PHOTO: NICOLAI DZYUBENKO

ACIAR-supported projects have involved the collection of genetic material from ancient and wild forms of crops in Central Asia. Shown here are oxen threshing wheat in the Bardakashan autonomous province of Tajikistan.

Plant breeders prepare for climate change

Crop breeding is proving a viable tool to assist in adapting to climate change

BY DR TONY FISCHER

Well before issues such as rising carbon dioxide levels and altered weather patterns began filling newspaper headlines, ACIAR crop researchers were laying the groundwork for a response to climate change.

It is not that we have been better than others at predicting the future but, through good scientific judgement and a bit of serendipity, many projects within ACIAR's Crop Improvement and Management Program already contain key aspects relevant to changing climate and weather patterns.

Consider ongoing ACIAR work, for example, to strengthen crop breeding in developing nations, much of which involves understanding and screening for traits that confer adaptations to drought and other climate constraints, conducting yield testing and releasing suitable varieties.

A critical part of this work has been to build local scientific breeding capabilities and engage farmers through on-farm testing. If you can help build the agronomic infrastructure in these nations and encourage farmers to shift from a subsistence existence towards a more commercial approach and stand on their own feet, they will be better able to cope with the effects of climate change. You cannot be sustainable or have crops that are resistant or tolerant in the face of climate change if you are struggling to survive under normal conditions.

Breeding projects range according to the needs of the collaborating country. Some have involved the introduction, testing, selection and, ultimately, release of improved crop varieties. Other projects have introduced the latest biological 'tools', such as molecular markers and transgenic approaches, to encourage specific traits.

The key effect of these projects is to be found in improved varieties in farmers' fields. But the identification of better genetic material, the use of smarter methods of breeding and/or the development of more skilled breeders are other important outcomes from ACIAR projects.

Particularly successful has been the work of ACIAR/AusAID with the Ministry of Agriculture, Forestry and Fisheries (MAFF) in East Timor to produce new varieties of the country's staple crops—maize, cassava, sweet potato, ground nut and rice—for farmers' fields.

In 2002, straight after the former Indonesian province achieved independence, extensive testing began on introduced improved cultivars. This led

PHOTO: CLIVE FRANCIS

Farmers and their families inspect a field demonstration of a new lentil cultivar in south-eastern Nepal.

to MAFF naming and releasing seven new varieties early this year, which have already being planted by hundreds of farmers. These are the first varieties ever released by MAFF.

This work will mean more food available for a country whose agriculture currently barely feeds its own farmers and is always threatened by El Niño drought.

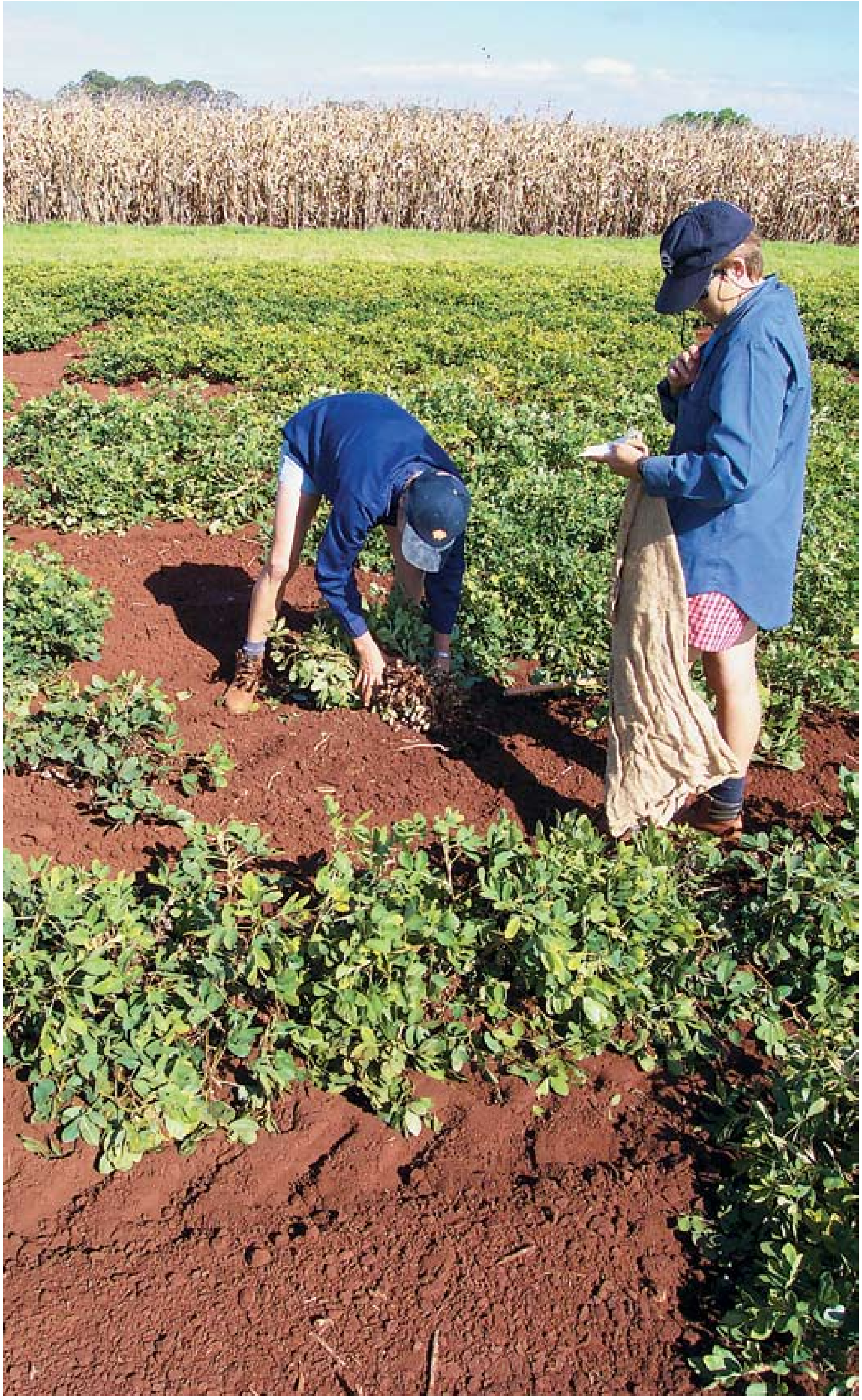
Afghanistan is another country where drought is already a big climatic factor. Here farmers are benefiting from new varieties of the major food crop—wheat—released in recent years under an ACIAR/AusAID-supported project conducted by Mexico's International Maize and Wheat Improvement Center (CIMMYT).

Drought is also a major climatic factor limiting production-crop breeding elsewhere in many of ACIAR's partner countries and so it is common for projects to deal with developing resistance to this.

Recent ACIAR peanut projects in India built on earlier work that assessed and analysed crop performance under drought in three key areas: water use, transpiration efficiency and harvest index (which indicates grain yield). Substantial genetic variation for these traits showed relationships to yield. As a result, a major

PHOTO: SHU FUKAI

Efforts to strengthen crop breeding in developing countries include work in Cambodia on drought-resistant varieties of rice.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Harvesting peanuts and testing yield samples from different breeding lines at the Department of Primary Industries and Fisheries Research Station in Kingaroy, Queensland.

targeted breeding effort based on these followed and involved many institutions across India, including the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). The first variety from the project, which was recently released in southern Andra Pradesh, has brought much excitement from farmers.

ACIAR-funded projects in Bangladesh and Nepal to improve lentils have also been significant. Lentils are grown on residual monsoon moisture in these countries by very poor farmers. Drought and warm-climate diseases are the major constraints of this crop, which is normally grown in temperate winter rainfall environments at higher latitudes.

The project has linked local and Australian institutions with the world centre for lentil breeding, the International Center for Agricultural Research in the Dry Areas (ICARDA). Much new genetic material has been introduced for testing and crossing, and superior new varieties have been released in both countries, leading to significant lentil production increases. One variety, Barimasur-4, released in 1996 in Bangladesh, adds an estimated 40,000 tonnes annually to local production. Improved varieties have also been recently released in Nepal.

Germplasm catalogues could become particularly valuable for identifying genes adapted to conditions that may emerge as climate change progresses.

Again, an important feature of these projects has been to train local breeders, which means they will be better able, when needed, to adapt to climate change.

Rainfed lowland rice comprises a major agricultural production system in the central Mekong basin, in north-eastern Thailand, and is another crop constrained more often by drought than other climate factors. ACIAR support has had a major effect on the breeding capacity and strategy used there. As a result, variety production time has been shortened by 30%, with drought-screening and wider testing likely to further improve efficiency, and promising high-yielding lines being produced.

Soybean is an important new crop in Vietnam and an ACIAR project has helped local breeders introduce genetic sources of adaptations to this country's seasonal climatic conditions. One variety—DT21—was released in 2006 and is now grown on several hundred hectares in the Red River delta region. It is adapted to winter and spring plantings, but will produce under summer planting as well, providing fresh seed for the next winter, important because soybean seed does not keep well over tropical summers. Other promising varieties are in the pipeline.

ACIAR-supported projects carried out during the past decade through ICARDA have also been laying important groundwork relevant to changing climatic conditions. These have involved the

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PHOTO: BRAD COLLIS

Australian researcher Dr Clive Francis searching for ancient pulse and legume varieties in Armenia as part of the ACIAR-supported germplasm collection work undertaken by ICARDA.

extensive collection, description and storage in gene banks of genetic material from ancient or wild forms of crops from Central Asia and the Caucasus (Eurasia). The genes they contain could be useful for introducing adaptations, such as heat resistance, into crops in response to climate change.

This work has also been valuable because climate change could be accelerating the extinction of some potentially important species, such as those that now exist only in unique mountain-top refuges, but which may disappear forever from the wild as conditions warm. The genetic diversity contained within these old varieties is sometimes called upon by plant breeders and this may now be particularly important in the face of new climate stresses.

Many of the world's major crops originated in Central Asia and the Caucasus, including wheat, barley and other cereals, grain legumes such as chick peas, lentils and peas, and forage legumes such as lucerne and clover. To date, more than 3000 new accessions of these and other agricultural species have been collected under ACIAR projects.

Germplasm catalogues are stored safely within their respective countries of origin as well as with ICARDA and are available to researchers throughout the world. These sorts of databases could become particularly valuable for identifying genes adapted to conditions that may emerge as climate change progresses. Similar ACIAR work in China has focused on gathering germplasm from old varieties of grain legumes, such as adzuki beans, faba beans and peas.

One way breeders can search for useful material in such collections is to match the climate of the location where the germplasm was acquired to that of the region they are targeting. This is significantly helped by good databases.

An excellent example is the database of tropical forage genetic material, developed as part of a recently completed ACIAR project involving CSIRO, the International Livestock Research Institute (ILRI) and the International Center for Tropical Agriculture (CIAT). This comprises the best available information on the adaptation and potential use of 180 tropical forage species. It is accessible via the internet and already receives thousands of enquiries every month.

ACIAR has supported similar projects through CIMMYT. These have made important contributions to databases such as the International Crop Information System (ICIS), Systemwide Information Network for Genetic Resources (SINGER) and International Wheat Information System (IWIS). Such databases will be important for successful plant-breeding programs for major crops worldwide and could prove to be crucial tools in building protection against climate change. ■

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