Barley Breeders and Maltsters – Working Together to Shift the Goal Posts
An industry discussion paper

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Australian barley breeders have answered the call to meet the quality of European and Canadian barley varieties. The current suite of new varieties and elite lines in the Barley Breeding Australia program are competitive in terms of yield, disease resistance and malt quality. It could be said that barley growers are receiving higher yields as a result of breeding efforts over the last thirty years, though there is also most certainly an impact from improved agronomic practices (Fig. 1). In addition, yield improvements have also been supported through breeding for improved disease resistance (Fig. 2) with the current barley varieties exhibiting superior disease resistance over varieties released as recently as last decade. Similar advances have been made in the area of malt quality, with substantial improvement in extract yield, disastatic power and fermentability (Fig. 3), with the release of varieties such as Flagship resulting in a rapid replacement of several older barley varieties.

There is little doubt that incremental improvements will continue to be made in the areas of yield, disease resistance and malt quality. However it is now time to look at the next area of focus for barley breeders. With barley growers and brewers requirements being addressed, it is the malting process its self that requires attention. The "maltability" of barley is the next challenge.

Three key areas to maltability are

1. Malt modification
2. Water saving barley
3. barley that results in a reduced carbon footprint during malting

1. Malt modification

Barley modification may be divided into two areas, protein modification as reflected by Kolbach Index and carbohydrate modification as reflected by wort beta-glucan and viscosity. Whilst in a germinating barley grain these two processes occur concurrently, in certain varieties these processes are less strongly linked. For example, a variety like Gairdner is able to achieve good physical grain modification, which is low wort beta-glucan and viscosity, at low levels of protein modification. In contrast, some other varieties such as Baudin exhibit rapid protein modification and at low Kolbach Indices can be wanting for physical modification.

This example of Baudin introduces another concept, that of vigour. Baudin, like Flagship are high vigour varieties. They are varieties that are able to be malted and fully modified without the use of the exogenous gibberellic acid, which while a useful tool for increasing the rate of modification, is of course not tolerated by certain markets. This high vigour characteristic can be a negative for a malthouse with poor temperature control, as vigorous varieties will be very difficult to manage, or at worst unable to be malted, over hot summer months using current malting regimes. There are many malthouses world wide that would find it difficult to process these varieties, including older malthouses in China, making this is a concern for the Australian barley industry as China is a key Australian barley export market. It will be important for barley breeders to recognise malt modification and the behaviour of vigour as a trait to select for in order to tailor barley varieties. Somewhat of a complicating factor is that malting barley is selected over a number of years from barley grown in small scale trials and micromalted. This type of selection process using the accommodating environment of a micromalter, often at lower levels of protein modification, and may mask the way a variety will perform in a commercial malthouse.

2. Water saving barley

Another challenge facing our industry is climate change. Several years of drought in many cropping, regional and city areas has put the question of sustainability of agricultural production and high water use industries in the spot light. Barley breeders are actively selecting material that will perform in lower rainfall, but will this translate to barley varieties that require less water to convert to malt or is this an independent trait requiring selection?

Historically, the malting industry has always been strongly focused on utility efficiency, driven mainly by the low margin/high volume nature of the industry. This places maltsters in good stead in times of tight water use, with typically less than 3.5 kL required to produce a tonne of malt. However, if the current trends in city and regional water reserve levels continue, there will be pressure to reduce this even further. The malting and brewing industries are embracing the challenge of recycling water for wash down functions. It is however pertinent to suggest that the malting industry should look at ways to further reduce water use an varieties that malt with reduced water inputs is one way to satisfy this expectation.

The single most dramatic way to reduce water use for the production of malt is to develop barley varieties that only require one steep, rather than the current practice of two steeps. Single steeping has the potential to reduce water use by approximately 40%. Unfortunately current barley varieties are reliant on two steeps to achieve the required quality specifications. Typically barley that receives only a single steep will not be adequately hydrated and as such have poor physical modification, with moisture not penetrating all of the endosperm to facilitate the breakdown of beta-glucan. Single steeping also puts pressure on water sensitive barley since the one water emersion employed needs to be substantially longer (to obtain desired moisture levels) than the two steeps when conventional steeping is employed. The adoption of single steep screening in barley breeding programs would be useful in identifying germplasm better suited to a single steep.

3. Barley that results in a reduced carbon footprint during malting

A further desirable characteristic of barley that could be selected for is low moisture modification. Typically green malt is hydrated to a peak germination moisture content of 45 to 46% to achieve the appropriate modification of the endosperm. If however green malt only required hydration moisture of 40 or even 30%, there would be a reduced energy requirement to remove moisture during kilning, thus reducing greenhouse gasses. Ideally a combination of single steeping and low peak germination moisture would deliver the greatest environmental benefit, which would also result in reduced manufacturing inputs further lowering the carbon footprint.

Summary

Australian barley breeders have delivered much of what they were asked to by industry groups such as MBIBTC, MBDC and MBQIP during the late 90's and early 2000's. Now the elite lines in the breeding programs are of superior quality than those two decades ago, but the evolution of barley breeding will demand more emphasis to be applied on malting process style criterion to be applied to the final selection of new varieties. This can be achieved through dedicated screening for these traits, and through differential malting studies, where a range of elite lines are malted under a series of unique micromalting conditions, together with varieties of a known maltability all of which will require financial inputs by stakeholders. That way an informed decision can be made on the best combination of traits to support both the domestic malting industry and the export grain marketers. The disadvantage of this proposal is that only a small amount of material can be assessed so advancement will require a long term commitment.

I would invite barley breeders to investigate the maltability of barley varieties, assess factors such as barley modification rate and suitability of varieties for single steeping or low moisture germination. It is essential that breeders, maltsters and grain marketers work closely together to ensure the best varieties in terms of both malt quality and maltability are released. Crucial to the success of this type of approach is barley breeders and maltsters/barley marketers continuing to work closely together.

Figure 1. Australian barley crop yields 1970 to 2006.

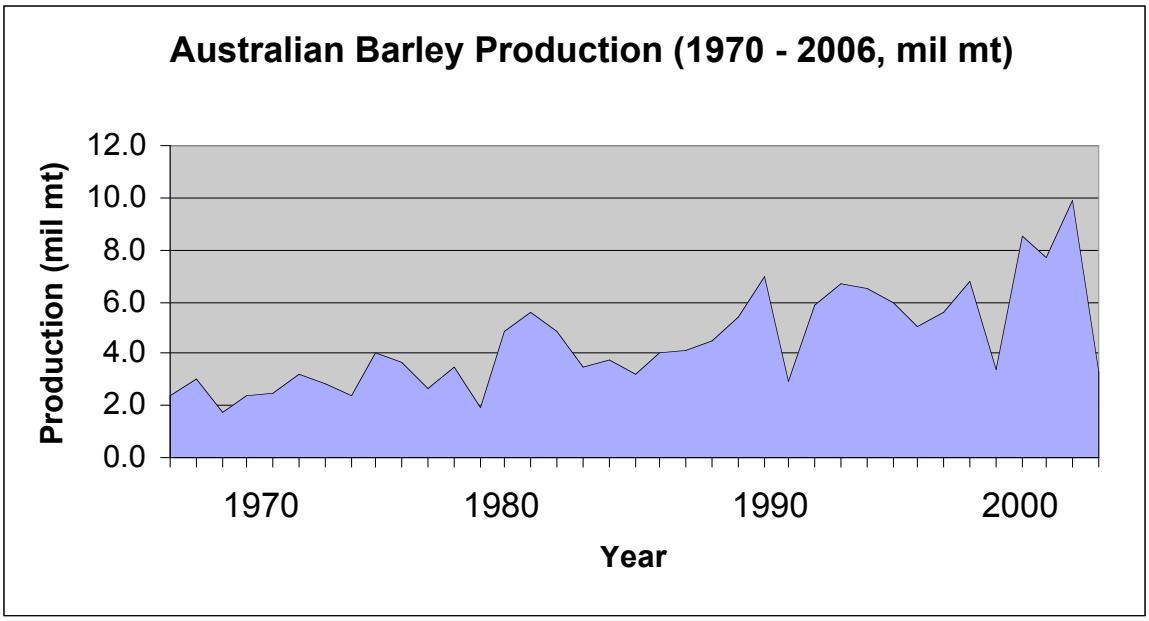
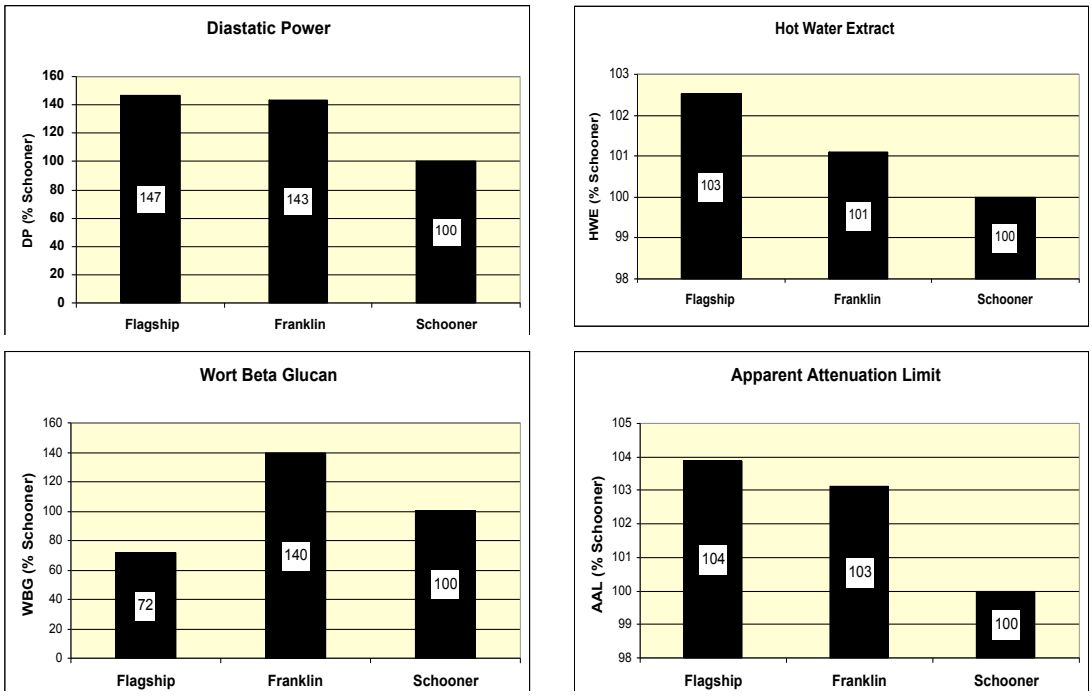


Figure 2. Disease resistance profile of barely varieties released by the Southern Node of Barley Breeding Australia.

Line	Scald	Powdery Mildew	Leaf Rust	SF Net Blotch	NF Net Blotch	CCN
Schooner	MS/S	S	S/VS	MS/S	MR	S
Sloop	S	S	S	S/VS	MR	S
Flagship	MS	R/MR	MS/S	MR/MS	MR/MS	R

Figure 3. The improvement in key malt quality parameters of barley varieties from the last two decades.



45 mean observations (AMBC, Industry and Waite Barley Quality Lab data)