National Oat Breeding Program for milling and feed end uses

**Project Details**

- **Project Code:** DAS00091
- **Project Title:** NATIONAL OAT BREEDING PROGRAM FOR MILLING AND FEED END USES
- **Start Date:** 01.07.2008
- **End Date:** 30.06.2012
- **Supervisor:** PAMELA ZWER (PRINCIPAL PLANT BREEDER)
- **Organisation:** SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE (SARDI)
- **Contact Name:** PAMELA ZWER

**Summary**

Demand for domestic and export milling oat continues to increase, with all the major milling companies increasing production by about 10%. The National Oat Breeding Program (NOBP) is centred at the South Australian Research and Development Institute (SARDI), located at the Waite Precinct in South Australia (SA), and the Department of Agriculture and Food Western Australia (DAFWA), located at South Perth in Western Australia (WA). Through classical plant breeding methods, genetic diversity was created by crossing germplasm with varieties and breeding lines adapted to southern Australia. Populations were selected for traits identified in the breeding priorities developed with industry and grower input. Three potential milling varieties - Wombat\(^D\), Dunnart\(^D\) and Bannister\(^D\) - were released during this project.

**Report Disclaimer**

This document has been prepared in good faith on the basis of information available at the date of publication without any independent verification. Grains Research & Development Corporation (GRDC) does not guarantee or warrant the accuracy, reliability, completeness or currency of the information in this publication nor its usefulness in achieving any purpose. Readers are responsible for assessing the relevance and accuracy of the content of this publication. GRDC will not be liable for any loss, damage, cost or expense incurred or arising by reason of any person using or relying on information in this publication. Products may be identified by proprietary or trade names to help readers identify particular types of products.
but this is not, and is not intended to be, an endorsement or recommendation of any product or manufacturer referred to. Other products may perform as well or better than those specifically referred to. Check www.apvma.gov.au and select product registrations listed in PUBCRIS for current information relating to product registration.

Copyright
Grains Research and Development Corporation. This publication is copyright. Apart from any use as permitted under the Copyright Act 1968, no part may be reproduced in any form without written permission from the GRDC.

Old or Archival Reports (Projects that concluded in 2007 or earlier)
The information contained in these older reports is now several years old, and may have been wholly or partially superseded or built upon in subsequent work funded by GRDC or others. Readers should be aware that more recent research may be more useful for their needs. Findings related to agricultural chemical use are also potentially out of date and are not to be taken as a recommendation for their use.

Conclusions
The evolution and stability of the NOBP occurred during the past two projects, DAS00039 and DAS00091.

Three improved milling varieties - Wombat\(^{(i)}\), Dunnart\(^{(i)}\) and Bannister\(^{(i)}\) - were released with new options for growers. Bannister was the first milling variety released for WA, but has also performed well in the eastern states. The improved varieties offer potential for expanded oat production to meet increased opportunities in domestic and export markets.

Disease nurseries were established in WA to assess disease reactions for *Stagonospora* (septoria) and Barley Yellow Dwarf Virus (BYDV) for breeding lines in stage two (S2), stage three (S3), and stage four (S4) trials. Technical expertise at DAFWA, led by the NOBP, developed protocols to ensure uniform infection for the nurseries and the collection of valuable data every year. Disease reactions for these two diseases were difficult to obtain under natural conditions in the past.

The literature review resulted in funding from the SA Grains Industry Trust (SAGIT) and SARDI to proceed with the project ‘Enhancing the grain yield and quality of oat under water deficits’. This project initiated discovery of oat traits associated with improved performance in water limited environments.

Seven breeding lines - MA6875W, MA7180W, MA7210, MA7930W, MA8178W, MA9058W and MA9345W - were recommended to the New South Wales Department of Primary Industries (NSW DPI) as potential improved dual purpose varieties.

The commercial partner selected to release SA milling varieties was originally ABB Grain, which was taken over by Viterra. The commercial partner selected to release varieties from WA was Seedmark (Heritage) from 2013.

Recommendations
Disease resistance is an essential component of the breeding program. Recently the Pga virulent pathotype of stem rust moved from northern NSW into the southern region, rendering the resistant (R) or moderately resistant (MR) varieties susceptible (S). The project team from DAS00102 continued the search for effective resistance genes for this pathotype in seedlings. Selected wild oat species in the National Oat Breeding Collection should be assessed for adult plant resistance (APR) to the Pga pathotype. Once effective gene(s) are identified, molecular markers should be developed to effectively select for resistance. Red leather leaf caused by *Spermospera avenae* became more prevalent in Victoria (VIC) and SA during this project. Little is known about the pathogen and it is often difficult to identify, as the leaf symptoms are similar to abiotic stresses and bacterial blight. Research to understand the environment that favours the pathogen, management practises to reduce the pathogen population and genetic resistance will assist both growers and the breeding program. This information would allow the breeding program to develop a red leather leaf nursery artificially inoculated each year to select for genetic resistance. Continued research to identify molecular markers for cereal cyst nematode (CCN) resistance is needed so that reliable markers are available to use in the general breeding program.
An understanding of genetic diversity and parental selection for important traits associated with capturing limited water resources and improved water use efficiency (WUE) is needed to determine the breeding strategy and priorities in the NOBP. The analysis of oat germplasm will greatly benefit from findings in other cereal crop species, where heavy and long term investment has resulted in the establishment of reliable phenotyping protocols and the identification of trait-defining genes contributing to salt, boron or aluminium tolerances. The potential for improving oat variety performance in southern Australia using parental lines identified with these desirable traits will increase consistency of productivity and product quality.

Outcomes

There are economic, environmental and social benefits from the release of improved oat varieties. The Australian grains industry benefits from increased gross margins, improved rotation options on-farm, improved processing efficiency and milling yield, product quality and customer satisfaction. The general public who eat oat products benefit from the health advantages associated with oat consumption.

The new variety Wombat\(^{(0)}\) is the first CCN resistant and tolerant potential milling variety, with moderate tolerance to stem nematode (SN). A high grain yield potential milling variety with CCN resistance and SN tolerance was not available for growers with these production constraints. Possum\(^{(0)}\) and Mitika\(^{(0)}\) are very susceptible (VS) and intolerant to CCN. Wombat is similar to Mitika for grain yield potential, but is about 20% higher yielding than Mortlock\(^{(0)}\) which was the traditionally preferred oat variety by millers. Wombat and Mitika produce 2.7t/ha in a 2.5t/ha yield potential environment (combined SA, VIC, NSW and WA data from 2004 to 2010). Wombat has 2% higher groat percentage than Mitika and 4-5% higher than Echidna. With a 1% increase in groat percentage, there is a saving of $100,000 for each 40,000 tonnes milled.

Dunnart\(^{(0)}\) was the next dwarf potential milling variety released from the program. It is about 10cm taller than Mitika and Possum and slightly later maturing than Mitika. Dunnart produces 2.7t/ha in a 2.5t/ha yield potential environment. It also has CCN resistance and is moderately tolerant to both CCN and SN. Dunnart is also moderately resistant (MR) to BYDV compared to the susceptible reactions of Mitika and Possum.

Bannister\(^{(0)}\) was the third dwarf potential milling variety released from the program for WA. It is 20% higher yielding than Carrolup and 6% higher than Kojonup\(^{(0)}\). Bannister yields 2.9t/ha in a 2.5t yield potential environment, compared to 2.5t/ha for Carrolup and 2.7t/ha for Kojonup. It has a groat percentage similar to Carrolup at 73.8%, compared to 74%. Bannister is resistant to leaf rust, whereas Carrolup, Kojonup and Wandering\(^{(0)}\) are very susceptible.

Achievements/Benefits

Domestic mills process about 255,000t of oat annually- 30,000t is exported for premium feed and about 200,000t is exported as a bulk commodity. The oat crop is worth about $105 million to growers. Demand for domestic and export oat continues to increase, with Uncle Tobys (UTC), Unigrain, Blue Lake and Quaker Oats increasing production by about 10%. The growth in consumption of oat in China and India provides new opportunities for domestic millers to export product into these markets. Currently at least one company is exporting to China, but the amount of product is not known. The increase in demand for milling quality oat has resulted in production moving into regions not traditionally known for growing oat crops, particularly in low rainfall regions.

The NOBP releases improved grain oat varieties for WA, SA, VIC and southern NSW. Increased gross margins for high quality productive oat varieties, coupled with agronomic advantages as a break crop in rotations, make oat production more favourable than in the past. In addition, oat is more tolerant of frost damage than other cereals and offers growers a more risk free option in frost susceptible areas. New oat varieties with improved disease resistance, productivity and enhanced quality will also ensure stable productivity for the expanding domestic and export markets.

Coordination between the SARDI and DAFWA nodes within the NOBP strengthened during this project. Technical differences were identified and addressed, so the two nodes operated smoothly. Trial sites were rationalised in SA and WA to focus on sites that consistently provided reliable data and were representative of current or potential oat growing regions. Crosses made for the eastern states continued as usual, but the crosses made for WA from the first NOBP (DAS00039) are now in WA trials for selection. Technical expertise was developed in this project to consistently encourage uniform infection in the septoria disease nursery sown at Mt Barker, WA. Septoria disease reactions were recorded each year, except in 2010 when drought limited disease development. As a result of this success, the septoria nursery was moved to Manjimup in WA where the BYDV nursery has been grown for several years. Protocols were determined for uniform BYDV infection by the second year.
of the first project. The Manjimup BYDV nursery provided reliable data each year. All entries in S2, S3 and S4 trials were evaluated in these nurseries. A nursery to evaluate SN tolerance was initiated when an agronomist called the project team’s attention to a paddock located at Farrell Flat, SA, with high nematode numbers. Breeding lines were sown every second year to evaluate SN tolerance. A faba bean crop was sown in the alternate year to maintain uniform high levels of SN.

Strong industry linkages continued in this project with UTC, Quaker Oats, Unigrain, Blue Lake and the Grain Industry Association of WA’s (GIWA) oat committee. The collaborative research program with Uncle Tobys progressed with UTC (Cereal Partners Worldwide/Nestle) investing in its mini mill capacity to reduce the time required to mill, steam and flake 20-30kg samples from the S4 trial. The porridge produced from the samples was evaluated by a trained sensory panel and the data provided to the NOBP.

The NOBP undertook the evaluation of dual purpose oat breeding lines from the Temora Dual Purpose Oat Breeding Program when Glen Roberts retired. This was a request from the GRDC. Dual purpose grazing/feed grain trials were sown at eight NSW sites in 2008 and 2009 and six sites in 2010. The trials were sown, maintained, grazed and dry matter weights collected by NSW National Variety Trials (NVT) and NSW DPI. When the Temora Research Centre was closed, the trials ceased. Data were collected for dry matter production, grain yield, disease resistance, grain quality and agronomic characters. Seven breeding lines - MA6879W, MA7190W, MA7210, MA7930W, MA8118W, MA9058W and MA9345W - were identified for potential release by NSW DPI.

A literature search was completed in 2009 to summarise current research for cereals in water limited environments. A proposal was submitted to SAGIT and funding was approved for a project titled ‘Enhancing the grain yield and quality of oat under water deficits’.

Three milling varieties - Wombat\(^{(1)}\), Dunnart\(^{(1)}\) and Bannister\(^{(1)}\) - were released during this project.

Wombat (Sv97181-12) is a dwarf milling variety that was commercialised by Viterra. It is similar in height to Possum\(^{(1)}\) and slightly taller than Mitika\(^{(1)}\). It is a mid-season variety, flowering about six days later than Mitika. Wombat is the first dwarf milling variety with CCN resistance and tolerance. It is also moderately tolerant to SN. Wombat has high hectolitre weight and low screenings compared to the feed variety Potoroo\(^{(1)}\), which was the first dwarf variety with CCN resistance and tolerance. It also has high groat percentage - slightly higher than Mitika.

**Other research**

There are many opportunities to advance oat variety development. The three main areas of concern in the breeding program are disease resistance to stem rust and red leather leaf, development of molecular markers to improve selection efficiency for a number of traits and improved oat yield and quality performance in water limited years and low rainfall environments.

Oat is a nutritious food, but there are opportunities to genetically increase beta-glucan to reduce cholesterol reabsorption, avenanthramides and tocopherols. This research should be carried out in a partnership with industry.

**Intellectual property summary**

All varieties are protected by Plant Breeders Rights (PBR) for the owners SARDI and CRDC. Royalties are dispersed according to the equity of the project specification when the cross was made. Commercial partners are Viterra for the milling varieties released from SA and Seedmark (Heritage) for WA.