Future genes in safe hands

By **NEIL LYON**

THE future of the world's wheat rests in massive vaults at the CIMMYT research centre just outside Mexico City, where 150,000 lines of wheat seed from primitive wild races to the latest purpose-bred varieties are safely stored.

Assembled over the past 40 years from countries around the world, including Australia, the facility's temperature and humidity-controlled vaults house a diverse collection of bread wheats, durum wheats, triticales and barleys.

It is the largest collection in a network of 11 international genebanks around the world that, in total, hold 600,000 accessions.

CIMMYT wheat germplasm collection head Thomas Payne said the material in the collection in Mexico was an important resource for plant breeders around the world. Interest in the world's botanical resources began when early explorers sent materials back to their 'home countries', but it was only in the past century that the importance of conserving the materials in a viable state for long-term use was recognised.

"People started to recognise the fragility of genetic resources and the fact that varieties could, and were, becoming extinct."

Mr Payne said that prompted a flurry of plant exploration and germplasm collection around the world for much of the 1900s. But that tailed off in the 1980s because nations became aware of genetic resources within their territories, he said. "There was a recognition ultimately that was codified through international treaties that stipulated the genetic resources within the boundaries of a country belonged to that country."

RIGHT: CIMMYT wheat germplasm collection head Thomas Payne with wheat lines in CIMMYT's collection.

IN COLD STORAGE

PRESERVING the world's largest wheat collection in CIMMYT genebank:

- 150,000 varieties, 350g of each variety.
- Two vaults, medium-term at 0deg C, long-term at minus 18deg.
- Seed viability remains at 85 per cent or above for 30 to 100 years.
- Seed available to breeders around the world, 5g of cultivated varieties sent, five to 10 grains of rarer wild species sent.

The resulting Convention on Biological Diversity recognised that the genetic resources within the territory of a sovereign nation were the property of that nation.

"It was enacted because countries were concerned, for instance, that a big pharmaceutical company would come in and make millions of dollars out of acquiring a medicinal plant."

But Mr Payne said an inadvertent consequence of the convention was it stopped germplasm sharing – in particular, sharing of agricultural crops. "So it was recognised there needed to be another legal instrument to facilitate the exchange of germplasm and the sharing of agricultural crops. A wheat variety that has been developed over the past 10,000 years and bred over the past 50 or 100 years has parentage representing many different countries. So how can you say who is the legal owner of, say, *triticum aestivum* – bread wheat – which originally evolved 10,000 years ago in what is now the Caspian Sea area of Iran.

"Is Iran the owner of all bread wheat in the world? We know many important varieties have come from Australia. Would you say Australia is the owner?

"So it was recognised that for crops humanity depends on, we can't assign a single owner."

Mr Payne said under the International Treaty on Plant Genetic Resources for Food and Agriculture, which was ratified in 2004 and came into action in 2007, agricultural germplasms were elevated to a special status that recognised their global significance.

"The intent of the treaty is to open up the sharing of agricultural genetic material.

"It says the recipient of materials from CIMMYT or any of the genebanks under the treaty are free to do anything they want to with the material. They are encouraged to share the materials they develop from the materials they receive from CIMMYT.

"They are also free to patent or restrict access to the material. But if they choose to restrict access to the materials, they have to pay a certain percentage of the income they receive into an international benefit-sharing fund."

Australian scientist and CIMMYT's Generation Challenge Program transition manager Peter Ninnes (pictured) said Australia was one of the first countries to sign up to the international treaty to share genetic resources.

Mr Ninnes has been instrumental in putting in place a structure from which Australia benefits from the genetic diversity of the wheat at CIMMYT.

"Australian breeders make their selections in the field in Mexico, the seed goes into quarantine in Australia and is then made available to the Australian breeding teams. That is how Australia gets access to the genetic diversity. The intention is that the information that comes out of the assessments in Australia feeds back into the program at CIMMYT."

The wonders of wheat

From previous page

Dr Barr said CIMMYT offered Australian researchers the unique opportunity to access 600 trial sites throughout the world.

"So, if we want to breed for resistance for a particular disease, we can identify the most reliable sites in the world," he said.

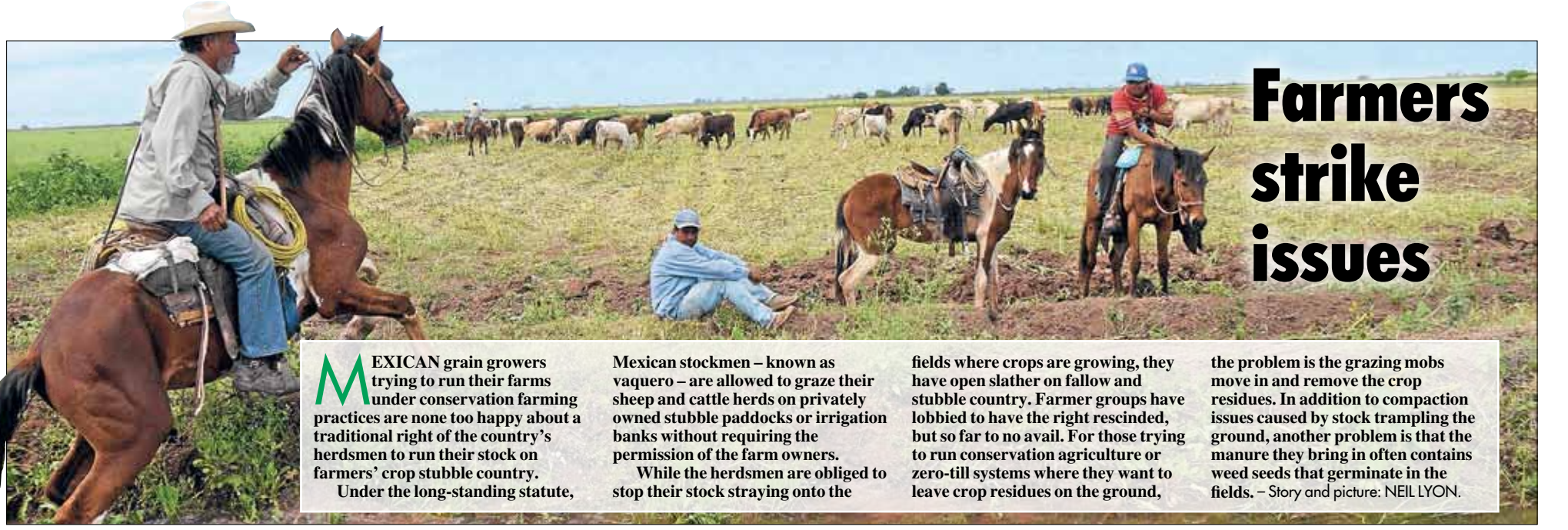
"We have done that for stem rust, stripe rust, leaf rust, fusarium, septoria, heat stress, drought stress, waterlogging, acid soils – all the things that affect the way a wheat plant performs.

"We don't have to make compromises. We can use our funding to pick the best sites that we know, year-in, year-out, [when] the particular disease or event happens."

Dr Barr said the biggest challenge facing Australian wheat producers and breeders was "always rust", followed closely by the need to keep increasing yield.

He said there was debate among scientists at the summit over whether wheat yields had plateaued and whether there was any realistic chance of further yield increases, but figures showed the global rate of yield gain was being maintained at 1 per cent.

Neil Lyon travelled to Mexico with the assistance of the Crawford Fund and the Department of Foreign Affairs and Trade's Council on Australia-Latin America Relations.



Farmers strike issues

MEXICAN grain growers trying to run their farms under conservation farming practices are none too happy about a traditional right of the country's herdsmen to run their stock on farmers' crop stubble country.

Under the long-standing statute, Mexican stockmen – known as vaquero – are allowed to graze their sheep and cattle herds on privately owned stubble paddocks or irrigation banks without requiring the permission of the farm owners.

While the herdsmen are obliged to stop their stock straying onto the fields where crops are growing, they have open slather on fallow and stubble country. Farmer groups have lobbied to have the right rescinded, but so far to no avail. For those trying to run conservation agriculture or zero-till systems where they want to leave crop residues on the ground, the problem is the grazing mobs move in and remove the crop residues. In addition to compaction issues caused by stock trampling the ground, another problem is that the manure they bring in often contains weed seeds that germinate in the fields. – Story and picture: NEIL LYON.

Wheat thrives in Mexico

By **NEIL LYON**

THE Yaqui Valley in north-west Mexico is an oasis of irrigated agriculture surrounded by a vast desert – an environment which is surprisingly ideal for breeding and developing wheat varieties suited to Australian conditions.

Many of Australia's wheat varieties have been developed by the Mexico-based international research organisation CIMMYT, in the Yaqui Valley.

Key to the research is one of CIMMYT's largest research stations, the Norman E. Borlaug Experimental Station (CENEB), which sits in the middle of the valley's 220,000-hectare irrigation scheme, where the average annual rainfall is only 250-300 millimetres.

CIMMYT Board of Trustees chairman and South Australian farmer Andrew Barr said the advantage of the station for developing Australian-suited varieties was it was in an irrigated desert where researchers could tightly control water and growing conditions. Mr Barr said in earlier years, researchers used to fully irrigate the trial crops, which masked genetic variation for some of the stresses that were important in different parts of the world, particularly Australia, "where we know way too much about drought and heat stress".

But in the past 10 years, CIMMYT has purposefully refocused its trials to target a range of different sowing times and moisture regimes.

"They still have early sown, full irrigation with 7 or 8 tonnes/hectare yield potential. But now they also sow late crops with water, which forces the wheat to develop in late spring/summer heat stress. It is not drought stressed – just heat stressed," he said. "They also have early sowing, but instead of a full irrigation system, they put in drip lines and modify the water to get 4t/ha, and also modify it to get 2t/ha. So now at the one station we have trials that yield 8t/ha, 4t/ha and 2t/ha; have drought and heat; heat alone; or full potential crops."

Mr Barr said it was more difficult to run such a range of different climatic scenarios, including testing for drought, under Australian conditions.

"In Australia the irony is that rain always gets in the way of a good drought from a breeder's perspective.

"You have a drought every four or five years, but in the Australian environment it becomes difficult for a breeder because you make progress in a drought year but the next one is a bumper crop, whereas in Mexico there is no rain to get in the way.

"CIMMYT can generate the different conditions year-in, year-out."

The dry climate and capacity to control crop development through irrigation have also seen farmers in the Yaqui Valley modify the type of crops they produce.

Mexican wheat specialist and CIMMYT Conservation Agriculture Program principal scientist Ivan Ortiz-Monasterio said where the valley was once a major bread wheat-producing area, today the emphasis is on durum wheat supplying both the domestic market and lucrative niche markets around the world.

"Where we have a comparative advantage in terms of producing very high-quality durum is because we have a very dry climate and irrigation. The type of durum people have access to in Europe, for instance, varies a lot from year to year because it is rainfed. The variation in quality is a hassle for the industry. But here we can produce very consistent quality year after year. With good fertiliser management we can produce the same quality year after year and the industry loves that."

Unusually, durum yields in the Yaqui Valley are higher than bread wheat yields – sometimes 0.5t/ha more. And over the past two years, thanks to the introduction of a new variety, Cirnio, irrigated durum yields have risen from an average of 5-6t/ha to 6-7t/ha. "That is something that hasn't happened over the past 35 years," Mr Ortiz-Monasterio said.

He said with such a focus on wheat production in the valley, the World Bank and Mexican government had been trying to diversify production.

"They ask why the farmers are using so much valuable water to grow wheat and not higher value crops. It is a good question, but if you start to grow vegetable crops, you start to saturate markets we have access to very quickly. Wheat is a very easy crop to manage. And farmers have been making very good money."

ABOVE AND RIGHT: The Alvaro Obregon Dam supplies water to the 220,000 hectares of irrigation farming in Mexico's Yaqui Valley.

LEFT: Australian wheat scientist and former CIMMYT director of wheat research Tony Fischer in a wheat trial at Obregon, Mexico, with CIMMYT scientist Ivan Ortiz-Monasterio.