

Wild ancestors offer climate hope

Researchers are drawing on barley's wild plant ancestors for the genes – lost over 10,000 years of farming – needed to ensure modern crops can withstand prolonged dry spells. **Brad Collis** reports



ICARDA research fields.

PHOTO: BRAD COLLIS

The goal of high-yielding and drought-resistant barley varieties – initially for feed markets, but ultimately for malting as well – is edging closer as trials begin to show the clear potential for germplasm collected from the harsh environments of Central Asia and the Middle East.

Researchers at the University of Adelaide have now evaluated more than 300 lines selected for them by the International Center for Agricultural Research in the Dry Areas (ICARDA) in northern Syria.

Many of these lines originate from regions of extremely low rainfall – less than 100 millimetres a year.

The best performers have already started being crossed with elite Australian lines and this germplasm is now freely available to Australian breeders under the new national Barley Breeding Australia program.

The University of Adelaide's Stewart Coventry says the first crosses were made in 1999, so some of the lines derived from ICARDA germplasm are now well advanced. However, these are being used as parents because of the need to eliminate unwanted characteristics.

Landraces and wild barley from dry areas, such as Syria and Central Asia, have been recognised by ICARDA researchers for some time as a rich source of genes for adapting crops to environments where drought stress is common. However, breeding those traits into modern varieties, whose genetic base may be narrower but with more advanced agronomic qualities, is a complex and long-term process.

Traditional barley tends to be tall, susceptible to lodging and prone to head loss and/or shattering – weaknesses no one wants to reintroduce to modern, commercial varieties.

New molecular techniques – such as tools that can explain the genetic basis of complex traits, or that can monitor the proportion of wild and cultivated DNA and allow marker-assisted selection for the key traits of interest – are helping, but Mr Coventry says the first commercial release of a modern drought-tolerant variety is still a decade away.

He says the GRDC-supported collaboration with ICARDA, which began in 1999, has revealed a large untapped genetic resource at a research institute whose

sole purpose is to improve crops, and agriculture generally, in areas that have a similar climate to Australia's grain belt.

"We need to increase our efforts to find out exactly what germplasm is available there because of the security this could provide as we head towards a less predictable climate."

ICARDA barley breeder Dr Stefania Grandi says the relationship with Australian breeders has become a two-way benefit, because the dryland traits being sought by ICARDA researchers are the same as those needed by barley growers in Australia.

"We have common interests," she says. "At a research level, this has helped us in terms of data analysis and experiment design – all overlaid by the fact we share a similar climate, which further facilitates useful germplasm exchange."

"Also, Australia's quarantine controls make it difficult for researchers there to work with barley's wild relatives. So we can do most of the pre-breeding at ICARDA to introduce the genes of interest from wild relatives, and only send to Australia the cultivated material which is no longer a quarantine risk."

The end goal for everyone is advanced varieties that have increased yield per millimetre of rainfall with less environmental impact and improved yield stability.

For researchers and growers alike, this is a constantly shifting target, because of the vagaries of climate change and the scientific frontier of soil limitations that are still largely unexplored.

The collaboration was expanded in 2002 to include WA, Victoria, NSW and Queensland in a national low-rainfall trial to examine the usefulness of ICARDA germplasm.

Mr Coventry says the project has provided researchers with a better understanding of the genetics and physiology of traits related to drought stress tolerance, particularly those focused on yield and physical grain quality. It is also now acknowledged that a wider range of barleys from similar environments, such as Spain, the Central Asia and Caucasus region, the Middle East and the West Asia/North Africa region, need to be evaluated.

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SYRIAN BARLEY *Grower knowledge tapped for new varieties*

Growers play a key role in barley breeding in Syria, where international researchers are also working with Australia's national breeding program to breed future varieties that will yield reliably in dry conditions.

In the Syrian program, genetic variability is generated by professional breeders, but selection at each step of the breeding cycle is a joint decision by breeders, extension specialists and the farmers who have been hosting the trials. The idea, explains ICARDA barley breeder Dr Salvatore Ceccarelli, is to run the breeding trials on actual farms in different environmental circumstances and to encourage among growers a sense of ownership of the research.

"We decide the lines that go into the trial, and the growers help to decide which ones progress towards the release of a new variety," says Dr Ceccarelli. "They score the different lines from 0 to 4. It's largely a visual selection, generally just before harvest, and we tell them to trust their eyes because it's hard for 16 farmers to all be wrong."

Dr Ceccarelli says that using farms rather than research stations has several benefits. The breeding program can cover a wider set of environmental and farm-management conditions, and grower involvement in each successive selection helps to stop the development of varieties that could prove unacceptable to growers for reasons a researcher might not anticipate.

It also helps to identify breeding material that is useful in the real conditions of farmers' fields, but which might otherwise be discarded in the more controlled environment of a research station. "It also recognises the generations of local knowledge that has built up in an area," he says.

Dr Ceccarelli says this "decentralised participatory plant breeding" saves time and money as it leads to the release of varieties that have a ready appeal to growers because of their involvement along the way. Also, it is the farmers who have been involved with the breeding programs who handle the first phases of seed multiplication of promising breeding material. This becomes

a natural extension of the trials because the plot sizes increase as the selections narrow, so by the time it is down to the final choice, a comparatively large area is under cultivation.

Dr Ceccarelli says the program has shown that growers – irrespective of education or culture – are very receptive to new ideas, provided they are not being expected to shoulder all the risk: "When you are farming in areas that receive less than 200 millimetres of rainfall a year, you are naturally cautious," he says. "But participatory breeding means breeders and researchers are absorbing some of the risk because we rent the land we use for the trials."

Participatory breeding



Model of participatory plant breeding systemised with farmers in Syria, Jordan, Egypt, Eritrea, Yemen, Morocco and Tunisia.



Sharing ownership: ICARDA barley breeder Dr Salvatore Ceccarelli meets with Syrian growers involved in on-farm breeding trials.

PHOTO: BRAD COLLIS

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DR SALVATORE CECCARELLI

Dr Ceccarelli, who has been developing participatory barley breeding programs in Syria, Jordan, Egypt, Eritrea, Morocco, Tunisia and Yemen since 1996, believes the more that researchers interact with farmers, the more sophisticated the farming becomes, the more knowledge is adopted and the more knowledge is shared.

And the overall appreciation of the role of science increases: "Farmers involved in bulking up the seed of improved varieties enjoy high reputations in their communities because it is widely known they have been working with breeders and researchers."

He says plant breeding consequently becomes a valuable entry point for establishing relationships between farming communities and other research fields, such as nutrient management and conservation tillage.

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