

Barley Breeding Australia – A New Paradigm – Working Together For A New Future

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Abstract:

Barley Breeding Australia has been formed as an unincorporated joint venture between: the Grains Research and Development Corporation, the Department of Primary Industries – NSW, the Department of Agriculture and Food – WA, the Department of Primary Industries and Fisheries - Qld, the Department of Primary Industries – Victoria, and the University of Adelaide. The parties agreed in March 2005 to “work together to establish an internationally competitive, cost-efficient barley breeding program. The objectives of the BBA are to: a) provide Australian growers with superior Varieties that enable them to compete in global markets; b) meet the needs of malt, feed and special purpose end-users; c) coordinate and recommend the release of Varieties into the Australian Market; d) contribute to education, training and teaching programs related to barley breeding; e) foster exchange of Intellectual Property Rights among the Parties; f) exploit synergies and avoid duplication in barley breeding; and g) encourage Commercialisation of Varieties that provide overall advantages to the Australian barley industry.

Keywords:

Barley Breeding Australia, malting, feed, alternate end-uses

Introduction:

The formation of Barley Breeding Australia has seen a major shift in the way the publicly funded breeding programs operate within Australia. Previously there were 6 main programs, now there are three nodes; BBA-North, South and West with a key role for DPI-Victoria in coordinating barley germplasm enhancement or pre-breeding. The former NSW-DPI, DPI-Vic and TIAR barley breeding programs are in the process of being phased out over the next few years with “pure” lines or reselections being advanced through their respective programs to regional stage 3 / 4 trials conducted by the three BBA nodes.

There have been significant shifts in the trial programs of the BBA nodes. BBA-West has responsibility for the “neutral to acid soils” of southern NSW, NE- and SW-Victoria and Tasmania. BBA-South now has responsibility for the “neutral to alkaline soils” of southern NSW, Victoria, South Australia and Western Australia (Esperance region). BBA-North has continued responsibilities for Queensland and northern NSW. The new trial programs are a reflection of both these new regions of responsibility and the transition from the previous breeding structures to the new ones. For example as the DPI-Vic program is phased out some of their trial sites will be taken over by BBA-South and BBA-West. It should be emphasized that the overall trial programs and portfolios will be under constant review with the aim optimizing efficiencies and available resources.

The undertaking of new regions of responsibility has meant a rationalisation of the trial programs in other regions. For example the BBA-West will be reducing the WA trials to accommodate the new eastern states program.

Another dramatic change in the profile of the breeding programs is the new emphasis for BBA-North to concentrate on feed barleys for the domestic regional intensive animal industries. A consequence of this is that the provision of malting varieties for the northern regional will be a

joint undertaking between the three nodes combining the adaptation and disease resistance of the BBA-North germplasm with the malting quality of BBA-South and BBA-West. Clearly this will be a major challenge for BBA.

Superior Varieties:

Barley breeding programs across Australia have made significant improvements with the release of the new varieties in recent years. Varieties such as DAFWA's Baudin, Hamelin and Vlamingh. The University of Adelaide's Flagship, Fleet, and Buloke, to name a few, represent major improvements in malting quality traits for the export markets.

Improving multiple resistances to diseases.

A major challenge to all BBA programs will be the pyramiding of multiple disease resistances and abiotic stress tolerances into high yielding, high quality germplasm. BBA has a major role to play in the coordination of the deployment of particular genes for resistance across regions. An example of this is leaf rust resistance with the role of the National Rust Control Centre under the leadership of Prof. Robert Park. BBA breeding nodes provide an excellent way of managing the strategic deployment and release of "Pyramided" leaf rust resistance genes providing a responsible way of protecting against the possibility of new virulent races emerging against individual major genes.

Scald is another disease where current major resistances are under threat. BBA again can play a lead role to devise strategies combining known resistances with more durable genes with the aim of protecting the few available major genes. In the longer term when more is known about the genetic control of the durable resistances we will see a more strategic deployment of these latter genes across BBA programs.

End-Users needs met:

An important communication and strategic input is the roles of the advisory committees or councils; The Western Region Barley Council, the South Australian and South Eastern Barley Advisory Committees and the Northern Region Barley Advisory Council. These groups together with major industry organisations such as Barley Australia, the Malting and Brewing Industries Barley Technical Committee (MBIBTC) and Pilot Brewing Australia facilitate broad stakeholder consultation in strategic planning and variety release decisions. It is anticipated that other groups representing the feed, food and alternate end-uses will be engaged and consulted in their areas of expertise.

A number of new malting quality lines are approaching advanced testing; for example WI4262 and WI4259 from BBA-South, WABARs 2312 or 2315 from BBA-West.

WI3416-1572 and WABAR2321 are undergoing trials for commercial evaluation to assess their suitability for domestic malt for domestic consumption. The collation of appropriate data and information under their respective "Commercialisation Plans" should enable informed decisions to be made concerning their suitability to different regions.

The largest congregation of intensive animal industries, especially beef, are located in the northern region. BBA-North has a key leadership role in the development of high yielding, disease resistant, feed barleys for ruminant animals. The other programs will draw on the developments from this program for their own feed variety programs and thus avoid duplication.

BBA-South has a long term interest in the alternate end-uses of barley especially functional foods. Barleys such as; normal, hullless, waxy, high amylopectin traits in various combinations are produced in the program. A new hullless waxy barley WI3693 has recently undergone pilot scale testing.

Coordinate and recommend the release of varieties :

The malting and brewing industries and the marketers have expressed a need to have a more coordinated approach to the recommendation and release of varieties into the Australian market. BBA will play a lead role, firstly through producing “Variety Development Plans” for each program and region to enable specific and efficient future targeting and resource allocation to meet the needs of the industry. “Commercialisation Plans” for each potential release will gather and collate relevant information indicating the merit of the new line and the justification for further testing and possible release. BBA can then oversee the more orderly targeting and release of new barleys for the region/market combination and resolve issues where similar barleys are proposed for release

Barley Australia, the Malting and Brewing Industries Barley Technical Committee (MBIBTC) and Pilot Brewing Australia have important roles in this process as does BBA’s industry partners in commercial evaluation of varieties for both the domestic and export markets.

Contributions to education, training and teaching:

Breeding programs and their associated research and development programs provide excellent undergraduate and post-graduate training opportunities in breeding, genetics and molecular genetics, quality, pathology and abiotic stress tolerance including plant and crop biochemistry and physiology. The outputs from gene discovery and pre-breeding programs have a direct “path to market” enabling students and research programs to focus on training to find solutions to real and ongoing problems.

Exchange of Intellectual Property Rights:

Sharing of equity from newly released varieties is related to the background IPR, the input from the breeding program, and the input from the various equity partners.

By way of example the new feed variety WABA2288 has the pedigree; Tantangara x VB9104. As such the owners of the two parents (NSW-DPI and DPI-Vic) will have an equity share because their variety or line was used in the cross. A share goes to the other equity partners DAFWA and the GRDC.

There are important consequences in sharing of IP as it has the potential to even out revenues from end-point royalties (EPRs) across programs. One program cannot exploit another’s variety in a backcrossing program for example without retuning shares to the background IP owners.

Exploit synergies and avoid duplication in breeding:

Before the formation of Barley Breeding Australia, there were six mainstream public breeding programs. By the end of the current phase of BBA there will only be the three BBA nodes: North, South and West. In the current phase of BBA there is a transition as three of the previous programs are “wound-down”. In this phase genetic material from reselected or effectively “pure breeding” lines are progressively moved through their respective programs and promoted to stage 3 and 4 regional trials. Promotion will be on “merit” with consultation between the “owners” of the advanced lines and the various BBA-nodes responsible for the carriage of the material prior to promotion to National Variety Testing trials. For example selected germplasm from the DPI-Vic, NSW-DPI and TIAR programs could be eventually promoted on merit to stage 3 trials throughout Australia. An important collegiate consideration has been to make sure material from different programs has an opportunity to be evaluated for its appropriate fit in appropriate regions.

A further example of the utilization of resources across regions can be seen in the new doubled haploids produced in the DAFWA facility. Doubled haploid plantlets in “tubs” are transported to NSW-DPI at Wagga Wagga for transplanting and “growing-out” in controlled environment rooms (CERs) and/or glasshouses. In the next generation further grow-outs will be made for seed increases in the field where screening for disease and agronomic performance can be made.

Encourage Commercialisation of Varieties:

Each BBA node is developing both “Variety Development Plans” and “Commercialisation Plans” for both justifying the release of a new line and documenting the merits and weaknesses of the line and therefore its suitability or otherwise to release in other regions. The first major test of the process will come when for example two equivalent barleys are approaching release in the same or different regions. An important future consideration determining the longer term viability of BBA will relate to the “value” of the end-point royalties gained as revenue and their role in supplementing the programs.

Challenges for the future:

Addressing the dilemma of “public” verses “private” and “how to get the balance right” between these extremes will be a key issue to be resolved in the medium to long term. Under any model, the efficiency and effective use of resources together with the optimal sharing of unencumbered IP and minimal duplication is an absolute way to operate the current and future BBA programs.

Climate change is a major challenge for BBA for which the programs are able to respond. There are some clear and apparent changes occurring which should be addressed in the short term. Seasons are becoming drier, warmer and the break to the season less predictable. Some weather patterns are becoming more extreme; for example the incidence of frost is increasing. The development of barleys with the optimal development patterns should be a priority. As breeders we have an incomplete understanding of which gene/allele combinations are in our current varieties. We understand even less about how these genes/alleles interact with each other and with the environment. A concerted effort involving, breeders, agronomists, physiologists and molecular geneticists will be required to develop the “next generation” barleys with known and more predictive responses to changes in sowing date in different regions and in response to a changing environment. Farmers should have a choice of variety on hand, in the bin, which is appropriate to an early break or a delayed sowing opportunity.

A significant issue which are fundamental to the future success of any breeding program is how to maintain and improve the rate of genetic gain. This broadly relates to gains in yield, adaptation, quality (malt, feed, food and alternate end-uses), disease resistance, and abiotic stress tolerance and being able to combine these traits into superior varieties. The “genetic supply chain” is a continuum from germplasm introduction to variety and as such provides a “path to market” for the barley research and development groups, pre-breeding group and germplasm enhancement programs.

It is critical to the future success of BBA as to how our germplasm resources and our enhancement programs are managed. It is from this process that we resource new genetic inputs. The ability of both germplasm enhancement and breeding programs to recombine the new genes/alleles through recombination will drive the efficiency and effectiveness of the development and integration of new genetic variation.