials using cassava roots and leaves will start soon, involving pigs in East Timor and goats in Indonesia.

ACIAR has also supported successful work in Cambodia, where ensiled cassava leaves were fed to cattle. ◂

Indonesia, March 2005: a farmer and Indonesian researcher observe the response to fertiliser and manure application in an on-farm fertiliser trial conducted by farmers in Yogyakarta.

Tamanbogo, Lampung, Indonesia, September 2004: farmers are very happy with the high yields of some new breeding lines.

Betano, East Timor, January 2005: farmers evaluate the yields, taste and plant type of new introduced varieties from Indonesia.

FEEDING PEOPLE AND INDUSTRY

Cassava (*Manihot esculenta* Crantz) has many uses, making it a vital staple food and cash crop for many farm families throughout the developing world. It is also used to produce commercial animal feed and for paper and textile manufacturing. Its starch is used for food manufacture (tapioca and arrowroot are both derived from cassava starch), pharmaceutical purposes and for the production of many other starch-derived products and ethanol.

Its tolerance to drought and poor soils means it is frequently grown in conditions too harsh for other more traditional crops. It is also easy to grow and relatively free of diseases and pests in much of Asia. Indonesian farmers grow cassava mainly for off-farm sale to processors. In East Timor, it is grown largely for on-farm and household use and to boost food supplies as needed.

Better stubble beats drought

The hardiest crop for the toughest conditions – researchers are working to boost livestock production from pearl millet straw, reports Fiona Conroy

PARTNER COUNTRY: India PROJECT: LPS/1999/062: Improving the quality of pearl millet residues for livestock
DESCRIPTION: Researchers are working together to improve livestock production by improving pearl millet's feed qualities
CONTACT: Dr Tom Hash, c.t.hash@cgiar.org

The thrust of modern plant breeding to increase crops' grain yields has often overlooked the importance that crop residues play as a source of livestock feed. Yet in dry, arid agricultural areas it is vital nothing is wasted. When grain crops are harvested, the straw left behind is a potential source of feed for sheep, goats, camels, buffaloes and cattle.

Developing new hybrid varieties of pearl millet – the most widely grown millet – that have good grain yields and offer better quality straw for livestock is the goal of a major ACIAR-funded project.

The project brings together plant breeders from the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) in India, livestock nutritionists from the International Livestock Research Institute (ILRI) in Nairobi, national program pearl millet breeders in India and both public and private Indian seed companies.

Millet is any of about a dozen small-seeded grasses that are harvested as grain crops and pearl millet is the fifth most important cereal crop globally (after rice, maize, wheat and barley).

It is grown in more than 40 countries, from southern and western Africa through to India and Myanmar in southern Asia. It is used as a staple food grain and source of feed, fodder, fuel and construction material.

India is the largest producer of pearl millet, both in terms of area (9.1 million hectares) and annual grain production (7.3 million tonnes). India's average crop produces per hectare about 800 kilograms of grain as well as a couple of tonnes of straw, says Dr Tom Hash, the pearl millet breeder leading the project from ICRISAT's headquarters in Patancheru, Andhra Pradesh, India.

"In agricultural terms, pearl millet is the dual-purpose grain and straw crop of last resort in the driest regions of the tropics and subtropics – it can grow in areas where other crops are not an option," he says. "It can cope with extreme conditions which include high temperatures, low soil fertility and minimum rainfall."

Dr Hash says farmers in the desert margins of the north-western frontier states of Gujarat, Rajasthan and Haryana in India, near the border with Pakistan, are expected to benefit from this project.

Pearl millet covers nearly seven million hectares in this region, which is home to about 60 million people and includes the most heavily populated desert in the world.

Farmers sow their crops when the rains arrive in late June or early July and then harvest from September to October, Dr Hash says. "Pearl millet allows them to harvest a grain crop just 65 to 85 days after sowing, often with less than 400 millimetres of rain during the growing season."

New varieties of pearl millet with good grain yields and better quality straw are the goal of a major new ACIAR-funded project.

Pearl millet growers in this region are mostly small, subsistence farmers who sow less than five hectares of the crop a year. Grain harvested is principally used for their own household consumption, with the main source of farm income coming from livestock and milk sales, making better quality feed stock important.

Pearl millet straw is harvested in bundles and stored to use as stock feed, but the challenge for Indian farmers is dealing with its poor feed quality – it has a digestibility of 40 to 45 per cent. The straw is often chopped and fed to livestock during the dry season as a maintenance ration to help slow their rate of weight loss. Dr Hash says pearl millet straw is not a great feed for livestock. "But it is produced locally and supplements the limited available grazing resources.

"When we've surveyed farmers, they've repeatedly identified livestock fodder as a high priority because it's the cash income from livestock that pays for items such as hybrid seed and school fees. Improving the yield and feed quality of the pearl millet straw will have a major impact on these people.

"Our economic modelling shows that by improving the digestibility of the straw by one per cent, and then having the improved varieties adopted by just 10 per cent of the farmers, economic returns to farmers in the region would increase by an estimated US$10 million a year."

Farmers growing pearl millet in India already recognise the benefits of buying and sowing hybrid varieties for increased grain yields. About 70 per cent of the pearl millet grown in India is sown to commercial hybrid cultivars, most of which were developed from ICRISAT parental lines.

Researchers are now looking at using conventional and biotechnology-assisted plant-breeding techniques to improve the quality of the pearl millet straw in the parental lines used to produce these commercial hybrid cultivars.

The project, which began two years ago, has investigated naturally occurring variation in the crop and is using gene-mapping tools to identify the portions of pearl millet's genetic material that control traits related to straw quality and yield.

Three pearl millet genetic regions have been identified that together have the potential to improve overall straw digestibility by up to five per cent – well above the one per cent increase used in the economic modelling.

The more favourable natural variants identified in these genetic regions are then incorporated into the elite parent lines of popular pearl millet hybrids using plant breeding techniques such as backcrossing.

"We have to make sure the plants we breed are going to better meet the needs of the farmers," Dr Hash says. "Pearl millet is a dual-purpose crop, so we have to make sure we don't compromise grain yields while breeding for increased straw yield and quality.

"So far we've found suggestions of an association between drought tolerance and improved straw quality, which is an added bonus."

Field trials of hybrids produced with the first new lines begin this year and will continue over the next three years as new parental lines with improved straw quality are developed.

The researchers are also working with private and public sector pearl millet breeders in India to trial new hybrids involving the improved parent lines, with the aim of making these hybrids commercially available. ◂

Mapping the future

Scenario mapping aims to provide policy-makers with options for action. Warren Page and Rebecca Thyer report

PARTNER COUNTRIES: China, India PROJECT: ADP/2004/045: Exploring alternative futures for agricultural knowledge, science and technology DESCRIPTION: Researchers are working to model different scenarios to better prepare for changing circumstances
CONTACT: Dr Mark Rosegrant, m.rosegrant@cgiar.org

Agricultural research, development and dissemination have played a key role in lifting agricultural productivity and food security as well as in reducing poverty. Scientific and technological advances made during the Green Revolution have had widely acknowledged benefits.

However, predicting the impacts that future agricultural knowledge, science and technology will have on food security, rural development and sustainability is not simply a matter of extrapolating past performances.

Future decisions and their impacts are inherently uncertain. However, by modelling different scenarios, research managers are better able to prepare for changing circumstances.

Systematic analysis of plausible scenarios has become a common decision-making tool and a range of scenarios, defining potential pathways for the adoption of agricultural technology, is being examined as part of an ACIAR-funded project with the International Food Policy Research Institute (IFPRI) and partners in India (National Council of Applied Economic Research) and China (China Center for Agricultural Policy).

This project aims to provide policy-makers with options for action, helping them to formulate appropriate policies and investment decisions on science, extension services and technology adoption.

The project leader, IFPRI's Dr Mark Rosegrant, says mapping future trends – including descriptive scenarios of current and likely trends and expected impacts – creates options for policy-makers. By providing a clearer understanding of possible trends and their implications, these options can help inform them of alternatives for investing in and supporting agricultural science.

Farmers are expected to be the main beneficiaries of the project in the medium and longer term, as the impacts of this research project will flow from policy and decision-makers through scientific research programs, extension services and finally to farmers and institutions involved in support of agriculture.

Trends include economic growth, population shifts and growth patterns and changes in public and private investment, particularly in extension services, within a broader context of changing sociopolitical environments.

Other important drivers include global climate change, changing dietary patterns and changes in government support policies and trading regimes.

Dr Rosegrant says that one of the real problems for policy-makers is assessing the impacts of policies over time and the consequences of these impacts beyond the specific sector for which they were intended, or the impacts of trends outside that sector.

"For example, a government-funded extension service may be reduced in size, but may also be the main pathway by which some exciting new technology was to be delivered to farmers," he says. "By using descriptive scenarios we can build options that catalogue alternatives for delivering technology and disseminate this to the people making the policies that influence pathways to adoption."

Alternative scenarios are being developed with scientists, policy-makers and farmers involved in the International Assessment of Agricultural Science and Technology for Development (IAASTD), which is working to assess the impacts of future agricultural knowledge, science and technology on hunger and poverty reduction in a sustainable fashion.

The expertise of several hundred scientists and policy-makers who are participating in the IAASTD assessment will be available for this project. From this expertise, plausible scenarios will be developed to provide some guidance on how to manage potential uncertainties.

FOR EACH PATHWAY THERE ARE LIKELY TO BE TRADE-OFFS AMONG THE ECONOMIC, SOCIAL AND ENVIRONMENTAL POLICY GOALS

The project is basing its agricultural scenarios on those developed in the Millennium Ecosystem Assessment (known as MA scenarios), launched by UN Secretary-General Kofi Annan in 2001. This assessment, completed in 2005, helped to determine priorities for action on several international conventions relating to biodiversity, desertification and wetlands.

A key to the success of the assessment – and the reason for basing the project scenarios on it – was the use of rigorous testing in the four global scenarios developed.

Dr Helal Ahammad, a project team member from the Australian Bureau of Agriculture and Resource Economics (ABARE), says analysing each scenario allows the team to look closely at pathways through which agricultural knowledge, science and technology are likely to impact on certain policy goals. "For each pathway there are likely to be trade-offs among the economic, social and environmental policy goals. It's important for policy-makers to be aware of these trade-offs in order to make informed choices regarding agricultural policies."

The scenarios developed in this new project will cover agricultural development to 2050. Both quantitative and qualitative analysis of productivity and growth trends will be used to test implications on adoption pathways and broader economy-wide parameters, with a focus on implications for the poor.

Quantitative analysis of parameters such as changes in water-related technologies and efficiencies, climate variability and change, energy prices and population and income growth within the scenarios will help check the consistency of the alternative futures, provide relevant numerical information and generally enrich the scenarios by showing trends and dynamics not anticipated by the story-lines alone.

By including changes in water-related technologies and efficiencies, climate variability and change, energy prices, population and income growth in the scenarios, testing using quantitative analysis is possible. For example, a broad picture of how farmer welfare may vary can be determined by factoring in changes in productivity and price levels, based on food commodity supply-and-demand shifts examined in economic and climatic scenarios.

To help in this process, national economic models of India and China will be used. Both countries are among the fastest-growing in the world, yet each also has farmers that are still to receive some of the real benefits of agricultural knowledge, science and technology.

By analysing alternative pathways created in each scenario, the wider implications of trade and subsidy policies and their impacts on food security and production can be better defined. An understanding of these impacts can then be used to qualitatively test policy scenarios in today's real-world context. ◂

ACIAR to help 'outgrower'

One of the more significant changes in the global forestry sector in recent times has been the shift away from centralised forest management to local forest management, writes Greg Clough

ANI NAWIR

Nurseries developed by a local tree grower cooperative in Bulukumba, South Sulawesi.

In at least 60 developing countries, forest management responsibilities now rest – to varying degrees – with local districts. This is changing the role of local forestry communities and their relationships with forest companies and authorities. It means these different groups must have positive relationships and partnerships if forestry is to be environmentally sustainable, cost-efficient and socially equitable.

The question of equity is of particular interest to Ani Adiwinata Nawir, a socioeconomist with the Center for International Forestry Research (CIFOR) in Indonesia.

She says poor, small-scale farmers often miss out on the benefits of commercial forestry: "We need to know more about the working relationships that tree-growing communities have with forest companies and forest authorities.

"If the relationship is fair, usually everyone is better off. In Indonesia this could help ensure forests continue to provide livelihood and environmental benefits for a long time."

Relationships between local growers and forest companies or forestry agencies are generally known as outgrower schemes, and they are playing an increasingly important role in the forestry sectors of Australia, Indonesia and elsewhere in the world.

ACIAR is funding a three-year research project to explore and refine outgrower partnerships between landholders, communities and companies to improve commercial forestry outcomes because of their potential to reduce poverty and encourage sustainable forestry practices.

Dr Digby Race, a scientist from Charles Sturt University (CSU) and one of several Australians working on the project, says partnerships in Indonesia and Australia between communities, companies, governments, market brokers and others are motivated by a range of factors.

"The global demand for wood products is skyrocketing," Dr Race says. "And what we are seeing is that if a timber-processing company in Indonesia or Australia has inadequate forest holdings or limited access to public forests, it often turns to the small-scale grower for additional supplies."

Apart from an increased supply of wood, other advantages for companies engaging with outgrower schemes may include improved resource security without investing in land, and greater diversity of supply.

Dr Race says small-scale growers may be attracted to outgrower schemes because they offer an alternative income or a guaranteed buyer. In some instances outgrower schemes may even offer financial support.

Ms Nawir says the outgrower concept is good in theory, but still needs improvement in its practical application. "Outgrower arrangements don't always live up their rhetoric. They aren't always equally beneficial to all parties. This is a shame because properly implemented schemes can generate new skills and new jobs, and lead to local infrastructure development. They can improve corporate-community relations and generate income and reduce poverty."

Certain difficulties and risks are currently associated with outgrower schemes, such as villager reluctance to commit to long-term contracts, which they often see as risky. A Washington-based non-government research organisation, Forest Trends, says schemes can sometimes lead to entrenched low wages, increased transaction costs for both sides and contractual and financial misunderstandings, and can even help to perpetuate inequitable patterns of land ownership.

By examining the pros and cons of existing outgrower schemes, the ACIAR 'Community partnerships for plantation forestry' project aims to enhance the contribution forestry partnership schemes make to rural and community development in Indonesia and Australia.

To achieve this, the project is pursuing several objectives. One of its most important aims is to analyse the strengths and weaknesses of specific agreements and recommend how they can be improved. This will require researchers to examine partnerships in three regions – one in Australia and two in Indonesia.

Dr Race says central to understanding how outgrower schemes work is to examine them from the divergent perspectives of the parties involved.

"When people form partnerships they usually assume the partners will be generally fair, that they will carry out their side of the deal and generally commit fully to the partnership," Dr Race says. "But this assumption can be problematic because so many factors are involved."

One factor is the long period between establishing and harvesting a plantation and the changes in timber prices during that time. Others include changes in the opportunity cost of growing trees as prices for food crops and livestock fluctuate, and changes in community or company priorities and government policies that affect growers and companies.

The ACIAR project is also trying to address the difficulty some partners face in negotiating fair contracts. Through its capacity-

tree schemes grow

building activities, the project is working with community groups, government agencies and timber companies to develop mutually beneficial schemes that support positive plantation development in eastern Indonesia.

Ms Nawir says the project will help smallholders improve their ability to assess different scenarios and forest options and better negotiate fairer partnerships. "If we succeed in enhancing these skills, we may just succeed in improving small-scale livelihoods."

In addition to CIFOR and CSU, the project's research organisations include the Indonesian Ministry of Forestry's Research and Development Agency and the World Wide Fund for Nature's regional office for Indonesia.

Through this combination of scientists and organisations from Indonesia and Australia, the project is using a collaborative research strategy in which complex real-world situations are examined in a co-learning arrangement with the project's beneficiaries.

As the research unfolds, researchers and beneficiaries might gain a better understanding of the rationale for existing partnerships. Together they can analyse the rationale, assess its strengths and weaknesses and, as a team, develop methods for optimising outgrower partnerships.

Dr Race says the project will benefit those at a local level, where partners in outgrower schemes will benefit from ACIAR's research, and a national level. "This kind of research directly helps outgrower schemes. But the sharing of knowledge between Australian and Indonesian organisations is important too. Also, Indonesia and Australia have many similar policy and commercial characteristics, so helping each other with common challenges will benefit both countries." ◂

ANI NAWIR

ANI NAWIR

Local communities collect teak seeds, which they sell for additional household incomes in Sumbawa, West Nusa Tenggara Province.

Outgrower research sites in Australia and Indonesia

The ACIAR 'Community partnerships for plantation forestry' project has two research sites in Indonesia and one in Australia. The three sites provide scientists with an array of outgrower schemes and community forestry partnerships.

Sumbawa – Indonesia

In 1999, the Sumbawa Forestry and Estate District Office designated 257 hectares to Semamung village as a community forest. The aim was to foster a sense of local ownership by providing access to forest products for household and commercial use in return for undertaking silviculture and forest protection. About 180 farmers are members of the local farmer forest group. An agreement for a similar farmer-government partnership in Lamenta village was established in 2004 under the Indonesian Government's social forestry program. Farmers and officials are optimistic about the partnership, but there are concerns that brokers are receiving unfairly high prices for organising the harvest and transport of teak from the forests. Also, there are questions over the community's right to harvest teak on state land.

South Sulawesi – Indonesia

In Bulukumba, private company PT PAL contracted local farmers to grow trees for the veneering factory it built in 2001. With good growing conditions and a harvest within five to eight years, some farmers are already receiving payments. Farm forestry has been established across nearly 12,000ha.

FORDA (Forest Research and Development Agency, Indonesia) researchers are analysing the outcomes for two villages. Although no written contract exists, PT PAL distributes free seedlings to farmers based on the mutual expectation that farmers will sell their timber to the company. Harvesting is expected to occur between 2007 and 2010. Farmers are likely to continue with this local approach to marketing by selling their standing trees to firms who will harvest and transport the logs to the company.

'Green Triangle' – Australia

In Australia's south-east, the 'Green Triangle' has a long history of commercial forestry, with both the South Australian and Victorian governments establishing large-scale plantations early last century. Commercial plantings of hardwood, such as blue gum, were established in 1991. By 2000, the region was home to 15 per cent of Australia's total area of commercial forest plantations, covering 224,184ha. Only 2.5 per cent of these plantations fulfil the farm forestry definition of 1000 hectares or less under individual ownership. This contrasts with the 30 per cent of the plantation area established on former farmland. Many large companies use investment schemes to fund blue gum plantations. The company secures the land and manages the trees for sale at around 10 years. The companies usually prefer to buy farmland to establish plantations, but will negotiate with landholders for access to high-quality land. Landholders usually receive an annual payment, over 20 years, which allows the production of two crops.

PARTNER COUNTRIES: Australia, Indonesia
PROJECTS: FST/1999/01 and FST/2003/025: Community partnerships for plantation forestry: enhancing rural incomes from forestry in eastern Indonesia and Australia
DESCRIPTION: This project addresses the impact of the move towards local forestry management
CONTACT: Dr Digby Race, DRace@csu.edu.au

FATAL ATTRACTION

Fruit flies in Vietnam are coming to a groggy end. Brad Collis reports on how a chance meeting helped deliver the solution to farmers' battle against devastating losses to the pests

Nguyen Van Dung has been travelling a hard road in recent years – but a road that millions of people aspire to travel. Nguyen has been treading the rutted route out of poverty. Over the past decade, Nguyen and his neighbours in the Chau Thanh district in Vietnam's Mekong Delta region have been putting behind them the culture and knowledge of traditional rice farming to become fruit growers.

It epitomises the aspirations that numerous aid and rural development agencies have had for years: to move people from subsistence monocultures into more diverse and higher-value agriculture.

But for the individual families and their villages it is an obstacle-strewn step into the unknown. It is a gamble that begins with some very hard years as rice-growing land is sacrificed for fruit trees that are going to take several years before they produce a crop; and this is in addition to the overriding challenge of learning a whole new way of farming.

But six years after Nguyen made the change, the difficult transition years are now just a memory and he considers himself to be basking in good fortune. He is no longer growing a crop merely to feed his family and collect a meagre income from local rice markets. Instead, he has a bountiful milk fruit and saboche orchard and, even more significantly, he now knows that he has only begun to explore the potential of his 1.5-hectare farm.

Nguyen, like his neighbours, had been losing up to 90 per cent of the crop to fruit flies because there was neither the local knowledge nor the practical tools for combating the voracious pest. Fruit fly had not been an issue for them as rice farmers and while pesticides might at first seem a straightforward answer, they are problematic in a landscape where open water has both farming and domestic applications.

What was needed – and what has been developed with Australian help – was a low-cost bait that was specific to particular pest fruit fly species and safe for both users and the environment.

As is so often the case, serendipity played an important role in delivering good science, and in the case of the fruit fly problem that was holding back Vietnam's horticultural ambitions it came in the form of one of Australia's iconic beer labels – Foster's.

The Australian brewer had moved into Vietnam in 1997, a few years before ACIAR began supporting a project led by Griffith University's Professor Dick Drew to tackle the fruit fly pest.

Farmers were becoming disillusioned and the whole diversification program – which was also seeking to give upland farmers a substitute for opium production – was in danger of collapsing.

The initial ACIAR project quickly sought to build up a comprehensive knowledge of the pest species and then to develop suitable controls. Shortly after the project started, Professor Drew found himself sitting on a plane with the managing director of Foster's Vietnam, Gary Bett, who is now Foster's Brewing International's senior vice president for Greater Asia.

Professor Drew asked Gary Bett what the company planned to do with its waste yeast, and so began a five-year collaboration that culminated in May this year with the commercialisation of a low-cost and effective yeast-based fruit fly bait.

The 'SOFRI Protein' bait, using beer waste reprocessed in a purpose-built facility at the Foster's Tien Giang Brewery outside Ho Chi Minh City, is the result of the ACIAR project initiated by Professor Drew and run by his Griffith University colleague Dr S. Vijaysegaran.

Several barriers had to be overcome, in particular getting the formula right to ensure the yeast waste produced at Tien Giang would attract the fruit flies that were causing the damage. The first step was conducting a survey of fruit fly species, using traps and a collection of host fruits throughout Vietnam, to determine which species was the problem. This was crucial to developing the right formulation.

The bait's commercialisation by the Cantho Pesticide Company (CPC) represents the culmination of a project that is seen not just as a measure of the success of the research, but as also reflecting the confidence that everyone has in fruit growers' own increasing commercial capacities – the fact they are able to pay for agronomic inputs.

Under the commercial arrangements that have now replaced the ACIAR-supported research and trials, Foster's Vietnam sells its processed yeast waste (protein mix) to CPC, which packages the product with a pesticide recommended by the International Centre for the Management of Pest Fruit Flies at Griffith University and the South Vietnam Fruit Research Institute (SOFRI).

Farmers mix the pesticide and protein mix into a water-based spray-on solution, which is applied in low volumes as a tiny spot to each tree in a fruit orchard, starting at fruit set and repeated weekly until harvest. The pest fruit flies are soon attracted to the spots where the spray has been applied and killed before they can lay their eggs in fruits. It is accurate, simple, inexpensive, environmentally friendly and puts a waste product to good use.

The protein bait is made by treating the initial beer waste with heat and enzymes, which remove the alcohol and convert the spent yeast into a protein that is highly attractive to the fruit flies. When diluted with water and a small amount of insecticide the protein can be applied as a spot on a tree, sufficient to kill flies with negligible impact on the landscape and useful insect predators.

Nguyen Van Dung has been trialling the bait for the past two years and says his farm income has risen by some 70 million dong (about $5000); money that he is now investing back into his farm for further crop improvement. "It is giving my family a more reliable future," he says.

Mr Le Van Ri, chairman of the Horticultural Association in Kim Son commune in the Chau Thanh district of Tien Giang province, says the SOFRI Protein bait is not only reducing crop damage and

Mekong Delta fruit grower Nguyen Van Dung in his orchard, which he says will provide a more reliable future for his family.

PHOTOS BY BRAD COLLIS

lifting incomes, but the project has also had the effect of raising farmers' understanding of environmental impacts; something that will be increasingly important as they aspire to higher-value markets with strict food quality requirements.

Le Van Ri says his association's 3700 members now have 1200 hectares of orchards and the long-term goal is to produce fruit of a high enough quality to export.

There is still a distance to travel to reach this target, but SOFRI director Dr Nguyen Minh Chau is confident that day will come, citing the development of the country's export rice sector as an example.

"In 1975 we set out to take rice from subsistence farming to an export industry in 25 years – and we started exporting in 1990," he points out. Vietnam is now the world's second-largest rice exporter. "We started our fruit industry with a similar goal in 1994 and I think we are on target to developing fruit that is suitable for export in another decade from now."

The managing director of Foster's Vietnam, Jake Jacobs, says the company has been enthusiastic about the fruit fly bait project since its inception. He describes the outcome as a very creative solution to a significant rural problem.

Mr Jacobs says spent yeast used to be incorporated into livestock feed, but the fruit fly bait is a way to add real value to the local community and its environment. "Of course the big question is: do Vietnamese fruit flies like any beer, or do they really prefer Foster's?"

Vietnam is in the final stages of joining the World Trade Organization, which will link it to global markets but also require it to conform with the stringent rules and regulations that govern international trade.

Researcher Dr Vijaysegaran says the 'clean, green' fruit fly control technology introduced by the ACIAR project is an important development in this ongoing transition from traditional rice farming to a modern export-oriented fruit industry in Vietnam. ◂

Le Van Ri, chairman of the Horticultural Association in Kim Son commune in the of Chau Thanh district.

Dr Vijaysegaran (right) with collaborating SOFRI researcher Dr Nguyen Van Hoa at the Foster's Vietnam yeast reprocessing plant.

YEAST MEETS PEST

BRAD COLLIS

Dr S. Vijaysegaran with, on the left, the raw yeast waste, and on the right, the protein bait after the waste has been processed and the alcohol removed.

Extensive trials of the SOFRI Protein bait have seen farmers' incomes rise fourfold. Brad Collis reports

In the lead-up to the protein bait project in Vietnam using spent brewery yeast, protein bait sprays had already been tested elsewhere in South-East Asia and Australia. For example, from 1986 to 1992 an ACIAR project in collaboration with the Malaysian Agricultural Research and Development Institute (MARDI) developed a beer yeast waste protein formulation called PROMAR, which controlled fruit fly in starfruit, soursops and chilli. However, the bait was not fully commercialised.

In 1995–96, an ACIAR project in collaboration with the Ministry of Agriculture in Tonga developed another beer yeast waste protein formulation and constructed a small prototype yeast protein production plant to provide Tongan farmers with protein bait.

In the ACIAR fruit fly project in Vietnam from 2001 to 2005, efforts were 'up-scaled' and the first fully commercial protein bait factory producing protein bait from beer waste was established at Foster's Tien Giang Brewery in the Mekong Delta.

This protein bait is known by the commercial name of SOFRI Protein 10DD and is now marketed by the Cantho Pesticide Company in South Vietnam.

Under ACIAR's Vietnam project, experiments were carried out in Tien Giang, Dong Thap and Ben Tre provinces to determine the efficacy of the SOFRI Protein bait in controlling *Bactrocera dorsalis* and *B. cucurbiate* on fruit trees and cucurbit crops.

Extensive testing, both in the laboratory and in the field, was conducted on various concentrations and formulations of SOFRI Protein. Laboratory tests involved counting the number of laboratory-reared adult flies attracted to the test bait and to a water control placed on opposite sides of a 30-centimetre cage. In the field, attractancy was assessed by applying a small spot (20 to 50 millilitres) of the test bait (plus insecticide) to foliage. A white groundsheet was placed under the treated foliage and the number of flies attracted and killed was counted.

These attractancy trials showed that SOFRI Protein, although not as attractive as some other insect lures, was still a good bait when used on its own in the field. The optimum application rate of SOFRI Protein was 100 to 150ml per litre of water.

Various trials showed that the protein bait needs to be used across a wide area for orchards to be protected to a level where damage is less than five per cent. When baits were used in small plots or farms, adult flies breeding in neighbouring untreated farms or orchards were still able to inflict significant damage on treated orchards. However, when protein baits were used over a wider area to cover a large number of farms or an entire village or hamlet, excellent fly control was achieved.

Two large-scale orchard trials were implemented, one on peach in the north and another on Barbados cherry in the Mekong Delta. The trials assessed the level of fruit fly control and also collected data on the increased yield and income achieved by farmers using the protein bait spot spray technique.

In Son La province, where peach was introduced to the poor H'Mong hill tribe people in the early 1990s, heavy fruit fly infestation in tree-ripe fruits has forced farmers for the past 10 to 15 years to harvest immature green fruits to avoid losses to fruit flies. Farmers obtained a low price of about 1000 dong per kilo of fruit and have considered cutting down their trees, or returning to their old undesirable practices (growing opium poppies).

Following trials over 35 hectares of peach with SOFRI Protein spot sprays, farmers harvested ripe peaches for the first time in more than 10 years of cultivating the crop – achieving higher yields and higher prices – and this was without resorting to dangerous insecticide cover sprays. Their fruit is now snapped up by wholesale buyers from Hanoi.

In 2005, trials were conducted over a larger area of 60 hectares of peach and the results were even more spectacular. The successful peach crop in the previous year (2004) had driven the price of ripe peach to 4000 dong per kilo, as a result of which the poor H'Mong farmers increased their incomes to 40 million dong (A$3347) per hectare in 2005.

In Go Cong province, Barbados cherry is a major crop that is processed, frozen and exported to Japan – but suffers yield losses of up to 70 per cent because of fruit fly.

A control program using a combination of SOFRI Protein bait sprays and methyl eugenol mats (Bactromats) has reduced the average level of damage to less than four per cent.

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Milk fruit

Milk fruit is a popular tropical fruit indigenous to Vietnam and Cambodia. It derives its name from its fragrantly sweet and milky white juice. The most popular way to enjoy the fruit is to squeeze the tough fruit until it becomes tender, so that the juice mixes with the meat of the fruit. A small hole is then cut at the top so the juice can be sucked out.

Saboche (also known as Sapodilla)

Saboche is an egg-shaped fruit with a sweet pulp that, depending on the variety, can taste like peach, banana or apple. Two popular species are grown in Vietnam: orange pulp and white-yellow pulp saboche.

PARTNER COUNTRIES: Vietnam, Sri Lanka
PROJECTS: FIS/2001/013: Culture-based and capture fisheries development and management in reservoirs in Vietnam; FIS/1997/1068: Reservoir fishery development and management; FIS/1994/040: Management strategies for enhanced fisheries production in Sri Lankan & Australian lakes; ADP/2000/018: The economics of developing reservoir aquaculture in Vietnam
DESCRIPTION: By providing relevant information on how to significantly improve the fish yield from reservoirs, the project aims to make fish more available and affordable to the rural poor and to generate livelihood opportunities for communities living near reservoirs
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Farming FOR THE FUTURE

These fingerlings are raised for sale to farmers building their own small aquaculture ponds.

BRAD COLLIS

Encouraged by the self-replicating success of ACIAR-funded farmer fishing trials in Sri Lanka and Vietnam, rice farmers in many other developing countries may soon be able to supplement their incomes through communally managed fishing from village reservoirs and the small lakes that form in flood plain depressions. Adrienne Jones reports

Farmer-managed trials have been a crucial and highly successful component of increasing inland fish production and developing best-practice models to increase fish availability and affordability in Sri Lanka and Vietnam over the past six years. Working with farmers, fishermen and regulatory agencies, aquaculture scientists have developed management strategies for the two forms of inland fisheries most common throughout Asia: capture fisheries based on large permanent reservoirs (usually dependent on species that reproduce naturally); and the less well developed, culture-based fisheries developed around smaller, seasonal reservoirs, which need to be stocked with hatchery-produced seed fish. The projects have been funded by ACIAR.

Australian project leader Professor Sena S. De Silva, from Deakin University's School of Life and Environmental Sciences, says the projects' findings should ensure the long-term sustainability of capture fisheries in large permanent water bodies in developing countries – and, by optimising the use of smaller reservoirs, give poor rural farmers an additional income source.

The concept of culture-based fisheries is to release hatchery-produced 'seed fish' into small, community-managed water bodies at the onset of the rainy season, and for these to be recaptured when they reach a certain size. This usually coincides with receding water levels during the dry months.

In the Sri Lankan and Vietnamese projects, farming communities downstream from small irrigation reservoirs were encouraged to take collective responsibility for all fishery activities – preparing the water body, stocking and harvesting the fish, keeping records, rearing fish fry to fingerling size in floating net cages (to sell back to cultivated fisheries that will rear them to market size), preparing feed for the fingerlings and marketing and selling the fish.

Professor De Silva says many of the initial attempts to use small water bodies for fish production failed because of an inappropriate choice of reservoirs and an overemphasis on the biology of the reservoirs. The ACIAR projects focused instead on developing holistic management strategies incorporating biological, physical, socioeconomic and political factors.

Researchers in Sri Lanka and Vietnam have used computer-generated software with Geographical Information Systems (GIS) technol-

ogy to develop an evaluative process for grading reservoirs according to their suitability.

The process uses a mathematical formula to group complex biological and socioeconomic factors affecting fish production under single or 'common denominator' criteria, enabling otherwise heterogeneous factors to be collectively evaluated.

For example, water quality criteria such as conductivity or chlorophyll *a* levels are assessed under 'water qualities'; catchment land use patterns, and correlated factors such as the number of buffalo per hectare, under 'catchment characteristics'; issues such as distance to the main road under 'marketing aspects'; and factors like family income under 'socioeconomic factors'.

Sub-categories are then weighted to allow reservoirs to be ranked as poor, fair, good or excellent. It is the first model of its kind used to conduct research into culture-based fisheries.

Professor De Silva says earlier culture-based projects were not as effective as they should have been because they concentrated on the biology of reservoirs.

"We took a step further and concentrated on the people, the catchment and the reservoirs, because they're all one entity if you want effective utilisation of resources," he says. "Catchment affects the nutrient quality of the water and people affect what you take out.

"We have a more holistic approach, which for the first time has quantitatively shown that the catchment area has an effect on fish production, and this could be used as a management tool."

While the activities of the fishing community *per se* are important factors in assessing the fisheries potential of perennial water bodies, Professor De Silva says it is the wider village community that primarily determines culture-based fisheries' success. "They are less resource-intensive with no capital input as such. What is basically needed is cooperation. You need the cooperation of the whole village. They are all farmers, they must be willing to be fishermen, to mess about with fish, to look after fish. It's a new ball game for them.

"With rice-growing, each farmer has a demarcated paddy and works on that paddy, but with fishing, all the farmers have to cooperate. They have to guard the fish until they grow, they have to get together and harvest together, then they have to sell the fish and divide the spoils."

Professor De Silva says that because it is a communal activity, other synergies develop: "There's social cooperation and potentially political cooperation as well. That's social capital. These are not quantifiables in dollars or cents, but they're very important. Culture-based fisheries cannot be sustained – they won't even get off the ground – without due consideration of this socioeconomic factor."

The first ACIAR projects evolved in 1997 when the Sri Lankan Government sought Professor De Silva's expertise in scoping sustainable management strategies for the country's existing inland fisheries, based on its perennial reservoirs.

As the first phase of the Sri Lankan project developed, the Government of Vietnam was also looking for strategies to improve fish yield from its once heavily subsidised perennial reservoirs, and also sought help from ACIAR. So Professor De Silva began working with Vietnam's Research Institute for Aquaculture No 1 and the Faculty of Fisheries at the University of Agriculture and Forestry, Ho Chi Minh City, in 2002.

Culture-based projects in Sri Lanka involved farmer-managed fisheries trials around 43 reservoirs selected at random in four administrative districts of the country's dry zones, where most of the reservoirs are located.

Fisheries Committees were appointed from farmer committees selected by the Sri Lankan Department of Agrarian Services. The trials evaluated optimum stocking densities, species combinations and ratios, best harvesting size and cost-benefit analyses over three growth cycles, each eight to nine months long.

Farmer-managed trials were also conducted in two provinces in Vietnam (12 in Yen Bai Province and eight in Thai Nguyen) over two growth cycles to establish optimum water conditions, stocking and harvesting parameters and the most effective management strategies.

The Sri Lanka projects finished after five years in June 2005, with a GIS model for predicting fish yield in the large reservoirs. The GIS 'common denominator' model for ranking the likely effectiveness of individual reservoirs for culture-based fisheries, and research findings on the economic, biological and socioeconomic inputs, were consolidated as best-practice approaches for culture-based fisheries.

The best-practice approaches – which have already been incorporated into Sri Lankan Government development strategies – include recommendations on reservoir selection, stocking densities, water quality, species combinations and relevant socioeconomic factors.

The Vietnam projects are still in their final stages and many of the research findings have been incorporated with the Sri Lankan findings to create a best-practice manual for regional use.

Professor De Silva says the most direct evidence of the projects' success is the major impact they have had on policy and development strategies in the region, particularly in Sri Lanka, where the Government has recently amended its Agrarian Services Act 47 of 2000 to legalise culture-based fish farming, and in Vietnam, where reservoir fishery development has now also been incorporated into the Vietnamese Government's strategic plans.

In Vietnam this is expected to result in the production of 200,000 tonnes of reservoir fish annually by 2010, mostly from the country's rural areas. Professor De Silva says the work has directly contributed to an increased interest in developing inland fisheries industries in other developing countries.

In recognition of the importance of the projects' findings to the region, ACIAR has also recently supported a further project to disseminate these findings through the intergovernmental agency NACA (Network of Aquaculture Centres in Asia-Pacific), a regional organisation comprising 17 member countries, including Australia.

"We've held workshops in Indonesia, Laos and Cambodia to disseminate our results," Professor De Silva says. "I take pride in these ACIAR projects because they have not only changed the policies and government thinking in both project countries, but we've also been able to produce a number of really good scientific publications which are of use to everybody."

While it is difficult to quantify the extent to which trial farmers have increased their incomes, he says they have benefited. "These people are rice paddy farmers, they're not unemployed, but they now have an additional source of income and additional income means the children get more schoolbooks. It's a snowballing effect. The whole village gains because it's a common resource.

"Of the 32 village communities we started in Sri Lanka, every one is continuing. Word has spread and more are coming in and telling the Government they want to do this. The people want it. I don't think they'd come on board if it wasn't productive for them. It's the same in Vietnam." ◂

WITH FISHING, ALL THE FAMERS HAVE TO COOPERATE ... THAT'S SOCIAL CAPITAL, NOT QUANTIFIABLE IN DOLLARS AND CENTS, BUT VERY IMPORTANT.

Modelling the next food revolution

Fisheries are an increasingly important part of the world's food system, but until recently were overlooked by policy makers. Rebecca Thyer reports

PARTNER COUNTRY: Malaysia PROJECT: ADP/2001/092: Fish in food: The critical role of fish in world food issues COMMISSIONED ORGANISATION: International Centre for Living Aquatic Resources Management, Malaysia DESCRIPTION: Integrating fish into the International Food Policy Research Institute's analytical models to raise the national/global profile of fish issues CONTACT: Dr Mahfuzuddin Ahmed, m.ahmed@cgiar.org

World fish consumption reached 14 kilograms per capita in the late 1990s, twice the level recorded in the 1950s. It shows no signs of abating. The rapid growth in the consumption of animal products in developing countries – dubbed the next 'food revolution' – has raised serious questions about sustainability.

Swift changes in supply and demand have also affected the livelihoods of the poor, with aquaculture shifting from an income-providing activity of the very poor to a profitable commercial enterprise.

Although fisheries and aquaculture are increasingly recognised as integral to the food system, until recently they were not integrated into analytical models of food systems used by the world's policy-makers.

Realising the benefits of analytical modelling, an ACIAR-funded team at WorldFish and the International Food Policy Research Institute (IFPRI) integrated fish into IFPRI's analytical models on agriculture and food, analysed aquaculture's key role in terms of rapid demand changes and, in turn, raised the profile of fish issues in national and global debates.

WorldFish project leader Dr Mahfuz Ahmed says fisheries are poorly represented and understood in policy circles.

"They are often not included in discussions about food and the environment, yet fish represent an important and increasingly large global food sector," Dr Ahmed says. "We thought it made sense to include fish in modelling, making fisheries more appealing to policy-makers."

Projections from the model provided the context for exploring nutrition, food security and poverty alleviation; environmental sustainability and public health; and technology needs and prospects.

Dr Ahmed says the modelling work has given policy-makers and researchers a 'fish outlook' in a globalising food economy, allowing them to analyse how trends in the fish sector will affect the poor and impact on the environment.

"It is also appealing to policy-makers because they are not just making statements, they have the background to support their arguments. For the first time, fisheries issues are being discussed in relation to food security and demand."

Dr Ahmed says the modelling work has also helped to form the basis for new projects. "Creating a global model for fish has brought it into the light. Making people aware of fisheries, global demands and changing marketing needs helps in policy debates.

"Aquaculture will expand at a fast rate. We want to know what the implications are for the environment and for the world's poor. Without effective modelling we can't work out what will happen."

During the project the team produced *Fish to 2020: Supply and Demand in Changing Global Markets*, Food Policy Report *Outlook for Fish to 2020: Meeting Global Demand* and *The Future of Fish: Issues and Trends to 2020*, which have helped to boost knowledge of fisheries' role in world food issues. ◂

See www.ifpri.org or www.worldfishcenter.org

Fish to 2020 – boosting knowlege of fisheries' role in world food issues.

Blueprint sets out significant increase in aid program

Australia will significantly increase its overseas aid spending with a strong focus on accelerating economic growth, boosting support for education and health in the region (particularly for women and children), providing incentives for good performance and adopting a more rigorous approach to tackling corruption.

The White Paper *Australian Aid: Promoting Growth and Stability*, launched by the Minister for Foreign Affairs, Alexander Downer, on 26 April 2006, maps out how aid funding will double to about $4 billion a year by 2010.

Over the next 10 years most of Australia's aid will be focused on the Asia-Pacific region – home to the greatest number of the world's poor.

The number of scholarships for Asia-Pacific students will double to 19,000 over the next five years.

The government will establish an Office of Development Effectiveness to monitor aid programs. It will publish an annual review assessing the aid effort.

The government will also fully 'untie' its aid, allowing foreign companies and individuals to bid for contracts, promoting greater competition and value for money. The White Paper's overarching principles include gender equality and partnership.

What will the White Paper mean for ACIAR? It sets out strategies for enhancing engagement in the region through policy coherence and a whole-of-government approach to aid delivery, and also to broadening participation beyond government – all of which will impact on the way ACIAR plans and conducts research and operations. The aid program will boost and diversify ACIAR's research investment.

ACIAR plays a key role in the development research program. Its research will be better integrated into the rural development strategy and form part of the single framework of country development strategies. In line with the paper's strategy to mobilise new links to the region, ACIAR will seek more private sector participation and research programs will incorporate gender considerations and support private sector-led rural and business development initiatives.

ACIAR looks forward to playing its part in the government's integrated and coordinated response to the complex development challenges in our region.

THE AUSTRALIAN DEVELOPMENT GATEWAY*

The Australian Development Gateway (ADG) is a free public website supporting knowledge-sharing for sustainable development.

The site is fully funded by AusAID and aims to support people working in Asia Pacific countries to reduce poverty and promote sustainability. It encourages aid practitioners to contribute knowledge and participate in discussion and enables people working in development to collaborate more effectively by sharing practical knowledge.

The ADG provides:

- access to quality resources on key development topics;
- business and employment opportunities;
- a directory of people and organisations working in development;
- online discussion forums and regular 'ask the specialist' features; and
- information on development activities and the people behind them.

The ADG website features nine topic areas that link to more than 1720 resources:

1. agriculture
2. development practice/effectiveness
3. disaster management
4. education
5. microfinance/enterprise development
6. governance
7. health
8. information and communication technology
9. water

To find out more, visit
www.developmentgateway.com.au

* ACIAR is proud to be an agriculture partner of the ADG

AUSAID

The White Paper on Australia's aid is launched by Foreign Affairs Minister Alexander Downer at the National Press Club in April.

For more information on the White Paper *Australian Aid: Promoting Growth and Stability* see www.aciar.gov.au

Deal seals Foster's fruit fly 'feast'

BRAD COLLIS

(Left to right) Do Van Thanh (deputy managing director, CPC), Nguyen Van Trung (managing director, CPC), Mal Skelly (Australian Consul-General), Nguyen Huu Chi (chairman of Tien Giang Province), Jake Jacob (managing director, Foster's Vietnam), Misha Coleman (ACIAR Country Manager Vietnam), Dr Nguyen Minh Chau (director, SOFRI), Dr Nguyen Van Bo (vice-president, VAAS) and Dr S. Vijaysegaran (Griffith University).

The commercialisation of a new, environmentally safe fruit fly bait developed from spent brewing yeast was marked by a ceremony at the Foster's Vietnam brewery near Ho Chi Minh City in May.

The SOFRI Protein bait is being commercialised by the Cantho Pesticide Company (CPC) and represents the culmination of an important ACIAR-supported project that opens the way for Vietnamese farmers to fully develop their fledgling fruit-growing industry.

The Vietnam Government began encouraging traditional rice farmers to diversify into tropical fruit trees in the mid-1990s as a way of introducing higher-value agricultural enterprises in poor rural areas. However, from the moment the first orchards started bearing fruit in the late 1990s, farmers suffered heavy losses to fruit flies.

The challenge was taken up by researchers from Queensland's Griffith University, in particular Dr S. Vijaysegaran and Professor Dick Drew, who encouraged the Foster's Group to also become involved by processing and supplying the waste yeast, which is the basis of the bait.

Collaborating researchers at the South Vietnam Fruit Research Institute (SOFRI) helped develop the final formula that creates a bait and pesticide for control of the specific pest species.

The work was also sponsored by the Crawford Fund, AusAID and industry.

Policy Advisory Council gets a wide-ranging tour

The Policy Advisory Council of ACIAR recently toured rural New South Wales on field visits as part of the annual council meeting in Australia. The program began in Canberra with a formal council meeting and a dinner with the Minister for Foreign Affairs, Alexander Downer.

The Council is the prime advisory mechanism for the minister, the board of management and ACIAR on international agricultural research and development collaboration. Partner country council members and representatives at the meeting included Dr Patricio Faylon (Philippines), Mr Jia Jingdun (China), Dr Nguyen Van Bo (Vietnam) and Dr Agus Muharam (Indonesia).

Members provide input on country research priorities and strategic issues for the Annual Operating Plan and the Corporate Plan 2006–10.

After its Canberra visit, the council travelled to Wagga Wagga and Orange in the heart of rural NSW for a two-day field trip. The itinerary included visits to the newly established EH Graham Centre for Agricultural Innovation, Charles Sturt University and the NSW Department of Primary Industries (Orange Agricultural Institute).

(Left to right) Mr Peter Core, Dr Patricio Faylon and Mr Jia Jingdun learn the finer points about Australian fish going under the hammer at the Sydney Fish Market.

Council members met with project leaders, Australian research providers and stakeholders.

Members also travelled through the Blue Mountains World Heritage area and completed the visit in Sydney with a cool but lively dawn tour of the Sydney Fish Market auctions and Sydney Aquarium. ◂

ACIAR's shop window to the world: www.aciar.gov.au

Our biggest and most visible 'shop window' – profiling our projects and the way we do business in developing countries – is the ACIAR website. ACIAR's website is designed to be information-rich, useable and highly accessible to both local and developing partner country visitors. The structure and content of the site caters for environments with low bandwidth and ever-increasing audiences for e-communications.

Visit the ACIAR website to:

- read about the latest agricultural research advances in bilateral and multilateral projects;
- learn about ACIAR's 13 research program areas and managers:
  - Agricultural Development Policy
  - Animal Health
  - Agricultural Systems and Economics Management
  - Crop Improvement and Management
  - Crop Protection
  - Fisheries
  - Forestry
  - Horticulture
  - Land and Water
  - Livestock Production Systems
  - Policy Linkages and Impact Assessment
  - Smallholder Farming Systems
  - Soil Management and Crop Nutrition;
- find out about ACIAR's current country strategies, indicative research priorities and focus areas;
- read about the recent launch of the Aid White Paper and *Pacific 2020: challenges and opportunities for growth*;
- learn how to participate in ACIAR's projects;
- read about ACIAR's Australian partner organisations;
- find out about our overseas partner organisations operating under the Consultative Group on International Agricultural Research (CGIAR) framework;
- check out our training programs available to partner country scientists involved with ACIAR projects to obtain postgraduate qualifications at Australian tertiary institutions;
- sign up to our consultants register;
- check out the latest news from CGIAR and International Centres;
- download or go shopping for the latest publications at our online bookshop;
- subscribe to ACIAR's scientific and corporate publications online;
- check out our news stories and upcoming events; and
- find out about the AusAID-funded Australian Youth Ambassadors for Development program. ◂

ROUNDUP

Australian Volunteers International seeking specialists for Eritrea Project

Australian Volunteers International (AVI) is seeking two agricultural specialists to work on a dryland forage project in Eritrea.

The 'Forage Options for Livestock' project is funded by the Australian Department of Agriculture, Fisheries and Forestry, partnered by Charles Sturt University, the University of Adelaide, Rural Solutions SA and the NSW Department of Primary Industries.

AVI is supporting the project with two key specialist placements aimed at enhancing its effectiveness and developing the sustainable agriculture sector in Eritrea.

One assignment is for a higher education adviser to work with the Hamelmo College of Agriculture to advise on strengthening the academic, research and development areas of the college and to teach farm management, livestock production and/or other agriculture-related areas. The other assignment is for a technical officer to work within the National Agricultural Research Institute to link Australian and Eritrean expertise in forage evaluation and support the experimental and training components of the project.

For further information, contact Renee Archer, 03 9279 1757, rarcher@australianvolunteers.com or visit www.australianvolunteers.com

Australian Youth Ambassadors for Development program

As part of the Australian Youth Ambassadors for Development (AYAD) scheme, five young people will leave Australia this month to undertake short-term assignments to help with international development activities in Asia-Pacific partner countries.

The AYAD scheme is an AusAID-funded program that places skilled young Australians between the ages of 18 and 30 in a development project opportunity in a partner country. Placements are either sponsored by the private sector, NGOs or government sectors through an assignment from that organisation. For Intake 17, ACIAR is providing assignments for five youth ambassadors to work on projects in Tibet, China, Indonesia, East Timor* and Vietnam.

The Prime Minister announced the AYAD program in August 2004. The youth ambassadors exchange skills and knowledge with local counterparts to strengthen the capacity of overseas partner organisations. They have the opportunity to forge friendships and associations, which in turn strengthen the people-to-people links so important to cultural understanding and strong foreign relations.

* On indefinite hold.

Australian Youth Ambassadors (left to right) Samantha Grover (Tibet ARI, China), Sharon Harvey (ACIAR education and training project officer), Rebecca Bolt (Gansu, China), Violet Rish (East Timor), Michael Rose (Vietnam) and Fiona Goss (Indonesia) meet with John Skerritt, ACIAR deputy director R&D programs in May.

NEWLY COMMENCED PROJECTS

ASEM/2004/047	Sustainable management of coffee green scales in Papua New Guinea
CP/2004/048	Integrated disease management (IDM) for anthracnose, Phytophthora blight and whitefly-transmitted geminiviruses in chilli pepper in Indonesia
FIS/2005/176	Masterclass – aquatic animal health
FST/2005/054	Seed distribution of Australian trees – limited extension
FST/2005/180	Laos teak/non-timber forest products agroforestry scoping study
FST/2006/015	Kupang Workshop 2006
HORT/2006/006	Development of an embryo culture manual and an embryo transplantation technique for coconut germplasm movement and seedling production of elite coconut types
LPS/2005/052	The development of cattle and buffalo breeding strategies and activities based on BREEDPLAN in Thailand
ASEM/2005/002	Community Agricultural Technology Program (CATP)
ASEM/2005/126	Sweet potato workshop, Papua New Guinea
SMCN/2002/100	Water harvesting and better cropping systems for the benefit of small farmers in watersheds of the East India Plateau
SMCN/2005/059	Modelling water and solute processes and scenarios for optimisation of permanent raised bed systems in China, India, Pakistan and Indonesia

NEW PUBLICATIONS

Monographs

Planters and their components: types, attributes, functional requirements, classification and description

The planting operation is one of the most important cultural practices associated with crop production. Planters are simple farm equipment that can improve resource-conserving cropping systems. Farmers can benefit from information on availability, attributes and performance of equipment. This manual provides guidance to the agronomic requirement for plant establishment and the implications for planter selection and management. ACIAR Monograph 121, $35.00 GST inclusive (plus postage and handling).

EXTRACT

Why is a planter needed for crop establishment? What are the implications for a planter's performance?

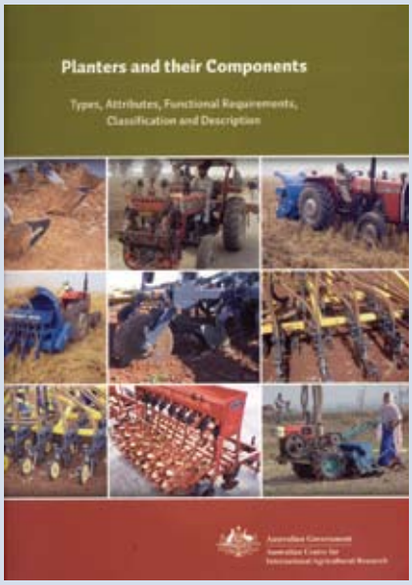
It is important to outline that crop establishment is the sequence of events that includes seed germination, seedling emergence and development to the stage where the seedlings could grow to maturity. The variables influencing plant establishment are:

- seed/species characteristics;
- external physical, chemical and biotic environment; and
- management practices (irrigation, fertiliser application, pesticide application).

The consequences of sub-optimal crop establishment on farm profitability include:

- yield reductions;
- replanting costs;
- forgone sowing opportunities;
- reduced weed suppression; and
- direct and indirect effects of secondary germination.

In crop production systems, establishment potential is dependent on the conditions prevailing immediately before planting and weather influences during the establishment period. The planting machinery is usually critically important in crop establishment as it can modify the pre-existing seed and soil conditions and dictate seed placement within the seedbed. The manual provides information on planters' performances in order to assist farmers with the selection, setting and management of all farm machinery needed to successfully establish crops over the range of conditions likely to exist at planting. A planter will perform all functions (furrow opening, seed metering and distribution, seed coverage and seedbed firming) when sub-optimal crop establishment conditions exist at the time of planting. This manual provides a guidance on the types of devices used to accomplish all functional requirements and their relative attributes for crop establishment.



Technical Reports

Pest and disease incursions: risks, threats and management in Papua New Guinea

This approach includes reports from several projects on plant protection and provides a comprehensive picture of pests and diseases of horticulture crops, damage caused by the plant pests and diseases and developing strategies to manage them. The series of papers were presented at the 2nd Papua New Guinea Plant Protection Conference held in Kokopo, East New Britain Province, in November 2004. This technical report brings together all scientists engaged in plant protection in Papua New Guinea to share their knowledge and experience in solving plant protection problems in the country and neighbouring Pacific countries. ACIAR Technical Report 62, $22.00 GST inclusive (plus postage and handling).

EXTRACT

What are the risks associated with incursions of plant pests and what actions can be taken to manage risks and threats associated with them?

It is important to outline some of the risks associated with incursion of plant pests, which include the human-mediated pathways such as:

- the deliberate movement of plant material;
- movement of people; and
- non-plant commodities plant.

Threats usually arise from lack of management of the risks related to limited control of the movement of material, people and goods into and within a country (particularly from infected areas). Incursions are unpredictable but actions can be simple (a system where people inform others of where things are happening) or involve extensive and intensive communication and control methods, which are all everyone's business. This approach outlines the main risks, threats and management practices to prevent the entry of pests, such as surveillance and monitoring, which are significant components of managing incursions.

The papers in this report also describe the main pests and diseases of horticulture crops, their incidence and distribution, such as for example the sugarcane pathogens, the *Oribius* weevil and the red-banded mango caterpillar, the damage caused by the weevil and treatments to exclude adult weevils from some plants. The report also addresses the development of management strategies against the invasive weed *Chromolaena*, such as the release and establishment at many sites of a new biocontrol agent, a stem galling fly.

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fax: +61 2 6217 0501; email: comms@aciar.gov.au if you believe you are eligible to obtain a complimentary copy. Other people may purchase copies from our website (www.aciar.gov.au) or freely download them as pdf files.
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ACIAR'S VISION

ACIAR looks to a world where poverty has been reduced and the livelihoods of many improved through more productive and sustainable agriculture emerging from collaborative international research.

The Australian Centre for International Agricultural Research (ACIAR) operates as part of Australia's international development cooperation program, with a mission to achieve more productive and sustainable agricultural systems, for the benefit of developing countries and Australia. ACIAR commissions collaborative research between Australian and developing country researchers in areas where Australia has special research competence. It also administers Australia's contribution to the International Agricultural Research Centres.