Pathways out of poverty

Poverty – and specifically how to reduce it – has been put firmly on the international agenda in recent months. The G8 summit and Live8 concerts have raised the profile of the world's poor and established the goal of eradicating poverty once and for all. The United Nations has set its own goals in relation to tackling poverty, known as the Millennium Development Goals. A recently held World Summit, in mid-September, measured progress against these eight goals set by the UN.

In many areas progress has been made; in others, the goals seem further from realisation. The plight of Africa's poor is well documented, but less so that of many farmers and rural dwellers in parts of the Asia-Pacific.

One part of the Asia-Pacific region where this is of increasing importance is South Asia. India is the largest country and the leading economy in South Asia, but also has the highest number of people living below the poverty line, some 220 million, or more than all the poor in Africa combined. The other countries of South Asia also have large numbers of people living in poverty.

For ACIAR, the attention focused on poverty and reducing it is not new. Helping farmers and others relying on agriculture to find pathways out of poverty is the role of ACIAR.

It is achieved through agricultural research. The role of agriculture in creating economic growth at the individual and village scale, and this growth acting as a catalyst to help smallholder farmers lift themselves out of poverty, has been well documented.

ACIAR's work in South Asia, and in the broader Asia-Pacific region, is helping evolve the potential of agriculture to create pathways out of poverty into reality.

PARTNERS
IN RESEARCH FOR DEVELOPMENT

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

Technical enquiries will be passed on to the appropriate researchers for reply. Reprinting of articles, either whole or in part, is welcomed provided that the source is acknowledged.

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Executive Editor: Warren Page, ACIAR, +61 2 6217 0500

Managing Editor: Brad Collis, Coretext Pty Ltd, +61 3 9670 1168

coretext

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Letters from readers are welcome, and should be addressed to:

The Editor
Partners in Research for Development
ACIAR
GPO Box 1571
Canberra ACT 2601
Australia

email: comms@aciar.gov.au

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South Asia

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Around ACIAR

Sharing the benefits

India's economic growth is moving forward at seven per cent a year, making it one of the fastest growing economies in the world. It already ranks as the 12th largest. Several factors are driving the pace of progress, two of which have been integral to India's relationship with ACIAR. Since the early 1990s successive Indian Governments have worked to deliver economic reforms. These, together with WTO accession and a thriving services sector, have driven economic expansion. This reform has also extended to relations with donor organisations. Since 2003 India has sought jointly-funded projects with smaller donors like ACIAR to help poor smallholder farmers who are in danger of being left behind by the fast-running economy. The majority of India's poor, as in other parts of South Asia, are in rural areas which have yet to feel the full benefits of broader economic change.

ACIAR support in South Asia focuses on improving smallholder crop and livestock production, and management of broad-scale land and water resources. Projects include those that target poor, marginalised farmers in the rain-fed, semi-arid areas.

ACIAR is well-placed to share Australian know-how in salinity, sustainable crop production and disease management – in neighbouring Pakistan and Bangladesh as well as India. ACIAR is working to spread the project outcomes and benefits through these countries. In Pakistan, ACIAR, with AusAID and Austrade, is embarking on a new Agricultural Linkages Program to build Pakistan's capacity in agricultural sciences. The three organisations are developing a program to cover commercial, academic, research and trade links between Australia and Pakistan.

ACIAR is also helping with specific issues in Sri Lanka, Bhutan and Nepal. These continuing projects focus on single issues where Australia's researchers have a comparative advantage. Targeted research in South Asia, home to more than a fifth of the world's population, has the potential to lift many farmers and rural smallholders out of poverty.

Milking supplements for all they are worth

Low productivity means Indian farmers struggle to turn milk production into income. **Whitney Macdonald** reports on projects to bring about change

India is the world's largest dairying country, producing more than 90 million tonnes of dairy products a year, but this figure disguises the low productivity at village level. The problem is the diet of the dairy cattle. A joint Australia-India research project supported by ACIAR has been working on the delivery of a new technology that will help cattle extract much more nutrition from their daily roughage.

The technology will also be useful for dairy cattle in northern Australia.

India has 300 million head of dairy cattle, but they belong to small village farmers whose entire herds are usually only two or three animals. And despite the vast national figure for dairy production, each animal contributes minimally to the total yield, producing just four to five litres a day – less than a quarter of the Western average.

So ACIAR is funding a project to increase the productivity of ruminants including dairy cattle and buffalo. An increase in milk productivity translates to a significant increase in economic gain for village farmers.

Ruminants in India – and also in northern Australia – often exist on a diet of poor-quality roughage. Digestion of this roughage begins in the rumen, one of the four compartments of the ruminant's stomach. Here, the fibre is broken down by symbiotic micro-organisms, a process known as rumen fermentation. Some of the digestive by-products are used for synthesis of microbial proteins. Once the food has passed through the remaining three stomach chambers, the digested product passes to the small intestine, where the remaining nutrients are absorbed into the ruminant's bloodstream.

Unfortunately, the particular micro-organisms that exist in the rumen of these animals often lack the specific nutrients to make rumen fermentation a more efficient process. Thus fibre and protein are not digested well, leaving the animals with a low nutritional intake.

Scientists at CSIRO Livestock Industries in Queensland, in collaboration with the National Institute of Animal Nutrition and Physiology in India, are working on a way to improve digestive efficiency in the rumen. This three-year ACIAR project has already had significant economic outcomes.

The research project, headed by Dr Chris McSweeney, has aimed to increase the productivity of ruminants by improving fibre digestion in the rumen. To do this, researchers investigated two approaches.

The first involved identifying and supplementing cattle feed with fungal inoculants that were superior in their ability to break down fibre compared to the fungi that naturally colonises the rumen.

"While often the dairy animals exist on a diet of poor quality roughage, it is high in fibre. If the function of the naturally occurring rumen fungi can be improved, or superior fungi can be identified for breaking down fibre, more nutrients will be available from the roughage," explains Dr McSweeney.

The second approach entailed adding nutrient supplements to stimulate the fungi to work more efficiently, thus increasing the digestive capacity of the existing rumen fungi.

"Ruminant diets in India and northern tropical Australia are often quite low in essential nutrients such as sulfur," Dr McSweeney says. "By supplementing their feed with sulfur compounds, we are able to better stimulate the rumen fungi to digest fibre more effectively."

Nutritional trials, conducted at the CSIRO in Queensland, assessed the effects of the fungus-specific nutrient mercaptopropionic acid (also known as MPA), as well as sulfur supplements, on digestion in the rumen.

When the diets of cattle were lacking in sulfur and nitrogen, the trials found that administering these supplements resulted in the transport of more microbial proteins to the small intestine. In addition, an increase in feed intake was noted.

As nitrogen is a key factor in protein synthesis by the micro-organisms that colonise the rumen, overall rumen function was enhanced through the inclusion of nitrogen and sulfur compounds. To make complete use of the added sulfur, the trials also highlighted the benefit of urea supplements. Responses occurred to levels of supplementation not previously predicted to be of benefit. The overall gains in digestive efficiency that were observed in the trials translate to a five to 10 per cent increase in cattle productivity.

The dietary changes that would need to take place to achieve these gains are well within the normal price range for dietary supplements already bought by farmers. Thus, farmers would not incur any extra costs. They could simply switch to buying more effective supplements.

Improving the efficiency of digestion through the addition of nitrogen and sulfur supplements was not the only successful finding of the nutritional trials. ACIAR-funded researchers also identified superior fungal organisms that, when used to inoculate the rumen, are able to more effectively break down fibre.

"Our nutritional trials using fungal treatments as dietary supplements for cattle in Australia proved promising. We are currently continuing this research on dry animals in India, to verify the gain in productivity translates to cattle in a different environment," says Dr McSweeney. "Once we have confirmed the results on dry ani-

A large output but low productivity: a woman churns milk in the Thar Desert, Rajastha.

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mals, we will move on to dairy cattle in India."

Although incorporating sulfur supplements into the ruminant diet is logistically feasible, the addition of fungal inoculants proves to be more difficult. "Administering fungal treatments requires greater technology to grow and distribute viable and productive organisms. These treatments may be of more use to dairy farmers, where the distance from fungal production to the dairy farm, particularly in India, is not so great," explains Dr McSweeney.

The benefits of the collaborative research efforts between Australia and India extend beyond the bottom-line increase of cattle productivity. A significant aspect of this work has been the development of cutting-edge techniques to study microbial ecology.

Utilising the latest methods has enabled scientists to better understand the organisms involved in the ruminant digestive process. Australian scientists are passing on this knowledge to their Indian scientific colleagues.

"Our collaborators in India are keen to continue these studies to gather more data on the effects of these supplements on dairy cattle in India. In addition, this primary study has served as the catalyst for spin-off projects in India," says Dr McSweeney. "It has been a very productive collaboration, both in the economic and scientific sense."

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A better diet for the cattle, a better diet for the family: a woman tends a cow in West Bengal, India.

In addition to the research tackling poor fibre digestion, ACIAR is also funding research aiming to increase ruminant productivity through more efficient protein digestion.

The project, which utilises a 'protected' or 'by-pass' protein, was initiated at the CSIRO by Dr Suresh Gulati. Now in the Faculty of Veterinary Science of the University of Sydney, Dr Gulati is in the fifth year of this research, working in collaboration with the National Dairy Development Board (NDDB) of India.

"Because most of the nutritious grains go to feeding India's large population, dairy cattle are often left with a diet of straw and the dregs of farming products," Dr Gulati says. "Such a diet lacks the amount and nutritional quality of protein, fat and other nutrients necessary for optimal milk production."

The small amount of protein that is ingested from the poor-quality roughage is mostly broken down in the rumen by micro-organisms. By developing a technology that protects the protein from being degraded in the rumen, more nutrients such as proteins and essential amino acids would be absorbed in the small intestine, effectively increasing the animal's nutrient intake.

"The challenge is to produce the most effective form of rumen-undegradable protein and demonstrate that inclusion of these supplements in the diet of lactating ruminants produces a worthwhile economic return to dairy farmers," says Dr Gulati.

The University of Sydney researchers, alongside the NDDB, have done just that. They have developed a way to supplement the diets of dairy animals with increased amounts of fat and protein from by-products without compromising the nutritional resources available to the public.

This novel technology uses oil seed meals as the source of the protein. Once the oil has been extracted from indigenous seeds such as sunflower, rapeseed and guar bhardo, the remaining proteins and nutrients are treated with a very small level of aldehyde that protects the nutrients from degradation in the rumen.

The collaboration between the CSIRO, the NDDB and most recently the University of Sydney led to the planning and construction of a semi-commercial 'by-bass protein' plant within the existing Indian cattle feed plant at Itola, Vadodara, in Gujarat state. The plant was commissioned in September 2002 and produces 50 tonnes of treated protein meal a day.

High quality-control standards have ensured that at least 75 per cent of this protein meal is 'undegradeable' by the rumen. Dairy animals receive this optimal 'by-pass' protein as one-quarter of their normal feed pellets. Without by-pass treatment to the protein, only 25 to 35 per cent of protein will survive rumen fermentation. Integration of the by-pass protein feed supplements has had a clear positive economic outcome.

"One kilogram of protected protein feed supplement directly results in the production of up to one extra litre of milk per day per animal. With each farm having on average two to three animals, it translates to a net gain of seven to 12 rupees (approximately A$0.30) per day per farmer," explains Dr Gulati. "While this may not sound like a lot of money, it is for the small village farmers."

An analysis of the economic impact of the by-pass protein feed, carried out by Professor P. S. George from the Centre for Development Studies in Thiruvanthapuram, Kerala, India, found that incorporation of the feed would result in an overall net increase in annual income of 4302.42 rupees per farmer.

Perhaps the possible impact of the by-pass protein feed is best summarised by Professor George's concluding statement: "This has the potential to provide a large increase in disposable income for village farmers."

Funded by the NDDB, construction of a second by-pass protein plant is now under way in the Indian district of Godhara in Gujarat state. Australian dairy farmers could also benefit from the by-pass protein technology. Scientists estimate that use of the improved feed supplements could result in milk production rising by 10 to 15 per cent.

As well as increasing the productivity of dairy animals, this technology could have future applications in improving the productivity of dairy products. For now, farmers in India are benefiting from having cows that produce more milk, which means more income. ◂

Sheep genes go full circle

A genetic 'find' could lift the reproductive rates of India's Decanni sheep. Whitney Macdonald reports

Understanding why some species of sheep are more likely to produce multiple offspring than others can be found in the genes. World-famous Merino sheep, like their distant relatives the Garole sheep of West Bengal, India, share a genetic trait.

This gene has caught the attention of scientists and shepherds in Australia and India as both groups seek to increase the numbers of multiple births. Manipulation of the Boorola fecund gene, now known as the FecB gene, is offering agricultural advantages to Indian shepherds, often struggling for meat output from Decanni sheep.

The FecB gene was originally named after the south-east Australian farm where it was identified. As evident from the large litter size (often three to four lambs) of Australian merino sheep, those that carry the FecB gene are more prolific than sheep that lack it.

Scientists at the University of New England in Armidale, New South Wales, are working in collaboration with the Nimbkar Agricultural Research Institute in India on an ACIAR-funded project to increase the reproductive rate of Decanni sheep, which lack the FecB gene.

The three-year project, which also incorporates research from the University of Melbourne, is taking place at the Nimbkar Agricultural Research Institute in Maharashtra state in India.

The project, headed by Dr Steven Walkden-Brown, aims to improve the productivity of sheep by introducing beneficial traits from Garole sheep into Decanni sheep.

"In the meat industry, the reproduction rate drives efficiency," says Dr Walkden-Brown.

Decanni sheep that are raised for meat in India typically give birth to only one lamb, while Garole sheep generally have twins.

Shepherds prefer twins because they put less demand on the adult animal feed supplies, while producing twice the meat output when sold at a young age.

"If shepherds were able to rely on the adult sheep producing twins, they could reduce the number of adult sheep kept for breeding, and thus reduce the cost of adult feed," Dr Walkden-Brown says.

Twins are the ideal number of offspring for a sheep.

"There is a critical three-to-four hour window following birth in which the mother needs to develop a bond with the lamb. If there are more than two lambs, the mother will have a much more difficult time establishing that bond in the short period of time after the birth, and the lambs will fail to thrive."

In addition to having the ideal reproductive rate, Garole sheep are able to live in wet conditions that typically lead to foot rot in other breeds, suggesting a genetic resistance to some parasitic infections.

As part of the ACIAR-supported project, researchers are developing ways to exploit the resistance traits of Garole sheep to benefit other breeds that are more susceptible to infection.

While Garole sheep have many of the optimal genetic traits sought by Indian shepherds, they lack other traits that are important for survival in India.

Garole sheep are very small, with short legs, and weigh as little as 15 kilograms. Decanni sheep are almost double the size.

The physique of the Garole sheep makes it difficult for them to sustain the physical requirements of the migratory lifestyle of an Indian shepherd, necessitated by land and food limitations.

In 2001, work conducted by researchers in New Zealand identified the presence of the FecB gene in Garole sheep as the reason for their increased fecundity.

Following the New Zealand group's discovery, the ACIAR-supported researchers were able to develop a DNA test for rapid detection of the FecB gene.

"With the aid of this genetic tool, we are able to screen large numbers of sheep for the FecB gene following extensive cross-breeding between Garole and Decanni sheep," adds Dr Walkden-Brown.

Through multiple rounds of cross-breeding and genetic testing, the project has already had some very successful outcomes.

"In the first year of the project, Decanni sheep bred with the FecB gene did not show a significant improvement in reproductive rate, due to inadequate adjustments to the research environment," explains Dr Walkden-Brown. "However, by the second year, once the sheep had adjusted to their surroundings, there was a statistically significant increase in the number of twin offspring."

Scientists are optimistic about the outcomes of this project.

"ACIAR has provided this project with enough support that we have been able to test a basic hypothesis, and are now able to take it to the natural farm setting, to test the success in a larger population," Dr Walkden-Brown says.

"Our future work will examine the scope for such reproductive technology in the Australian sheep industry." ◂

Shepherds in Maharashtra are beginning to benefit from more prolific sheep.

Bedding down crops

New raised-bed systems may counter some of the soil and water problems of irrigated cropping, reports **Warren Page**

Irrigated cropping is widely practised in Pakistan and in India's rice-wheat belt. Yet the practice contradicts the high value placed on water by being relatively inefficient. Despite cropping rotations being different in Pakistan and India, several common problems are emerging: low yields, the beginnings of salinity, deteriorating soil structures, groundwater depletion and water scarcity.

Pakistan's cropping sector rotates a number of crops including wheat. Irrigated cropping dominates, with 80 per cent of cultivated land relying on some form of irrigation.

India's rice-wheat rotation is vital to the country's efforts to provide enough food. Rice and wheat provide 85 per cent of total cereal production and 60 per cent of the total dietary calorie intake.

The countries are not alone in confronting salinity, water use efficiency, declining yields and soil problems associated with cropping. Australian crop sectors are also seeing the same problems emerge in southern irrigated growing areas.

One innovative approach to these issues is raised cropping beds. These beds are formed and left in place for up to five years. Crops are planted into the beds, with access provided by narrow trenches between the beds.

In Australia, this approach has shown promise in allowing high-rainfall zones to be cropped, and also as a more water-efficient option for broadacre crops in irrigation areas. In high-rainfall areas, the trenches either side of the beds drain away excess water and prevent waterlogging, while in irrigation areas the trenches deliver a controlled water supply to the root zone.

Two projects are now trialling this technology to see if raised beds can deliver similar water-efficiency solutions to Pakistani and Indian farmers.

Raised beds have been trialled in a past-project with initial results showing yield boosts of 35 per cent for maize. Wheat yields were also increased, by 20 per cent. This new project is helping in the expansion of raised beds in Pakistan.

In Mardan, Pakistan, the project has a dual focus. The first is establishing beds to develop optimal approaches for crops. Three types of beds are being trialled: wide beds, narrow beds and flat basin seed beds, the final as a control.

How these beds affect water interactions is crucial to their long-term viability. Irrigation water is introduced to the trenches between beds.

The movement of this water from the trenches to the root zones under the beds, known as subbing, is measured. This subbing must be at a sufficient level to ensure the crop roots can access water.

Two farmer groups are working with researchers to trial raised beds in the extension focus of the project. Each group has bought a

PHOTO: S S KUKAL

ACIAR projects are assisting in the expansion of raised-bed cropping in the region.

bed former/renovator and seeder for use.

Rabi wheat has been sown, with crops showing superior growth on raised beds than in traditional flat irrigation basins. Some encouraging results are also emerging regarding salinity, with raised beds having less salt in crop root zones than found in normal seed beds.

One aspect helping the Pakistani researchers has been collaboration with their counterparts working on the Indian raised bed project.

The Indian project, now in its fourth year, has been examining similar issues, though for rice-wheat rotations.

Rice planted on the beds has a portion of the root system in unsaturated soil. Although this presents a different challenge than in growing maize and wheat in rotation, many of the issues of water use and crop performance are common in both projects.

Site-specific recommendations have been critical to the success of the project in India. An early finding has been that in many areas, rice yields are lower on raised beds than in conventional planting.

Drying-out of the beds and subsequent water stress during tillering (sprouts emerging from the crown of the wheat plant) is a major factor. Sandy loam soils are particularly vulnerable, but early irrigation and increased sowing rates compensate.

Wheat yields on freshly formed raised beds are, however, higher than those on the flat.

Other options also being investigated are alternative crop rotations, including soybean and maize. When rice is replaced with either maize or soybean on beds, promising yields increases have been reported, including for wheat. In both projects changes in soil and water interactions are being monitored, with positive results reported.

Irrigation management, via drip irrigation, and water being added to trenches are being assessed. Each demonstrates that water savings are possible, but climatic factors might determine which provides the greater savings.

In Punjab province, the Indian team has sampled water to a depth of 1.8 metres, revealing wheat is extracting water at least to this depth. This is an important factor in limiting groundwater depletion and salinity. The lower the depth at which water is extracted, the less salinity rises.

Shallow-rooted crops do not extract water at lower levels, which together with over-irrigation is resulting in water tables rising, freeing up salt trapped in soils and bringing this closer to the surface. Groundwater is, however, over-utilised, depleting this.

Research undertaken in Australia as part of the projects has also produced similar positive results, opening up the possibility that raised beds may become a feature of the cropping landscapes in all three countries. ◂

Expanding the agricultural linkages

A new program promotes closer cooperation between Australia and Pakistan

A new program to forge increased agricultural links between Pakistan and Australia was announced in June 2005, with ACIAR to manage one component of the program. The Australia-Pakistan Agriculture Linkages Program, worth A$6.6 million over four years, was formally announced by the Minister for Foreign Affairs, Mr Alexander Downer, and the then Minister for Agriculture, Fisheries and Forestry, Mr Warren Truss, on 16 June 2005.

The idea behind the program arose during the visit to Australia by the President of Pakistan, Pervez Musharraf. The Australian Prime Minister, Mr John Howard, and President Musharraf discussed closer cooperation on several fronts, including agriculture.

The program aims to expand links between the two countries by facilitating a greater exchange of expertise in the academic, agricultural and commercial sectors.

"The program will help forge new academic, agricultural and market linkages to produce an increase in the productivity and sustainability of agriculture in both countries," Mr Downer said in announcing the program.

Pakistan and Australia share similarities in agriculture, with broadacre cropping an important part of each country's output. Some of the same constraints to increased productivity, such as salinity, water management and the management of biotic and abiotic stresses, feature in both countries. Pakistan also has common interests in livestock production and health.

ACIAR will manage the Technical Activities component of the three-part program. The remaining components, involving development scholarships and the facilitation of market linkages, will be managed by AusAID and Austrade respectively. AusAID will fund the Program.

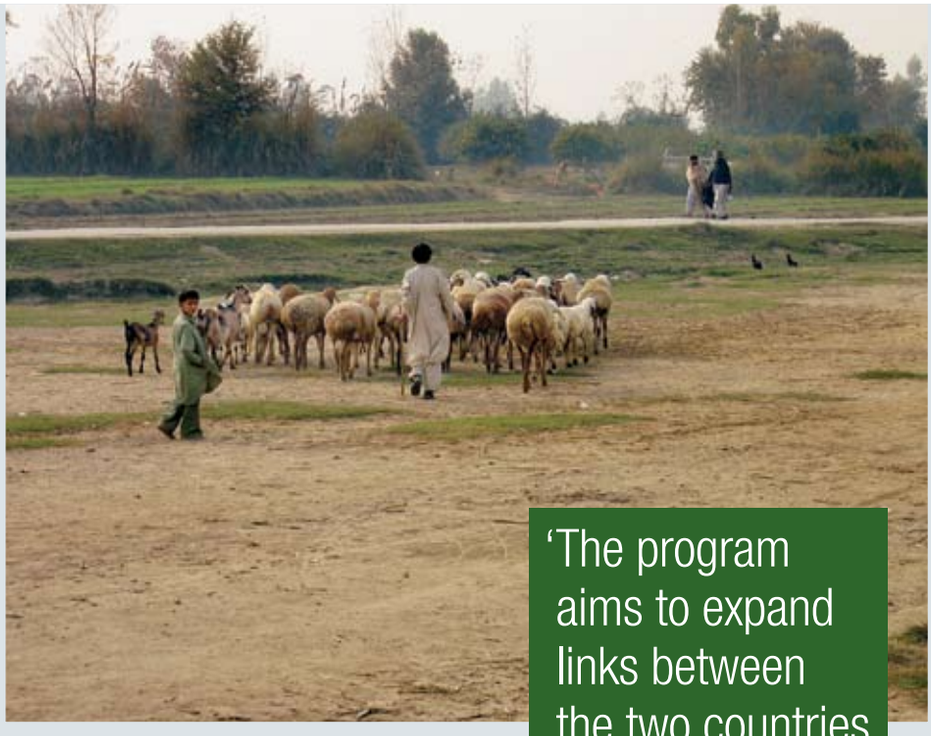
The ACIAR-managed Technical Activities component will involve A$5 million over four years, beginning in 2005–06.

"Through ACIAR, the program will enhance existing links with a new program of technical exchanges and economic research and development projects," Mr Truss said. "This includes staff exchanges, targeted seminars, scoping studies, small projects and research and analytical activities."

ACIAR has held an initial consultation with relevant Pakistani stakeholders to assess the main areas of priority. The results of this consultation are now available on the ACIAR website, www.aciar.gov.au.

ACIAR has worked with Pakistan as a partner country since 1984, with a focus on natural resource management, particularly relating to dryland and irrigated cropping.

Many of the relationships that have been established in this time, along with ACIAR's knowledge of the agriculture sector in Pakistan, will be important in developing the program. ◂



'The program aims to expand links between the two countries by facilitating a greater exchange of expertise'

Fellowship sows the seeds of opportunity

Warren Page on shared experiences, expertise and respect

One reason why many ACIAR projects exceed people's expectations is the dedication of researchers, and this has been particularly noticeable in ACIAR projects involving conservation tillage and raised beds in India and Pakistan. Dr Harminder Singh Sidhu, a research engineer at India's Punjab Agricultural University (PAU), is a passionate developer of the Happy Seeder – a tractor that allows wheat to be sown directly into rice stubble.

Developed by Dr Sidhu and his PAU team during an earlier project examining stubble management machinery for direct-drill farming systems, the seeder is now being manufactured by an Indian machinery company.

Before the seeder was developed, straw left over from paddy rice farming had to be removed. This was done either by hand, by ploughing or by burning.

The seeder combines the attributes of a forage harvester, cutting and lifting the straw while a drill 'plants' the seed. Straw is then sprayed out the back to cover the seedbed.

Not content with this successful innovation, Dr Sidhu and his team have now developed a Combo Happy Seeder. This new model improves the establishment of wheat in the soil and produces a more even spread of straw mulch.

The Combo Happy Seeder is now being tested throughout India. The seeder tractor is also beginning to gain acceptance in Pakistan.

In 2003, Dr Sidhu and Dr S.S. Dhillon, also from PAU, travelled to Pakistan to share their experiences of stubble management and also bed planting technology. The Pakistan Agricultural Research Council hosted the visit.

Dr Sidhu also travelled to Australia in 2005 under an ACIAR John Dillon Fellowship. Fellows are selected on a range of criteria – involvement in a recent or current ACIAR project, coming from a developing country, and having demonstrated potential as a future research manager and leader.

By supporting a six-week visit to Australia, the Fellowship provides an opportunity for international researchers to see how agricultural research organisations operate in Australia; their management techniques and processes that can be applied in home organisations.

Dr Sidhu with a Happy Seeder, to be towed by a tractor.

Dr Sidhu says his visit to Australia provided a unique career-development opportunity: "I got the chance to see and understand the workings of various Australian institutions.

"It was great training, and I can now see my technical scientific inner-self in a managerial role very clearly. The Fellowship was a very effective tool to enhance my capabilities in the area of research and management."

For Dr Sidhu, the Fellowship also provided the opportunity to meet colleagues from other developing countries and discuss common problems and opportunities.

"This Fellowship gave me an opportunity to meet, know and live with people of different countries, cultures and different language, which enabled me to see globalisation in a different context."

Dr Sidhu says another highlight was meeting Australia's Foreign Minister, Mr Alexander Downer. The Minister presented Dr Sidhu, and the other John Dillon Fellows, with a plaque recognising the Fellowship, at Parliament House in Canberra. ◂

Dr Sidhu receives the John Dillon Fellowship plaque from Mr Alexander Downer.

Crowding out weeds in India

Increasing herbicide resistance in weeds called for a new approach. **Warren Page** reports on efforts to align several management options

Weed competition for crops has been the bane of farmers for time immemorial, and while modern herbicides have provided some relief in recent decades, their effectiveness is declining as weeds develop resistance. The experience in India mirrors this global trend. The Punjab and Haryana states in north-west India produce a third of the country's wheat, and from the late 1960s, when higher-yielding dwarf wheat varieties were introduced, to the late 1980s, production remained stable. But by the early 1990s, yields began to decline dramatically and one of the main causes was the weed, *Phalaris minor*. This had been kept under control with herbicides, but by the 1990s was developing herbicide resistance.

In India wheat is grown in rotation with rice. During the rice rotation, weeds are not a problem; the *Phalaris* only emerging during wheat germination. With both the wheat and weed competing for water and nutrients, overcrowding kills or reduces the growth of smaller crop plants. Wheat does not mature at the same speed as *Phalaris* so it struggles to compete, resulting in reduced yields.

In India's case, the development of *Phalaris* resistance was the result of overuse of one herbicide, isoproturon, over a 15-year period. The problem became noticeable when isoproturon-resistant *Phalaris* emerged rapidly in the early 1990s. In 1990, spraying killed about 78 per cent of weeds. By 1993, this had fallen to just 22 per cent.

Wheat yields began to plummet at a similar rate. In the worst-affected regions, yields were reduced by 50 per cent, falling to 1.5 tonnes per hectare, or even further.

Some farmers began to switch from wheat to sunflowers to make up lost income.

In the 1992-93 season, the introduction of a new wheat variety, changes to herbicide recommendations and alternatives to isoproturon all helped to arrest the slide, but this respite would be at best temporary.

The higher cost of the new herbicides, and the likelihood of future resistance emerging, meant that any option that put all hope of control on a herbicide alone would never be sustainable.

So ACIAR, together with the International Maize and Wheat Improvement Center (CIMMYT) and Haryana and Punjab Universities, sought to develop an alternative approach – integrated weed management, to build on earlier work by the Rice-Wheat Consortium.

This aligns several management options to extend the effectiveness of chemical spraying, rather than hoping for an alignment of optimal conditions to counter the yield decline from herbicide

resistance. It was anticipated these options would fit into a new approach to preparing soils – zero tillage.

Four management options were identified and trialled: changes to crop rotations, earlier sowing times, higher crop densities and the judicious use of alternative herbicides.

Also, wheat varieties that are more competitive were identified, and have started to be introduced into crop rotations.

It has been found that earlier planting of these varieties can reduce the direct competition between wheat and *Phalaris*. Planting wheat a month earlier than usual gives it an opportunity to grow without direct competition. This ensures wheat germinates and establishes itself before conditions become favourable for *Phalaris*.

Increasing crop densities further crowds the emerging weeds, changing the dynamics so that the weeds are the smaller plants, rather than the wheat. The reduced number of weeds in turn allows for more judicious spraying of herbicides. Less spraying reduces the likelihood of resistance and extends the timeframe in which the herbicide is effective.

These options were then integrated into a change to tillage practices. Zero tillage does not disturb the soil, with seed planted in the residue of rice crops. This lack of soil disturbance makes it hard for *Phalaris* seed to establish itself.

Zero tillage agriculture was introduced by international research organisations as an option for increasing yields rather than for weed control, but incorporating the management options for *Phalaris* with zero tillage is regarded as an effective integrated weed management package.

The main barrier to this has been farmers' need to be convinced that a change to zero tillage will deliver the wheat yields and the *Phalaris* control that they used to enjoy in the 1980s.

In the past, farmers have not adopted zero tillage. In the 1970s, Punjab Agricultural University experimented with zero tillage but failed to spark the imagination of farmers. One of the main problems was the lack of suitable equipment.

In zero till, seed is introduced to the soil via a drill. This helps water run through soil quicker, and allows rice straw residue to cover soils, keeping them closer to optimal temperatures in both colder and hotter weather. Disturbance to soil is minimised. This improves the soil's chemical, physical and biological properties and increases carbon storage, which helps reduce greenhouse emissions and boosts yields.

The drawback for farmers is that drilling into soil that has not been ploughed requires specialist equipment.

During the project, many of the trials were undertaken in farmers' fields, giving them a close look at the machinery and possibilities. The control of *Phalaris* was in itself enough to convince many farmers, and when coupled with increased yields, led to a demand for drill equipment.

Project personnel from both India and Australia supported the development of suitable drill equipment by several manufacturing companies. For example, spacing of 15 centimetres was used, rather than the 22cm that is used elsewhere, to deliver cropping densities that match the needs of integrated weed management packages.

This has helped accelerate the adoption of zero tillage farming throughout Punjab and Haryana states. Twelve recognised drill manufacturers are now operating, supplying equipment to farmers in both states. More than 3000 drills are in use.

An independent impact assessment of the ACIAR-supported research, which led to the acceleration in adoption by three years, has demonstrated benefits to India of A$238 million, arising from an investment of A$1.3 million.

This return is part of the A$1.8 billion in benefits that zero tillage has begun to bring to India, identified in the assessment.

A seeder to allow planting of wheat into rice-straw stubble, similar to that now being trialled for raised beds.

S S KUKAL

Measuring experiments with waterlogging-tolerant wheat.

Wheat yields are up to around 4t/ha in many areas of Punjab and Haryana. Given that the project identified that isoproturon-resistant *Phalaris* had spread throughout the rice-wheat growing areas of both states and that other herbicides would have suffered the same fate, the introduction of zero tillage and integrated weed management has made a dramatic difference to farmers. ◂

Sue McAlister reports on key water management projects in India, Pakistan and Australia that are helping all countries find better ways to balance competing water demands

PARTNERSHIPS AND MANAGEMENT THE KEY TO SUSTAINABLE WATER USE

Water is essential for everyone's survival. Yet it is growing harder to come by every day. Living on the planet's driest inhabited continent, Australians know this only too well, and have responded by developing advanced expertise in the science, technology and management of water. To help share this knowledge, ACIAR has provided nearly A$2 million in funding for two particular projects in India and Pakistan – water allocation in India and conjunctive water management in Pakistan. These projects combine the application of Australian expertise in water governance and service delivery with the vital participation of local administrators and users.

The Indian project is complex, as it involves three federal states agreeing on how to allocate, manage and develop the diminishing waters of the Krishna River Basin. In Australia, the often competing demands on water resources of the Murray-Darling Basin river system spread across four states. The lessons from the management of the Murray-Darling Basin are part of the reason why Australian expertise was sought for the Sri Lanka-based International Water Management Institute (IWMI) in the Krishna River Basin project.

ACIAR Research Program Manager Dr Christian Roth says there are two sides to water management: the scientific-technical-economic, and the political-administrative-societal. Australia's role in the Krishna Basin is to provide sound, impartial information on the scientific-technical-economic so that Indian authorities and communities can work on the latter. The stakes are high: the three states involved have a combined population of 215 million.

One of the challenging aspects of Australia's role in the project is marrying biophysical with socio-economic assessments; in other words, reconciling conclusions about how much water there is and where best to put it to sustain quantity and quality of supply (and the environment), with conclusions about how best to allocate and use it for economic benefits by maximising water productivity.

'Hydrologists and economists often have very different perspectives'

"Hydrologists and economists often have very different perspectives," says Dr Roth. "But members of the Australian multi-disciplinary team assembled for the Krishna Basin are all talking the same language and are working towards a shared conceptual framework for water allocation, involving stakeholders in the process of matching water resource availability and allocation against the highest economic returns."

From its beginning, the Krishna catchment area presented challenges of a uniquely Indian kind. Traditionally, its water was used mainly for irrigation. However, India's rapid population growth, especially in urban areas, and burgeoning industrial sector is placing unprecedented demands on a finite body of water and food-growers' ability to sustain themselves and their crops.

Another factor is size. One of the project's earliest stages involved collating massive amounts of water quantity and quality data, generated and stored by a large number of governmental, bureaucratic and research bodies. This was a daunting task, but has been completed by Melbourne scientist Dr Biju George and the IWMI-led team.

There has also been tangible progress in other areas. India's Federal Government has reconstituted the Krishna Basin Tribunal along the lines of the Murray-Darling Commission to mediate between competing interests, including different state governments and water authorities. One of the states comprising the Krishna River catchment area, Karnataka, was initially not that keen on participating, but has since been sufficiently impressed to increase its allocation of resources to the project. And Dr Roth explains: "The collaborating Indian institution, Jawaharlal Nehru Technological University, has provided an enormous additional resource in the form of nine Master of Science students undertaking research aligned with the project."

The Krishna Basin project may now provide a template for Australian assistance elsewhere in the Asia-Pacific region. Already, the Mekong River Commission, with representatives – and sometimes competing interests – from Laos, Vietnam, Thailand and Cambodia, has approached ACIAR about funding for a similar project. However, as Dr Roth explains, such support is never a one-way street: "Australia is definitely building its water resource management skills and knowledge through participation in this large and significant Krishna Basin project."

Pakistani and Australian scientists, irrigation managers and farmers have worked together to develop improved conjunctive water management in the Rechna Doab, part of the Punjab region of Pakistan.

ACIAR Research Program Manager Dr Ian Willett says the irrigation agriculture system in the Rechna Doab, like many such systems in Australia, suffers from insufficient fresh water.

"Conjunctive water use involves optimising the use of fresh, saline, surface and groundwater sources," he says. "There are two sides to this. One is technical, or 'hard': planning how to physically get hold of the maximum sustainable amount of all water sources and how best to use them together, productively and safely. The other side is human, or 'soft': developing societal and institutional arrangements that will enable the scientific and engineering plan to be carried out."

It is often the 'soft' side of things that proves hardest to change, yet the Punjab Irrigation Department has adopted the models for institutional arrangements identified by the project team.

The Rechna Doab project was coupled with a project in the large Coleambally irrigation area, south of the Murrumbidgee River in south-east Australia. Both areas produce rice and wheat and both face the same fresh water scarcity, waterlogging, salinity and farm viability issues. Both also turned for help to the CSIRO.

One of two Australian scientists who completed the Rechna Doab project was Pakistani-born Dr Shahbaz Khan, who is Stream Leader of Irrigated Systems and also Professor of Hydrology at Charles Sturt University. "The conjunctive water management models developed for the Coleambally and Rechna Doab systems were an example of learning from each other's experience," he says. "For instance, the farm economics expertise of our Rechna Doab scientist guided Coleambally water management analysis, while the state-of-the-art groundwater management models developed by the CSIRO in Coleambally helped develop similar expertise in Pakistan."

A computer farm model customised for Rechna Doab was developed and given the distinctive Australian name SWAGMAN. Stakeholders in the Rechna Doab (mainly regional planning bodies) were trained to use the SWAGMAN model, which balances irrigation profitability with natural resources management. The Centre of Excellence in Water Resources Engineering at the University of Engineering and Technology in Lahore has also been given a copy for educational purposes.

The projects in Pakistan and India have helped to further the understanding of sustainable water management from a number of perspectives, most notably those of managers, farmers, hydrologists and economists. All bring their own ideas, but by building the tools needed for all views to be heard, the projects are ensuring that water management is based on a framework that incorporates everyone's needs. ◂

Growing seafood without the ocean

Warren Page and Geoff Wilson report on a possible benefit from salty soils

PHOTO: STEWART FIELDER

Easing the pressure on natural ocean fish stocks: Fish being harvested from a community pond in Rohtak Village, left; and saltwater aquaculture ponds in Australia. Credit Stewart Fielder.

Salt and soils do not mix. This has been known from ancient times; conquering armies would sometimes spread salt on an enemy's farmland to destroy its agriculture.

Modern farmers have as their enemy naturally occurring salt, rather than that dispersed by marauding armies. It is rising water tables that are on the march, mobilising ancient salt deposits in countries like India and Australia, both having large areas once covered by seawater.

As this salt approaches the surface it is being 'sown' into soils, all but crippling productivity.

Many management approaches have been tried over the years and research continues. One of the more recent and novel ideas is to use 'interceptor banks' to intercept saline water as it rises through the soil and direct it into holding ponds (or farm dams), and use these for raising saltwater fish species.

Short-season crops, or pastures, have shallow root systems that do not soak up rising water in the same way as deep-rooted trees and some perennial species. So rising groundwater is not absorbed in large quantities until it reaches surface subsoils, where it prevents healthy plant growth. This, combined with over-irrigation, increases salinity.

Channelling this saline water into collection ponds before it reaches the root has the potential to keep farmland arable, and provide a resource for inland aquaculture that could help to ease the growing pressure on natural ocean fish stocks.

To this end, Australian and Indian scientists are collaborating in a three-year ACIAR project to support the use of saline holding ponds in cropping and grazing lands for profitable aquaculture.

Several barriers have to be overcome. Inland salt water is not always like seawater, even if it is from ancient oceans. The concentration of chemical salts can vary greatly and can have adverse effects on fish, crustaceans, shellfish or the water-borne microorganisms upon which juvenile fish feed.

The same applies to the extremely variable salty waters from land degradation or faulty irrigation. Lightly salted waters can be suitable for some fish and crustaceans, while the heavily salted waters may have commercial uses only after chemical treatment.

Nonetheless, the salty water resource in both countries is huge – and is growing – and everyone agrees long-term economic answers are needed.

In Australia, it is forecast that 12 million hectares of farmland will be salt-affected by 2050, affecting the livelihoods of about 74 rural and metropolitan towns and cities.

In India, about 8.57 million hectares are predicted to succumb to salinity over the next few decades. In addition to this, some 41 to 84 per cent of groundwaters in north-western India are naturally saline.

Researchers believe that using collected saline water for commercial enterprises such as saltwater aquaculture will provide the commercial incentives needed to sustain long-term management options.

They are looking at the potential to grow fish, crustaceans, shellfish, edible seaweeds and other halophytic (salt-tolerant) plants that can create food and farm incomes at village, regional and national levels.

In India the proposal has the potential to increase food production and create an alternative income source for farmers in salt-affected lands. Dr Stewart Fielder, scientific officer, marine fish breeding, with NSW Fisheries at Port Stephens, says that in both India and Australia, basic husbandry used to culture target species elsewhere (on the coast) is being used in experiments. The intention is to evaluate coastal technology in an inland environment.

"Feeds are obtained from either coastal feed mills or made locally using the same ingredients and formulations as on the coast," he says.

Dr Fielder says the objective of this ACIAR-funded program is to identify opportunities and develop technology for integrating aquaculture with agriculture in degraded areas.

Such integration is moving towards fish feed proteins produced from farmer-grown cereal grains, rather than from a declining (and more expensive) wild-catch of anchovies and other aquaculture feed fish.

It is hoped that successful integration of aquaculture into traditional farming lands could finally overturn the age-old rule that soils and salt cannot mix. ◂

Eye in the sky manages degradation

Australian experience in tackling rangeland degradation in its semi-arid pastoral country is helping Indian land managers. **Ava Bentley** reports

Land degradation has long been an issue for land users, administrators and planners in countries with arid and semi-arid rangelands, including India and Australia. Despite that, many farmers, particularly those in developing countries, have limited awareness of when degradation is occurring, resulting in too little time to remediate lands before permanent damage occurs. Land planners too struggle to know degradation is occurring.

In many cases, the degradation of land, or damage to soil structure and vegetative cover, is caused by over-grazing and variable rainfall. Such conditions lead to low vegetative resilience – a limited ability to recover following substantial wet-season rains. The difficulty for those on the ground is that such damage is not obvious until it is very hard, or even impossible, to recover. At the same time, poor farmers are relying on this land, even as it is in decline. So where permanent, irreversible land damage occurs, poverty follows.

In the Thar Desert region of Rajasthan, in India, land degradation is occurring at an increasing rate. The region contains more than 200,000 square kilometres of arid land, has a fast growing human population (approaching 20 million) and increasing livestock numbers, all of which accelerate damage to fragile arid landscapes.

The issue in this region is an interesting example of how difficult these types of problems can be, because the damage is not obvious on the ground but clearly visible from the air. To assess the extent and causes of land degradation in Rajasthan, and provide tools with which to manage and prevent further damage, an ACIAR-supported project was undertaken in collaboration with Indian scientists from the Central Arid Zone Research Institute (CAZRI) and Australia's CSIRO Centre for Arid Zone Research.

Dr Margaret Friedel, CSIRO scientist and project manager, says the aim was to adapt Australian technology for use in the Thar Desert region: "Remote-sensing technology has been used very successfully in Australia, and our intention was to use similar technology to assess the causes and extent of land damage in Rajasthan."

It was hoped that use of the technology would provide local land management planners, policymakers and administrators with the capacity for better land management decisions, and for developing preventative land care measures.

The technology uses remote-sensing data captured by satellite (old and new) and combines this with ground-level information relating to vegetation, grazing and village communities in a Geographic Information System for a more complete assessment. By placing new satellite images over old images, researchers are able to see how a particular area of land has responded to grazing, rainfall or other agricultural factors.

'Poor farmers are relying on this land, even as it is in decline. So where permanent, irreversible land damage occurs, poverty follows'

Such an assessment can pinpoint areas of poor regrowth that may indicate reduced resilience and potential degradation. It gives a bird's-eye perspective to the problems, which can make them far more visible for land planners and administrators, and trigger further investigation or action.

CSIRO scientist Gary Bastin says this type of assessment is called the Resilience Method: "The Resilience Method is one approach to determining the impacts of grazing on rangelands. It produces maps showing vegetative growth as either above or below average, and can assist with particular management practices and government inputs to areas in greatest need of attention."

Local farmers are not in a position to utilise this technology directly, and have limited capacity to understand the nature of degradation, even though they can be the best source of data.

ACIAR Research Program Manager Dr Ian Willett says that making contact with villagers is important: "The project's underlying philosophy was that if people involved in agriculture can tell if they are degrading land, and are involved in decision making, then they are more likely to take actions to reduce degradation."

As the project progressed it was apparent that local farmers were not in a position to utilise this technology directly. As a result the project's emphasis shifted to ensuring that CAZRI land managers could utilise the new technology and share this with land administrators to help villagers manage their lands and act upon signs of degradation.

In keeping with the project's philosophy, the data collected about degradation in Rajasthan has been translated into a language easily understood by local land users. Block Development Officers, who work at the local level with villagers, are a potential means for helping villagers to recognise degradation and understand what they can do to remediate this. Now that it is possible to assess degradation at an early stage, and undertake action to remediate this, land planners and administrators, together with villagers, can take action where it is needed – on the ground. ◂

CLEAN TECHNOLOGY presenting challenges for tanneries

India's A$10 billion leather industry is using Australian expertise to tackle its environmental problems. **Robin Taylor** reports

The leather industry in Australia has come a long way in terms of its environmental credentials. India is now adopting some of the same methods, thanks to innovative researchers and an ACIAR project. Salinity in tannery effluents is a critical problem in many countries, including India, where the leather industry employs 2.5 million people and is worth about A$10 billion.

About 60 per cent of tanning occurs in the southern state of Tamil Nadu, where, in 1996, the Indian Supreme Court ordered the closure of more than 500 tanneries for environmental non-compliance.

Salt has continued to contaminate effluent and to enter rivers and groundwater. The aim of the ACIAR project, a collaboration between India's Central Leather Research Institute (CLRI) and CSIRO Leather Research Centre, was to develop and apply methods to eliminate, or at least significantly reduce, salt use in hide and skin preservation and processing.

The leader of the project, CSIRO's Catherine Money, a world leader in leather processing research for better environmental outcomes, could see the opportunity to drastically reduce the amount of salt and other additives without affecting leather quality.

"The high salinity of tannery effluents is an enormous problem in India, threatening a lot of the tanneries in Tamil Nadu with closure," explains Mrs Money. "Over the three years since the project started, the situation has worsened and the tanneries are getting pretty desperate about what to do."

In the rigorous conditions of southern India, where temperatures of 40°C and high humidity are common, some of the short-term preservation systems used by leather processors in Australia are not suitable.

The four major areas where Mrs Money and her colleagues, the Indian project leader, CLRI Director Dr T Ramasami and project coordinator Mr N. K Chandrababu, thought they could have an impact were: reducing the amount of salt used in the hide and skin curing process; short-term hide preservation by chilling; pickle liquor recycling; and direct chrome liquor recycling.

In India, fresh skins are preserved ready for tanning by covering them with salt. Goat skins are salted with between 50 and 100 per cent salt by weight and cattle hides with 40 to 50 per cent. In Tamil Nadu, the effluent from the soaking of salted skins is required to be evaporated in solar pans, but this system is usually inefficient and little salt is removed from the site.

Low-salt systems, which could reduce salt use three- to four-fold, have given promising results and are being trialled commercially with goat skins. Because the amount of waste salt is significantly reduced, all the evaporated salt should be able to be reused or used as a fertiliser for coconut palms.

"It is feasible for unopened goat skins to be salted as usual, but with about 20 per cent salt by weight," says Mrs Money. "Collection

In India, fresh skins are preserved for tanning by covering with salt (left). Above, the skins are turned flesh-side out for a second salting at Mumbai salt works.

PHOTOS: RITA SIEKRIS

centres, often already controlled or influenced by tanners, will supply the salt pre-mixed with suitable additives to small operators and also do salting themselves."

In Australia, chilling has been widely used for many years as a method of preserving hides. Chilled hides are usually kept for only a few days, but they may be kept for more than a week at low temperatures. Initially, chilling was thought to be too difficult for Indian conditions, but it now appears that it may be viable for some hides and skins.

"Chilling is increasingly being used for food storage and transport in India and CLRI has completed trials and costings which are very encouraging," says Mrs Money.

CLRI has developed a mobile chilling unit for industry trials and demonstrations, which will be used for chilling hides in Kerala and transport to Erode. "Eventually, we expect that chillers will be set up in Kerala and Erode and that insulated trucks will be used to transport the chilled hides," she says.

The hides are collected from small dealers and hung in the chiller, where they will keep for seven days without the need to preserve them with salt. In Australia, where conditions are more favourable, hides will keep for longer.

"It is much more difficult to implement in India, where you are working with many small operators and in hotter conditions," says Mrs Money. She believes that training people to use the chiller properly will be difficult.

After the hides are thoroughly chilled (about one hour), because they are well-insulated they can be transported to the tannery in crates in insulated trucks.

"The tannery that we have done a great deal of work with is KKSK Leather Processors. They are innovative and willing to listen and make changes," she says. "They will install chillers if the trial results are good." KKSK Director Mr Rafiq is championing the chilling technology.

The third recommendation introduced by the project is pickle liquor recycling. Pickling is the process that readies the skins or hides for tanning. The pickle liquor (water, acid and salt) is added to the prepared hides or skins to prepare them for the tanning chemicals. In Australia, tanners used to discard pickle liquor after 10 or 20 uses, until CSIRO research showed that it could be used indefinitely. An Australian collaborating woolskin tanner has recycled commercial pickle liquors for more than 250 cycles. Amazingly, in India the pickle liquor was not being reused at all.

Pickle liquor contains a lot of salt, which was being discarded after each use and required evaporation and disposal. In trials at Tamil Nadu, pickle liquor was successfully reused 15 times and it was still working effectively.

"It's hard getting people to mentally accept that you can go on using it more, but that is the next stage," says Mrs Money.

The final recommendation of the project involved recycling the chrome liquor used in the tanning process to stabilise hides. Recycling is widely accepted in the Australian industry and reduces the use of both sodium chloride and chrome powder. In India, the normal practice is to recover chrome from the liquor, but all the salt that is used goes to the evaporation ponds.

"It is far more efficient to just keep reusing that chrome liquor and top it up with salt and chrome," explains Mrs Money. "Initially the Indians weren't interested, but we have carried out successful commercial trials in India and shown that it does work and that leather quality is maintained, contrary to their expectations."

The project has been extended in order to get the recommendations more widely adopted through the tanning industry.

While the proposed low-salt preservation will entail little change for first handlers of skins, greater care will be required to ensure even salt application.

One option that may bring about change is if tanners were to pay more for skins with less salt and good preservation and less for skins with excess salt. The collaborating tanners will be the champions of the new technologies. ◂

Targeted approach maximises farm help

Warren Page reports on ACIAR activity in some smaller South Asian nations

Australian expertise in crop production, particularly dryland cropping systems, allows ACIAR to effectively target its research projects to farmers in South Asia who have similar production constraints to those experienced in Australia.

The majority of ACIAR projects in this region concentrate on India and Pakistan, which have the largest populations. However, a suite of small projects is also now under way in Bangladesh, the next most populous country in the region, and there are small problem-specific projects in Afghanistan, Bhutan, Nepal and Sri Lanka.

Most of these ACIAR projects involve aspects of crop production and crop management, including pest control, because of the crucial role of field crops in providing staple foods.

Multilateral centres of the Consultative Group on International Agricultural Research (CGIAR) are often engaged to lead these projects, particularly those centres with a mandate for the crops widely grown in the region.

These include the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the International Rice Research Institute (IRRI).

Training and capacity-building is an important feature in many of these projects. A dual approach is utilised, with in-project training accounting for most of the activities undertaken and a small number of fellowships providing training opportunities in Australia.

Taking the toxins out of cropping

Bangladesh and Nepal are at the opposite ends of South Asia; one with some of its land below sea level, the other sitting in the Himalayas. But both countries have a common problem of toxic elements affecting cropping.

In Bangladesh it is arsenic, occurring in groundwater and seeping into soils, that causes problems. Nepalese farmers grow the potentially toxic Lathyrus crop.

Groundwater is used in irrigated cropping in parts of Bangladesh. The source of the arsenic found in groundwater is unknown. Crops, particularly some vegetables, have shown high concentrations of arsenic, suggesting transfer involves both water and soils. As irrigated crops use groundwater arsenic is transferred to plants and also leaves traces in soils.

Lathyrus (grasspea) is grown in Nepal for use in dhal, a staple food. It has the benefit of being drought-tolerant, but also contains a toxin, ODAP. This causes the condition known as Lathyrism, a neurological disorder. During drought or poor seasons Lathyrus is one of the few available food sources, being more heavily consumed than normal and increasing the risk of Lathyrism.

Two ACIAR projects are working to overcome these issues. Both projects have a common connection: each has a John Allwright Fellow linked to the project.

Ms Kazi Farzana Akter, of Bangladesh, has been studying for a PhD at the University of South Australia, examining the widespread problem of arsenic in Bangladeshi soils.

"In Bangladesh alone, out of 64 districts, 60 districts are affected with arsenic pollution and with more than an estimated 20 million of its 126 million people likely to be drinking contaminated water. This calamity is considered as a slow tsunami of Asia," Ms Akter says.

She is examining arsenic contamination in soils, and working on a dual approach to managing arsenic.

"The most important aspect of my work is to develop reliable and cheap techniques for the measurement of arsenic in water and biological samples. However, the second most important part is to identify exposure pathways, especially from diet, and to investigate the impact of arsenic-contaminated irrigation water on crops."

Ms Akter is hoping to complete her PhD early in 2006, after which she will return to Bangladesh.

The ACIAR project addressing arsenic, now completed, examined the pathways by which arsenic transfers from groundwater to crops and how soils are involved in this interaction.

Three key findings emerged from the project research. Irrigation with arsenic-contaminated water does not result in uniform arsenic uptake. Different plants accumulate arsenic in different degrees. Green leafy vegetables, particularly arum, act more effectively as arsenic accumulators.

Arsenic contamination dramatically decreases plant yields in some soil types but not others. This is an important result in developing recommendations in at-risk areas, where reduced yields only increase the pressure to plant crops.

Plant arsenic uptake is also influenced by soil solution arsenic concentration and soil pH levels. In particular, the time that arsenic remains in soils is important. Arsenic 'ages' the longer it is in the soil, reducing its availability to the plant and plant uptake.

These findings, connecting the food chain with arsenic intake by humans, have been used to disseminate information on reducing dietary consumption of arsenic-rich plants.

A major component of the project was the communication of information to government, NGOs, UNICEF (Bangladesh) and farming communities. A pamphlet has been developed as part of a simple education strategy for the education of Bangladeshi villages dealing with arsenic contamination.

A separate project in Nepal, to improve both lentils and Lathyrus, has been successful in identifying new varieties of both crops.

Lentils are the main food staple and increasingly an export commodity demanded by Indian consumers. In both Nepal and India lentil is used to prepare dhal, a cooked dish that provides a high proportion of dietary protein intake.

The use of Lathyrus as a lentil substitute in poor seasons makes identifying improved lentil varieties, and Lathyrus with low-toxin levels, important.

By characterising how lentil varieties perform in the relay-sown systems common in Nepal, and the impacts of diseases and soils on

yields, suitable varieties have been identified. These have resistance to disease and are higher-yielding. Providing higher-yielding varieties is an important factor in reducing Lathyrus use, by ensuring more supplies of lentils are available. In particular, any yield gains during low water conditions or drought will be important for reducing Lathyrus consumption.

Ms Renuka Shrestha, a Nepalese scientist involved in the project, spent time in Australia studying for her PhD as a John Allwright Fellow. Ms Shrestha has now completed her PhD studies on how lentils cope with water deficits. Her expertise will be valuable in ensuring that research to build on the project continues.

Some of this research may involve the continued trialling of low-ODAP Lathyrus varieties, identified through the project and trialled in a variety of conditions. Substantial training of scientists in methodologies undertaken through project activities and a base of improved varieties of lentil and Lathyrus, with lower toxin levels, has been established.

As a result Nepalese researchers, like their counterparts in Bangladesh dealing with arsenic in soils and groundwater, are better equipped to continue the research begun through ACIAR.

Dr Chencho Dorji inspects traps to capture emergent fruit fly in an orchard in Bhutan.

Getting the drop on fruit fly in Bhutan

Mandarins are the main export crop of Bhutan. For many farmers, a good crop relies on most of the fruit being harvested. So a pest that can cause premature ripening and fruit to drop from trees before harvesting could be a problem. The Chinese citrus fruit fly, *Bactrocera minax* (Enderlein) is capable of causing up to 70 per cent of fruit to drop in severely affected mandarin orchards.

Chinese citrus fruit flies are common in all citrus-growing areas of Bhutan, and in southern China and north-east India. These flies are different to most other fruit flies, producing only one brood per season with delayed egg hatching. For these reasons, approaches to fruit fly management proven elsewhere have not been as effective in Bhutan.

Understanding why this is the case – and the factors influencing fruit fly infestation – is the first step in developing an approach that targets the individual characteristics of the Chinese citrus fruit fly. This has been furthered through ACIAR-supported research.

Working in collaboration with the National Plant Protection Centre of Bhutan, Griffith University's International Centre for Management of Pest Fruit Flies has undertaken a survey of fruit fly life cycles.

This research, carried out in the mandarin orchards in Rimchu, Phunaka, revealed that fruit flies first appear in April. Mature adult females are able to lay eggs under the skin of young fruit in June and July. Larvae then hatch in the fruits, only becoming visible in late September.

As the larvae feed on the ripening fruit they accelerate the maturing process; this fruit being detectable as it turns a characteristic yellow colour. The fruit then drops to the ground, carrying the larvae with it. Larvae then burrow into the ground and pupate in the soil over the winter months, before emerging in April to begin the life cycle again.

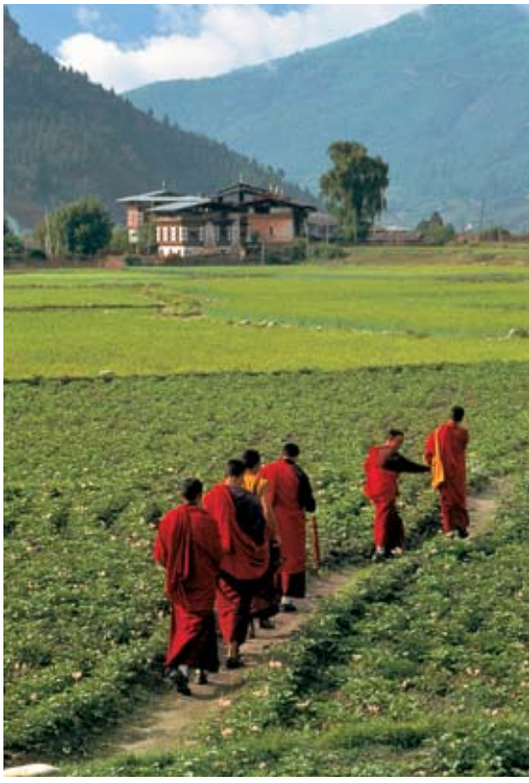
The experiments used involved bagging of branches and selectively revealing fruit for a two-week period to determine when flies lay eggs and how these develop. Every two weeks, until September, bags were folded back on two branches in order to expose the fruit to fruit flies, after which the branches were enclosed again with the bags.

As a result, the researchers learnt when the fruit flies deposit eggs. A second phase of the life cycle, when pupae emerge from soils in infested areas, was also defined by placing traps over the fallen fruit. This allowed the researchers to capture the emergent pupae at the end of the winter period and determine the time period until the flies reached sexual maturity.

From this understanding, strategies to protect crops have been formulated. These have been trialled, using cover sprays applied at specific times in the life cycle and protein baits to attract flies.

By using either sprays or baits in June, when adult flies are looking to lay their eggs, it is possible to control fruit flies and reduce fruit drop. Protein baits have the advantage of having a reduced effect on the overall ecosystem.

A national fruit fly control program is being initiated to run in conjunction with the National Citrus program of the Department of Agriculture in Bhutan. ◂



FRUITS OF change

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Increasingly, urbanisation is threatening the traditional way of life of many indigenous communities. ACIAR has a mandate to improve the wellbeing of people in developing countries – and Australia – by lifting agricultural productivity to assure food supply. Some ACIAR research directly benefits indigenous communities across the Asia-Pacific, by helping adapt traditional practices and creating enterprises that 'fit' their culture.

These reports, compiled by **Janet Lawrence,** detail some of the imaginative approaches towards helping hill tribes in South-East Asia, island communities in the Indo-Pacific and Aboriginal communities in Australia. They show how indigenous groups are restoring and maintaining the plant and animal species on which they have traditionally depended, while developing skills for new industries.

Hill tribes in the upland regions of Thailand, Laos, Vietnam and other countries in the region, are eking out a precarious existence. These ethnic minorities have traditionally practised 'slash-and-burn' agriculture but that way of life has come under threat, blamed for causing severe environmental damage.

ACIAR has funded many initiatives to introduce more sustainable farming practices in hill tribe areas, and to help these people lift their living standards by growing crops that are more profitable than the low-yielding upland rice. Such alternatives also help to make opium growing less attractive.

A program has been running for the past decade to develop a sustainable temperate fruit industry – first in Thailand and more recently in Vietnam and Laos. The production of high-value 'low-

chill' temperate fruits such as plum, peach, nectarine and persimmon is a definite prospect for hill tribe regions, and could generate two or three times more income than rice. The term 'low chill' describes a minimum exposure to cold to initiate flowering, rather than the hard chill needed for stone fruits grown in cooler climates.

Researchers have confronted many challenges in the project: identification of suitable orchard sites, selection of the best varieties, working out orchard management techniques, establishment of nurseries and tackling insect pests and diseases. Marketing strategies have also been needed to ensure the produce has a chance of being sold competitively in larger population areas.

Thailand initially received 2000 stonefruit trees. In the course of the most recent project, Vietnam and Laos received more than 1300 trees – different varieties of peach, plum, nectarine and persimmon. Researchers have compiled a management-decision package for growing temperate fruits in subtropical environments of Asia and Australia. The package includes basic and advanced manuals to help farmers and extension officers learn technologies such as deficit irrigation, mulching, tree training and management, and pesticide-free ways to control fruit fly.

In Thailand, fruit production has reached the commercialisation stage. Hill tribe villages near Ang Kang and Khun Wang are producing and marketing the peach 'Tropic Beauty', and have recently established cool-store facilities at Ang Kang. Refrigerated trucks transport the fruit to larger cities such as Chiang Mai and Bangkok.

The temperate fruit orchards have also become a tourist attraction. Affluent Thais enjoy driving to the hills to sample and buy premium grade fruit, further increasing local income.

In the central highlands of Vietnam, ethnic minorities (such as the hill tribes) have practised slash-and-burn agriculture for generations – clearing and burning patches of forest for cropping – leaving a legacy of deforestation, erosion and declining soil fertility. The farmers are being encouraged to settle in villages and adopt permanent agricultural practices, but they need to learn how to make this change long-term and sustainable.

An ACIAR project involves scientists studying large amounts of existing information about the region's soils and interpreting its constraints to productivity. From this process they are developing strategies to tackle erosion and degradation and provide a foundation for long-term productivity.

They are developing a soil capability classification training package for Vietnam, which initially is being used to train extension officers from Gai Lai Province and also World Vision. These officers will take the 'how to' knowledge to farmers.

Revitalising marine populations

Coastal communities across the Indo-Pacific have traditionally relied on the sea for food and income. Growing populations and more effective harvesting methods have led to serious declines in many marine species. The worst-affected communities have been those with few alternatives for generating income.

ACIAR has funded research to learn more about the life cycles of species on which these communities depend, investigating how to restore numbers and the possibilities for aquaculture.

Since 1995 ACIAR and the WorldFish Centre have undertaken a strategic research partnership to understand more about bêche de mer (a number of species commonly known as sea cucumbers or sandfish). The dried animals are prized in Asia and are therefore important for village income. Harvesting has been intense.

Bêche de mer studies have involved a threefold approach:

- population dynamics studies, contrasting trends in stocks between fished areas and adjacent marine reserves;
- fisheries management; and
- augmenting stocks by culturing then releasing juveniles to enhance natural populations.

Some of the results of the ACIAR and WorldFish studies are being implemented in community-based management arrangements for sandfish stocks.

The government of Papua New Guinea was eager to promote community-based management of marine stocks but had no suitable mechanism. An AusAID/World Bank Rural Development Sectoral Review recommended project assistance to develop and trial processes for establishing community-based resource management within areas of customary marine tenure.

Subsequently an ACIAR project provided the first attempt to establish community-based fisheries management by increasing levels of environmental awareness in target communities. The project also resulted in a process of benefit to the marine environment and one which is readily transferable throughout PNG.

The community initially selected to participate was Obulaku village on Kiriwina Island in the Trobriand Islands, where the proportion of sandfish exported had dropped dramatically. The shallow, easily harvested species had been overfished and the deeper, less accessible species comprised an increasing proportion of the catch. The project's goal was to develop community-based bêche-de-mer fisheries management plans that incorporated socio-economic considerations.

The project was based on the Facilitated Community Action Process (FCAP), used through a three-year AusAID project in Samoa. Obulaku village comprises 62 households, with a population of 298. The village contained six separate clans. The traditional leaders asked the team to work directly with individual clans. Separate meetings were held with clan leaders to gain their support and to encourage them to involve all their members. Initial participation in clan meetings involved people identifying pictures of key marine species and then providing the local name, and also by promoting discussion about posters depicting 'healthy' and 'unhealthy' marine environments.

The discussions generated concerns within the community about the existing situation and an awareness of actions that could be taken to improve the situation. Project staff then arranged meetings with clans to identify problems and their impacts on the community. After a clear identification of the problems, the gathering discussed causes and solutions and proposed the actions required to achieve the desired solution. The research team then compiled the information into 'problem and solution trees' for the whole village.

Some of the actions generated from the process included a set of precautionary measures such as size limits, a ban on the use of destructive harvesting techniques and bans on dumping rubbish in the marine area.

As part of the community-based management program in Obulaku, the community agreed to monitor their bêche-de-mer harvest. The project staff developed a simple diary for recording the daily catch. It was observed that the value of sandfish harvested by fishers from Obulaku was significantly higher than landings by fishers from other villagers, and there were fewer rejects. The researchers concluded that the community-management process led to fishers from Obulaku becoming more aware of the importance of harvesting the larger size classes of sandfish, from both a conservation and economic perspective.

A similar story has emerged from the study of trochus populations. Australia, Indonesia and some Pacific Island nations supply about

90 per cent of the world's trochus shell, which is used for high quality buttons and crafts. Falling production and increased scarcity of the trochus raised concerns of over-exploitation in areas where communities had fished for centuries. In Australia, concerned Aboriginal communities from King Sound in Western Australia approached the Northern Territory University, hoping to gain access to the hatchery production skills the NTU had developed for trochus.

Once a hatchery was established further help was needed to reseed coral reefs with hatchery-produced juveniles.

ACIAR funded the WA-based research and work in Indonesia and Vanuatu. Successful hatchery techniques emerged and reseeding trials started. The release of unprotected juveniles on to coral reefs worked for WA, but it was not the universal solution for enhancing trochus stocks. In Vanuatu and Indonesia, the young trochus needed to be caged to protect them from predators.

The success achieved with reef reseeding in WA by the King Sound Aboriginal communities led to the Aboriginal and Torres Strait Islander Commission (ATSIC) helping to set up the Kimberley Aquaculture Aboriginal Corporation (KAAC). In 2001, with the help of the WA government, KAAC established a $3.2 million multi-species hatchery in which trochus would be cultured for reseeding depleted reefs.

A different approach was used in Vanuatu. Experiments with adult trochus on the islands of Tanna and Aniwa showed that the relocation of just 163 brood-stock trochus led to a rapid increase in juvenile trochus populations. The scientists concluded that the presence of the adults not only generated a larval supply of juveniles but also enhanced conditions for attracting other larval trochus to settle on the reef.

In another development, a wide-ranging project based on the theme of sustainable aquaculture in the Pacific and northern Australia got under way in 2004. The project is targeting promising research outcomes from past ACIAR and WorldFish Centre projects. Research topics include post-larval fish capture and culture, bêche de mer production and reseeding, the health status of black tiger shrimp in Fiji, feeds for tilapia and freshwater prawn in PNG and Fiji and integrated prawn-taro farming on Wallis and Fortuna.

Self-managed woodlands

Tropical woodlands have significant biological and environmental importance in the tropics, including northern Australia, and demands on these woodlands have increased substantially as other ecosystems have become fully committed or exhausted.

In northern Australia, European-based farming has replaced traditional Aboriginal practices in many tropical woodland areas. In Africa, the extensive miombo woodlands (a type of deciduous woodland that covers a vast area of southern Africa) are under pressure because of increased clearing for fuel wood and the conversion of marginal grazing lands for crop production. The increasing demands that are being placed on these ecosystems must be balanced against their limitations.

An ACIAR project sought to improve the framework for resource planning in these woodlands by enhancing the capacity of resource managers (farmers in particular) to identify, plan and implement sustainable natural resource management options. Researchers used the techniques of 'action research' (or 'learning by doing') so that local participants could involve themselves in the research.

In Zimbabwe, the project was hampered by the political climate, particularly in regard to land-planning issues, but outcomes have still been encouraging.

A Zimbabwe-based NGO, the Communal Areas Management Program for Indigenous Resources (CAMPFIRE) Association, generated local interest and enthusiasm with a series of pictorial news sheets on land-use and planning issues. Critical to local acceptance and participation in the project was to accord the local chief and his headmen equal authority with government agencies. Through this project, the government planning institution has shown it is willing to collaborate with NGOs in the land planning process and engage in constructive dialogue to overcome perceived community inertia towards land-use planning on communal lands.

Similarly, in Australia, project people working with the Aurukun Aboriginal community took great care to abide by the community's established protocols. Aurukun is in the western region of Cape York in northern Queensland. It is one of the larger communities in the Cape, with about 1200 people. Participatory decision-making in resource management in this tropical savannah environment was a new concept for the community, but eventually the people started to express their own opinions and make their own decisions. Enthusiasm for, and within, the project increased through time. The local Aurukun Council became enthused about the prospects for such work and made natural resource management a key employment and education issue for the shire.

Opportunities from the forests

As natural rainforests dwindle, largely due to unsustainable logging practices and/or the encroachment of shifting and permanent agriculture, harvesting high-value rainforest products from plantations on previously degraded land has emerged as a viable, long-term option. Such an industry also offers long-term employment opportunities, export earnings and environmental advantages for many countries in the Asia-Pacific.

Previous research supported by ACIAR demonstrated that widespread, severe nutritional deficiencies were limiting establishment and productivity of high-value timber species in many of the soil types available for plantation forestry in north-east Australia and the south-west Pacific.

An ACIAR project developed fertiliser strategies for plantations in Fiji and the Solomon Islands and established a training program in partner countries.

On Kolombangara Island in the Solomon Islands, researchers developed a potting medium for plantation species, using decomposed coconut shells. This medium was superior to forest soil, and seedlings grew much faster. Producing the medium has created a small industry for village women, who grate the composted coconuts through a metal screen to produce the final product. The women are also paid to plant the seedlings in the composted mixture and transplant them to the plantations. Because the coconut medium is lighter than soil, the women can carry and plant more seedlings in a day, increasing their earnings.

There is also potential to domesticate and commercialise some of the indigenous trees and shrubs that produce edible fruits and nuts in PNG and the Solomon Islands. Already many of these provide nutritious foods and also an extra income source at local markets. ACIAR is funding a feasibility study of *Canarium indicum* (which produces a nut called the galip nut in PNG and ngali in the Solomons) as a pilot to determine the place of the nut in household diets, and its income potential.

Another valuable crop is sandalwood. Vanuatu already harvests the tree for its aromatic oils. A similar opportunity exists with native sandalwood resources on Cape York, but a lack of information about the local species is limiting industry growth. A study is determining prospects for establishing plantations of elite varieties of sandalwood.

Portable sawmills are, in theory, an ideal enterprise for small-scale operators. They have been around for some time and can undertake high-quality milling that adds value to milled forest products. They are cheaper to use than conventional mills and are less damaging than conventional harvesters. However, less than 20 per cent of mills seem to be operating efficiently, due to a lack of technical expertise and poor maintenance. Limited opportunities to market the product also contribute to the problem. ACIAR hopes to give the portable sawmill industry a boost through improving the design to make the mills more effective and reliable.

Better quality cattle, and a chance for horticulture

In the Weipa region of Cape York in northern Queensland, cattle production is one of the few economic enterprises that fit the lifestyle of the local traditional owners. Through the 1980s and 90s, the mining company Comalco leased a cattle property to provide pastoral work for local Aboriginal people and fresh meat for the mining town. After the loss of the market for fresh meat in Weipa, and a downturn in the live export trade for cattle during the Asian economic crisis, the company decided to sell the property. This decision was made with the traditional owners' agreement.

But there was still the opportunity to accommodate a grazing enterprise using improved pastures established on the Comalco mine site through its mined land rehabilitation program. Beef cattle production could provide meaningful employment and income for the traditional owners post-mining.

Comalco began trials on the use of leucaena along with suitable grass to provide improved cattle feed. This work was linked to an ACIAR project in West Timor, Indonesia, where the scientists developed a management package to improve the dry season supply of forage from high-performing leucaenas that had been identified from earlier ACIAR projects.

In consultation with Comalco and the traditional owners, the project team identified management strategies for the sustainable use of the leucaena/grass areas as holding pastures for cattle prior to live export. The leucaena that had been introduced during rehabilitation of the mine site was inappropriately managed and had subsequently become a weed problem. The project scientists studied the impact of cattle grazing on leucaena, weed control and the animal productivity of leucaena-infested rehabilitated land. They found that the deep-rooted leucaena trees accessed subsoil moisture and produced high quality forage well into the dry season.

Cattle grazing leucaena continued to gain weight, whereas cattle grazing native pastures rapidly lost weight at this time of year. The productivity of the leucaena/grass pastures could be further enhanced by using improved leucaena varieties (with lower weed potential) and the intensively managed hedgerow system developed in central Queensland. Comalco is undertaking productivity trials of this system in 2006.

Other communities on Cape York, and a community in Samoa, stand to benefit from the establishment of horticultural industries. Project researchers are undertaking rapid rural appraisals to gather data and then construct a tailored information system that lists key commodity interests for each community. This process will help the communities to determine the most suitable crops to grow and to assess financial and technical aspects of growing them, and determine their market prospects. Following this process will raise the chances of success and profitability in their enterprises.

From the viewpoint of the Australian component, the project team has held discussions with a range of groups in Aboriginal communities and with commercial growers near Cooktown. They met key stakeholders in the Aboriginal community of Mapoon and members of other communities of Napranum near Weipa and Lockhart River.

The Mapoon community is the main focus in the initial stages of the project. In Mapoon, they have recently established a community farm to supply local fruit and vegetables to the community store. In the longer term, they want to grow yams and taro and cultivate local bush foods that are not readily available in mainstream marketing. The community is also interested in amenity plantings of local and introduced ornamental and fruiting plants.

Working with NGOs

In May 2004, the ACIAR Board adopted a strategy to increase the emphasis on practical implementation of the results of ACIAR-supported research projects. The new strategy shifts the balance of ACIAR's investment towards a greater proportion of projects that deliver tangible benefits to end-users in the near-to-medium timespan – of between five and 10 years.

ACIAR's Annual Operational Plan 2005-06 outlines changes to the Centre's project development processes and approaches (see the April 2005 edition of *Partners*).

Partnership has been the key. From its inception, ACIAR has set benchmarks for working with research partners in Australia and developing countries. Partnerships with organisations that can help deliver research results to indigenous and other communities have seen ACIAR endeavour to increase opportunities to work with non-government organisations (NGOs) and forge links that will help ACIAR more effectively target the most disadvantaged communities.

Large-scale community development is long-term and costly. ACIAR is focusing its support on community-level activities at a pilot scale, entrusting the community development partner with responsibility to carry out subsequent 'scale out' of the work to other districts and provinces in the partner country.

ACIAR is most attracted to partnerships with NGOs and others that will foster technology adoption where the NGO partner has had an on-going presence in the target community.

This may involve the design and funding of a project activity that follows on from an earlier ACIAR-funded project. A single technical intervention is only part of the development picture – farmers are looking for livelihood/income solutions and these are only possible through partnering with groups that are there for the longer haul.

Weipa cattle, thriving on leucaena/grass pastures.

HITTING THE THE MILLENNIUM DEVELOPMENT GOALS

Ensuring that everyone benefits from progress towards the MDGs requires a global focus

Global efforts to eradicate poverty (income of less than US$1 a day) have in recent months focused on the Millennium Development Goals (MDGs). The eight goals, first articulated by the United Nations in September 2000 (see facing page), have been in place for five years. In many areas considerable progress has been made, and awareness of the issues of poverty is very high.

Much of this awareness focused on the plight of the poor in sub-Saharan Africa, but this is not the only centre of deprivation, with the Asia-Pacific region also home to widespread poverty.

In Africa some positive achievements have been delivered. ACIAR's involvement in a project to develop a vaccine against Newcastle Disease (ND), a particularly prevalent and virulent disease affecting village poultry, has led to initiatives in Mozambique, supported by AusAID and a number of NGOs, working with government agencies.

Sra Luisa Arnaldo, a 36-year-old widow with three children, living in Chirodzi-Ponte, Mozambique, saw her efforts to rear chickens hampered by ND outbreaks. Using a traditional production system, Luisa has been unable to rear any more than three chickens at a time, barely enough for her family.

In 2003 she participated in the AusAID program, using the ACIAR-developed vaccine, to vaccinate chickens against ND. After her initial outlay of US$0.25 per bird, by October 2004 she had 25 chickens, including five roosters, which she sold for US$2.25 each.

Some of the money Luisa used to invest in buying a goat, which has subsequently produced offspring. Much of the rest has been used to allow her three children to attend primary school.

Work is now underway to ensure other countries have access to the same vaccine, and the benefits available through its use. Several of those countries are in the Asia-Pacific region, the main focus of ACIAR's operations.

The region, despite receiving less than a third of the amount of global aid directed to sub-Saharan Africa, has double the number of people living in poverty, more than 700 million. Fourteen of the world's Least Developed Countries are also in the region. Population in the Asia-Pacific region is also expected to rise by around one billion people in the next 45 years.

Smallholder farmers, and those relying on forestry and fishing, make up the bulk of the poor and hungry. Helping to create and accelerate growth in agricultural and rural sectors can make a genuine difference in eradicating extreme poverty and hunger, by helping rural areas and smallholders gain from the economic growth underway in many countries in the Asia-Pacific region.

Poverty in the Asia-Pacific region is often overlooked due to the successful development occurring in many countries. Vietnam provides an excellent example – with an emerging economy (growing at five per cent a year), stable governance systems and WTO accession, poverty does not spring to mind.

Yet almost 30 per cent of Vietnam's population (around 25 million) live below the poverty line (Vietnam Households Living Standards Survey (GSO2003)).

In some rural provinces this rate reaches 45 per cent, many of these people being smallholder farmers.

For many rural poor throughout the Asia-Pacific region agriculture is still the main food provider, income generator and employer. ACIAR's past and present research is tackling a range of problems constraining agricultural productivity in a variety of systems.

In countries like China, India and Thailand, this research is helping smallholder farmers access the benefits of WTO accession and a growing economy. Increasing productivity creates a leverage for market entry and can help poor smallholders exploit any comparative advantage they may have.

For other countries, the benefits of WTO accession and trade are still more likely tomorrow than today. Despite this, agriculture still presents the best opportunities to many rural peoples, including smallholders.

ACIAR's approach is to work with partner countries to meet their identified needs, such as diversifying agriculture beyond the rice-dominated system of Cambodia, or to introduce improved food staples, such as in East Timor.

Other examples include work in Papua New Guinea on developing more equitable income flows in palm oil plantations, that is boosting incomes, empowering women and helping children access education. In the Solomon Islands, project work aimed at boosting food security is delivering improved management options for fishing resources, such as village sea cucumber fisheries.

While ACIAR projects may deliver outcomes that address targets and goals across the MDGs, most align with Goal 1 – Eradicate extreme poverty and hunger, and Goal 7 – Ensure environmental sustainability. ACIAR's partnership mode of operation links to Goal 8 – Develop a global partnership for development.

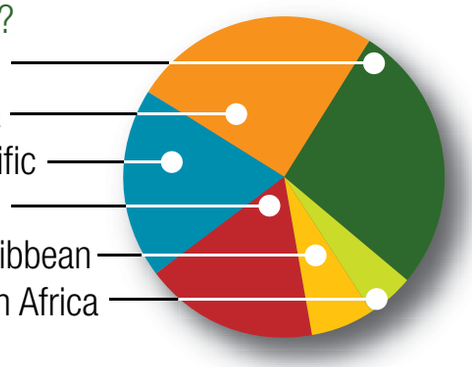
ACIAR's research will continue to work with partner countries in the Asia-Pacific region to meet the agricultural needs of those countries. In doing so, projects that reduce poverty and help to improve the sustainable management of natural resources will continue to produce results that also help progress towards the Millennium Development Goals. ◂

TARGET

Vietnam's economy is growing at almost five per cent a year, yet almost 30 per cent of the country's population (around 25 million) live below the poverty line.

WHERE ARE THE HUNGRY?

221m India
204m Sub-Saharan Africa
156m Other Asia and Pacific
142m China
53m Latin America / Caribbean
39m Near East and North Africa

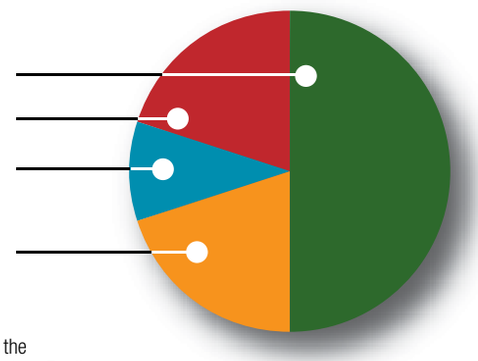


Total numbers of undernourished people in the major regions of the developing world. A further 37 million undernourished live in the industrialised countries and countries in transition.

Source: FAO 2004

WHO ARE THE HUNGRY?

50% Smallholder farmer
20% Rural landless
10% Pastoralists, fishers, forest-dependent
20% Urban poor



Source: UN Statistics Division, Progress towards the Millennium Development Goals, 1990–2005, Goal 1– Eradicate extreme poverty and hunger

UN MILLENNIUM DECLARATION GOALS

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria and other diseases
7. Ensure environmental sustainability
8. Develop a global partnership for development

ACIAR initiates two projects in Iraq

After two decades of limited access to international developments in agriculture, Iraqi scientists are being brought up to speed

PHOTOLIBRARY.COM

ACIAR's first two projects in Iraq have begun. Two problems are being addressed: the first, to improve wheat, barley and pulse and forage crops in the country's north; the second, research to improve pest management in the citrus/date system of central Iraq.

Over the past two decades, Iraqi scientists have had limited access to international developments in the agricultural sector. Bringing these scientists up to speed on issues relating to crop improvement and management and pest control will be of aid both in the projects and also in broader agricultural applications. Training courses will be undertaken outside Iraq.

A lack of international access has also resulted in crop varieties planted in Iraq being those sourced in the 1980s. Since that time, crops and management techniques used in Iraq have not changed, despite significant advances elsewhere. More appropriate modern varieties, coupled with the adaptation of improved management practices, including tillage, fertiliser and weed control, are needed.

The crop germplasm project will work to identify and introduce suitable varieties. Low rainfall necessitates seed varieties well suited to the dry climate and tolerant of, or resistant to, salinity, drought and diseases.

The International Center for Agricultural Research in the Dry Areas (ICARDA) has an extensive collection of suitable germplasm possessing disease and stress tolerance and resistance characteristics to match cropping conditions found in Iraq. Germplasm from the ICARDA collection will be trialled for its suitability.

To support the introduction of these varieties, management techniques will also be identified. Current yields of crops are only about a third of those grown under similar conditions in other

The pace of agricultural production in Iraq is soon to increase through ACIAR-assisted research.

countries, reflecting just how far behind almost two decades of isolation has left Iraq.

The introduction of improved cereal varieties, including high-protein legumes, could also result in improved dietary intake, both for humans and animals.

Jasmine whitefly is a major agricultural pest of citrus in Iraq, but unlike for other pests, effective controls are not available. Citrus trees are planted below date palm plantations, of which dobas bugs are the main pest.

The pest management practices for dobas bugs target the canopy of date trees, above citrus trees, and in doing so kill natural enemies of jasmine whitefly, but not the fly itself. This spraying exacerbates jasmine whitefly problems, resulting in yields of around 30 per cent of what should be achieved.

In the second project, Australian scientists will initially assist Iraqi senior scientists to develop a National Strategy Plan for the control of jasmine whitefly affecting citrus production in central Iraq. Integrated pest management, utilising the latest research and aimed at controlling both whitefly and dobas bugs, should substantially boost production. Training in Australia of junior scientists in integrated pest management practices will enable them to implement the newly developed plan upon return to Iraq.

A successful implementation could add up to A$100 million a year in productivity gains for the citrus/date system.

The projects have been shaped to match Australian expertise to Iraqi conditions and priorities and by the constraint of limited access to Iraq by Australian scientists.

Both projects are co-funded by AusAID and ACIAR and managed by ACIAR, and are being implemented by ICARDA and Australian research organisations.

ROUNDUP

New appointments

Jeff Davis

Jeff Davis has joined ACIAR as Program Manager for Policy Linkages and Impact Assessment. The program is responsible for monitoring, evaluating and assessing the impact of ACIAR-funded research. It also works to improve interdisciplinary linkages between economic and biophysical research and development activities.

Dr Davis is returning to ACIAR after a nine-year period with the Rural Industries Research and Development Corporation. During that time he was General Manager for Research (Establishment Industries). Before that he was coordinator of ACIAR's Economic Evaluation Unit. Dr Davis undertook a PhD at the University of Minnesota in the US as a Fullbright Postgraduate Study Award recipient in 1979. He previously completed a Bachelor of Agricultural Economics (Honours) at the University of New England and Master of Economics (Honours) at Macquarie University.

Dr Davis has worked at the Industries Assistance Commission, NSW Agriculture and the ANU, as well as undertaking consulting and lecturing positions.

John Cullen

John Cullen is ACIAR's Research Program Manager for Crop Improvement and Management. The CIM program works to deliver improved crop varieties through germplasm conservation, plant improvement and better crop management.

Mr Cullen has a Bachelor of Science from University College, Dublin, and a Master of Science from Trinity College, Dublin. He began his career as a research assistant at UCD before joining an international pharmaceutical company in Ireland. In 1988, he migrated to Australia and worked at the Australian National University's ANUTech as a technology transfer officer, liaising with industry, academia and government. He was Manager of Commercial Research at Griffith University before joining the Grains Research and Development Corporation as Program Manager for Crop Improvement. He joins ACIAR after 10 years at the GRDC.

Peter Rolfe

Peter Rolfe is Research Program Manager for Animal Health. The Animal Health program is responsible for identifying investment opportunities in animal health and food safety research. Dr Rolfe has a Bachelor of Veterinary Science (Honours) and a PhD from the University of Sydney. He has worked at the University's Rural Teaching Clinic and in NSW Agriculture as a veterinary officer at Grafton, NSW, advising local beef, dairy cattle and poultry industries on animal health matters. After his PhD studies in animal parasitology, Dr Rolfe led the parasitology research team at the Elizabeth Macarthur Agricultural Institute, NSW Agriculture. In that time he has also consulted to a number of aid projects in China and Indonesia. Dr Rolfe also managed the Yeerongpilly Veterinary Laboratory (QDPI) and later was Animal Health Program Manager for Meat and Livestock Australia, where he was responsible for investment in animal health research on behalf of the red meat industry. Prior to joining ACIAR, Peter was a Global Project Team Leader for Pfizer Animal Health .

NEW PROJECTS

ADP/2004/045 Exploring alternative futures for agricultural knowledge, science and technology (KST)

ADP/2004/044 Economic analysis of technical barriers limiting agricultural trade of China

ASEM/2004/077 Postgraduate Scholarship Scheme for UNITECH, University of Lae, Papua New Guinea

ASEM/2004/042 Assessing and extending schemes to enhance the profitability of the PNG coffee industry via price premiums for quality

CIM/2003/067 Ensuring productivity and food security through sustainable control of yellow rust of wheat in Asia

CP/2005/035 Survey toolbox for plant pests – a practical manual for surveillance of agricultural crops and forests

CP/2004/010 Building integrated pest management capacity in Iraq, initially concentrating on control of jasmine whitefly in the citrus/date system of central Iraq

CP/2002/115 Diseases of crops in the central provinces of Vietnam: diagnosis, extension and control

FIS/2005/025 Fisheries rehabilitation in tsunami-affected Indonesia: community needs assessment and resource status

FIS/2002/075 Application of PCR for improved shrimp health management in the Asian region

FIS/2002/074 Capacity development to monitor, analyse and report on Indonesian tuna fisheries

FIS/2001/083 Inland aquaculture in Papua New Guinea: improving fingerling supply and fish nutrition for smallholder farms

FST/2004/009 Facilitating the availability and use of improved germplasm for forestry and agroforestry in Papua New Guinea

FST/2003/049 Review of portable sawmills in the Pacific: identifying the factors for success

FST/1999/095 Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia; genetics and silviculture

LPS/2004/073 Capacity building on cattle production at Dong Giang district, Quang Nam province, Vietnam

LPS/2002/081 Development of emerging farmer crop-livestock systems in northern Republic of South Africa

LWR/2005/051 Development of training workshops in Indonesia for post-tsunami rehabilitation

LWR/2005/004 Management of soil fertility for restoring cropping in tsunami-affected areas of Nanggroe Aceh Darussalam Province, Indonesia

LWR/2003/039 Improving the management of water and nitrogen fertiliser for agricultural profitability, water quality and reduced nitrous oxide emissions in China and Australia

LWR/2002/094 Promotion of conservation agriculture using permanent raised beds in irrigated cropping in the Hexi Corridor, Gansu, China

Project variations

AH/2001/005 Salinity reduction in tannery effluents in India and Australia

ASEM/2002/014 Improved productivity and the participation of youth and women in the Papua New Guinea cocoa, coconut and oil palm industries

ASEm/2001/037 Improving the marketing system for fresh produce of the highlands of Papua New Guinea

CP/2000/094 Diagnosis and control of soil-borne fungal diseases of plants in Indonesia

FIS/2003/037 Artisanal shark and ray fisheries in Eastern Indonesia and their relationships with Australian resources

LPS/2001/077 Poultry feeding systems in Papua New Guinea

LWR/2000/030 Growing more rice with less water: increasing water productivity in rice-based cropping systems

SFS/2001/068 Technical support for regional plant genetic resources development in the Pacific

SMCN2000/046 Overcoming magnesium deficiency in oil palm crops on volcanic ash soils of Papua New Guinea

SMCN/1999/005 Improved soil management on rain-fed vertisols in Nusa Tenggara, Indonesia

NEW PUBLICATIONS

Monographs

SAFER SELECTION AND USE OF PESTICIDES – INTEGRATING RISK ASSESSMENT, MONITORING AND MANAGEMENT OF PESTICIDES

This book describes a process to select safer pesticides and to improve the management of pesticide use. It addresses the need for good pesticide selection and management in Vietnam and throughout Southeast Asia.

Angus N. Crossan, Nguyen Thi Thu Trang, Pham Ngoc Ha and Ivan R. Kennedy (eds). ACIAR Monograph 117, 84pp, price $15 (plus postage and handling).

Impact Assessment Series

REVIEW OF THE RETURNS TO ACIAR'S R&D INVESTMENT

ACIAR's Impact Assessment Series 35, authors David A. Raitzer and Robert Lindner.

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SCALING OUT IMPACTS: A STUDY OF THREE METHODS FOR INTRODUCING FORAGE TECHNOLOGIES TO VILLAGES IN LAO PDR

This working paper presents the results of a study to research the effectiveness of three participatory extension methods for scaling out forage and livestock technologies to new villages in Lao PDR.

Joanne Millar, Viengxay Photakoun and John Connell. ACIAR Working Paper 58, 36pp.

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Book Review

REVIEW OF THE RETURNS TO ACIAR'S BILATERAL R&D INVESTMENTS

ACIAR has invested A$1.1 billion (in real 2004 A$) in bilateral research since starting operations in 1982. But what is the value or worth of this investment? Has ACIAR broken even or run at a loss? In an effort to answer these questions, ACIAR has undertaken a review to quantify the returns on investment.

Across three different categorisations of assessed benefits based on selected project investments, the results show ACIAR has delivered good returns.

The most notable part of this result is that these returns are based on less than 10 per cent of ACIAR's bilateral project investment: only those projects that have been the subject of an external impact assessment were included in the review. These returns alone have been sufficient to justify the entire ACIAR bilateral investment portfolio.

ACIAR conducts impact assessments of chosen projects or suites of projects. When the Review was commissioned, 34 formal impact assessments had been completed, with 29 of these forming the basis of the analysis.

A framework to place the results of individual assessments within a realistic context of deliverable benefits was developed. Three scenarios of benefit aggregation were constructed:

- potential benefits of all ACIAR-attributed results estimated in all 29 assessments;
- plausible benefits based only on findings supported by transparent evidence of adoption of R&D project outputs; and
- substantially demonstrated outcomes that are highly certain to occur and have robust benefits.

Many of the impacts of ACIAR projects are difficult to attribute and necessarily make assumptions on the likelihood of all parts of the impact assessment being realised.

Each of these 29 assessments was critically reviewed, based on a framework of principles and criteria to score the probability of benefits. These were derived from selected analytical literature.

To estimate which of the benefits from impact assessments should be included in each scenario two principles were used, transparency and analytical rigour. Transparency is scored against assumptions made in the assessment, data sources and an explanation of data treatments. Analytical rigour relates to the data set utilised, appropriate data treatments, plausible counterfactual scenarios being developed, adequate consideration of the relevance of economic benefits and appropriate institutional attribution.

Therefore, the higher the score of the estimated benefit for each criterion, the closer the impact is to being certain to occur. Those impacts in the substantially demonstrated benefits scenario are those with the highest scores for transparency and analytical rigour.

In each scenario, benefits are divided between those already realised (through 2004) and those inclusive of future projections (through 2004 and beyond). These were then run through the three scenarios, under a real discount rate of five per cent.

Scenario	Benefits to date: benefit/cost ratio	Benefits inclusive: benefit/cost ratio
Potential benefits	1.33	3.06
Plausible benefits	1.00	1.62
Substantially demonstrated	0.84	1.31

In all but the 'substantially demonstrated' scenario, for benefits to date, the small group of projects used for the review indicates that ACIAR has matched or exceeded returns on its total bilateral investment. These estimates indicate ACIAR provides excellent returns for a development agency.

This review proves that even with the most conservative assessment of benefits, generated by only three per cent of its total research investment, ACIAR has proven its value.

As future impact assessments, and those published subsequent to this review, are released, it is expected that many new and often unanticipated benefits from past investments will become evident.

The study also demonstrates that Australia receives nearly half of its investment in ACIAR back under the potential benefits scenario, almost entirely through productivity-related benefits. Indirect benefits such as improved knowledge and enhanced institutional recognition are not included, since these cannot be readily quantified.