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. ◂