In the Shadow of Wheat

Farrer Memorial Oration, 1990

This is a copy of the 1990 Farrer Memorial Oration, presented by Dr David Sparrow.

The Farrer Memorial Trust was established in 1911 to perpetuate the memory of William James Farrer and to encourage and inspire agricultural scientists. Initially it awarded scholarships for 'study or research in agricultural problems'. Later it included the delivery of an annual oration and the presentation of the Farrer Memorial Medal to a distinguished agricultural scientist for service rendered in the fields of research, education or administration.

For more information see the Trust website at

www.dpi.nsw.gov.au/farrer-memorial-trust

1990 Farrer Memorial Oration

'In the Shadow of Wheat'

Dr David Sparrow

Waite Agricultural Research Institute

Glen Osmond. S.A. 5064

A little over one hundred years ago, in 1886, William Farrer commenced his wheat breeding research on his property, Lambrigg, in N.S.W. near the future site of Canberra. Although he worked in relative isolation on the far side of the world, his contribution to scientific plant breeding ranks alongside those of his contemporaries in the Northern Hemisphere. Farrer's peers, Hays in the USA, Saunders in Canada and Biffen in England, may be better known, but his achievements were of equal importance. Macindoe writing in 1939, was of the opinion that even before the discovery of Mendel's work, Farrer was already aware of the role of inheritance in rust resistance and of the possibility of transgressive segregation in certain characters, a phenomenon that had escaped Mendel.

Farrer was ahead of his time as a plant breeder, with his use of hybridization and progeny selection to combine the best parental characters into an improved variety: a system viewed with suspicion by some. For example, reporting in 1907 on wheat breeding experiments at Roseworthy College, Perkins favoured, for crop improvement, 'selection within existing varieties rather than the *haphazard* business of intervarietal hybridization'.

Although Farrer worked solely with wheat, he did have a tenuous connection with barley. He claimed that his cultivar Bobs was the result of a wheat : barley cross, with the latter as pollen parent. Since he was unable to find any barley characters in the progeny of this or several subsequent attempts at cross hybridization, it is unlikely that an interspecific hybrid was involved.

Farrer's work and the release of such varieties as Federation and Bobs, at the turn of the century, revolutionized Australian wheat production. But, the same period is also important for the Australian barley industry. In charting the development of that industry, it is possible to identify certain landmarks. Landmarks which occur at roughly 30-year intervals from the beginning of the century.

In the early 1900's Sam Prior, a farmer of Brighton, South Australia, selected and multiplied seed from early maturing plants found in a crop of English Chevalier barley. This selection was distributed and further increased by Alfred Barrett of the Kent Town maltings. The variety became know as Prior's Chevalier (or just Prior), spread throughout Australian barley growing areas and remained the mainstay of the crop for seventy years. It's success was due to its early maturity and its ability, unlike imported European varieties, to fill its grain in a dry spring.

The second phase of development commenced in the late 1920's and early 1930's. It is marked by the beginning of regular barley exports, chiefly to Britain and stimulated by the Ottawa Agreement of 1932 which established Empire Preference Tariffs.

The second phase is also marked, in 1927, by the appointment, in Victoria, of Alan Raw to carry out the first Australian barley breeding program. This program resulted in the release, in 1941, of the first Australian bred variety, aptly named Research. Ian Phipps and Albert Pugsley at the Waite Institute and Jim Breakwell at Roseworthy dabbled in barley breeding, but were primarily wheat breeders. However, Breakwell did produce the variety Maltworthy, which unfortunately was not accepted by maltsters. All these tentative efforts came to a halt during, or slightly after, the '39-'45 war.

The third phase of development stretches from the late 1950's to the present and has seen a dramatic increase in the area of barley grown and of grain produced. This has been due to the advent of new varieties, greater attention to the agronomy of the crop, improved

harvesting machinery and a heightened awareness of the export potential for barley. This phase is marked by several factors, not least the beginning of the regular export of Australian made malt to various Pacific, East Asian and even some South American countries. Malt is an important value-added agricultural export commodity which predates many of those currently in vogue.

But the prime factor at the start of this third phase was the establishment in 1956 of the Barley Improvement Scheme in South Australia and Victoria. The initiative for the scheme came from the malting and brewing industries and was largely due to the efforts of Lance Walters of the South Australian Brewing Company and Alan Callaghan at that time, Director General of Agriculture in South Australia. The scheme, which predated the Wheat Research Levy, used contributions from the processing industries and the Australian Barley Board matched by the Commonwealth Government to support breeding and agronomic research toward barley improvement in the two States. As a result, the Victorian program was revived, the South Australian Department of Agriculture took on agronomic studies and variety testing, whilst a breeding program commenced at the Waite Institute under the supervision of Keith Finlay.

During the 1960's, other States followed suit to establish their own barley improvement programs. These programs beside researching various aspects of the crop, have produced a cohort of new varieties adapted to different areas of the Australian cereal belt. As a result, there has been an enhanced interest in barley as a crop in its own right and not just as an after thought to wheat. The shadow receded. The steadily increasing production over this period is illustrative of this increased interest.

The fourth phase will be the next 30 years. The boundary between the third and fourth phases of development is less distinct than the others. The 1980's have already seen several changes in the administration of research funding. The Barley Improvement Scheme was discontinued in 1980 in favour of a research levy for the whole of the Australian crop.

Initially, funds were controlled by the Wheat Research Council - that shadow again - but for the last five years, by a specific Barley Research Council. Now, in 1990, a Grains Research and Development Corporation, controlling the research in all cereal and pulse crops, is about to be established. Since the Corporation is likely to be dominated by the largest crop, wheat, the shadow is still lurking.

One factor that might mark the fourth phase is the realisation, or is it the rediscovery, that barley has an important role in human nutrition. Barley, like oats, contains a level of soluble fibre not present in wheat or rice. In America and Australia, there is now good evidence for the ability of barley, when included in human diets, to lower plasma cholesterol levels and improve other aspects of health. In a recent study by the CSIRO Division of Human Nutrition, a diet including either oat bran or barley foods reduced the cholesterol level of 21 males by 6% in one month in comparison to wheat foods.

The value added potential for barley in food products is probably greater than for all its other uses. The development of markets here and overseas will need a concerted development effort involving the marketing authorities and the processing industries.

In this fourth phase, there are good prospects for export markets for the Australian barley crop, whether as raw grain for animal feed, as grain for malting, or in some processed form: Both grain fed meat and malt are good value-added export commodities that can be exploited further. Figures presented at a recent workshop predicted an increased export potential for malt and malting barley over the next decade of nearly double the best figure achieved to date. An increased emphasis on processing quality necessitates an increased research effort on grain quality. That is not to say that improvements in field performance will be neglected; improved disease resistance, straw strength and yielding ability will continue to be addressed.

There are many challenges to achieving further advances for the Australian barley crop. These challenges involve all sections of the industry from grower to processor and include marketing, administration and research.

What then is the challenge to the barley grower over the next 30 years. Apart, that is, from concern with high interest rates and production costs which bedevil more than agriculture.

The grower will need to pay increased attention to the details of growing a productive crop with the best possible grain quality to secure the highest return, within the constraints of so-called sustainable agriculture. Nothing new really, but greater care and attention to detail will have to be given to herbicide and fertilizer practice and the selection of suitable, probably regional, varieties to achieve the best quality. Even in some cases, involving contracts for special demands, for example a particular variety for food processing. The next generation of growers will need to be better educated in all aspects of farm management. Rough estimates suggest that only 5% of Australian farmers have had appropriate tertiary training. In New Zealand the figure is 20-25%, in the U.S.A. 50% and is higher still in some European countries.

The challenges facing the marketing authorities are critical to the future profitability of the crop. Some of these were addressed by the recent Barley Marketing Review. The disposal of the Australian barley crop is still in the peculiar position of being handled by several, competing, authorities. Surely the pooling of resources into a National Barley Board would have many advantages. But, should not be in conjunction with a Grains Board where the special demands of barley marketing might rapidly take second place to the disposal of the wheat crop.

It is also important that a barley marketing authority becomes more closely involved in investigating market requirements and relaying such information to growers and researchers,

an area the review did not address. The Middle Eastern market for feed grain is unlikely to be as reliable as in the past and does not have the value added component of a processed product.

For example, a possible market for barley food products in Asia needs market research and development. In co-operation with food processors, the barley marketing authorities would need to develop acceptable products from suitable varieties, set up trial shipments, and test marketing. Perhaps along the lines of the Wheat Board's hot bread shop in Moscow.

And what of the challenges facing the processors, dominated by the malting and brewing industries? The problem of developing and holding markets overlap with those mentioned above, and are already an ongoing process in export malt sales. These industries must become more closely involved, or reinvolved, in research funding. This could most simply be achieved by a statutory levy on malt production.

At the present time the testing of the processing quality of new and potential varieties is fragmented around the States. What is needed is a National Centre for Barley Quality Research. Our competitors, Canada, have had one for years in the Grain Commissioners Laboratory in Winnipeg; in the USA there is one in Madison; there is one in the Netherlands and two in Germany, in Berlin and Munich, both closely associated with University teaching in cereal chemistry. The Carlsberg Research Laboratories in Denmark are funded by the Carlsberg Foundation, from brewery profits, but are engaged in a range of activities from basic science to the applications of science to industry problems. There is also a Brewing Research Foundation in Britain funded by industry, including strangely the Australian industry.

With the help of the South Australian Barley Research Committee, a start has been made towards a centre which will undertake strategic and applied research related to barley quality and provide an independent evaluation service for both industry and barley breeding programs. We are looking to industry, marketing authority and government to cooperate in this venture, to bring Australia on to a par with its competitors.

The Australian Wine Research Institute started in a small way, but now has an industry supported budget of about $1.5 million per year. Perhaps over the next decade a similar development can service the Australian barley industry. As another example, the milling and baking industries provide nearly half of the Bread Research Institute's annual budget in excess of $3million.

There are other challenges in the sourcing of funds for research programs and the regulation of those programs. The system of production levies on all growers, despite some problems of seasonal variability, is relatively equitable. Importantly it does involve the growers as a partner in research. In agricultural research it is essential to establish a rapport between researchers, growers and processors. Not only does this aid what is clumsily called Technology Transfer, but it provides an exchange of ideas between the partners, which can temper the expectations of the latter and the flights of fancy of the former. The State Barley Research Committees have been an excellent example of this partnership; they must continue.

At the other extreme is the possible funding of research through plant variety rights royalties. As far as the major Australian field crops are concerned, these have no advantages over the present system. There is no money in a royalty on seed sales where the grower only needs seed at say, five year intervals, unlike Europe where seed production is tricky and the growers buy new seed annualy.

Plant variety rights are part of what might be called a Proprietory Rights syndrome - secrecy for profit, which does not sit well with publicly funded research, but which, unfortunately, is creeping in to some organisations. Any restriction to the flow of information and material between public research programs is detrimental to the total national effort.

The success of Australian barley improvement programs over the past 30 years is in large part due to close cooperation between programs, a type of researchers' club, with the free

exchange of varieties, joint projects and regular Barley Technical Symposia. Similarly, with wheat and the biennial Wheat Breeder's Assemblies.

There are dangers in too much external control of research programs which tends to stifle flexibility and the development of innovative ideas. Excessive administrative demands, in the name of accountability, can bury research under a mountain of paper. Central planning is badly discredited elsewhere, is it still appropriate in Australia?

Scientific research, particularly agronomic and breeding research, (which of necessity covers several seasons) needs continuity of funding. Monthly targets, half year profits, performance indicators are not applicable to research. It is the long term sustainable gain that matters. Investment in research now can repay 100 fold in 10 years time, conversely failure to invest can be costly. The paucity of research funds for barley from 1975 to 1980 allowed the Canadians to get ahead of us in the malt export market. The present emphasis on three-year-only projects, is a constraint to progress. A system of rolling funding built around permanent core staff needs to be developed.

As Professor J.D. Bernal has said "It is talent that needs to be funded not projects".

But where to find the talent?

This is the educational challenge. Currently, there is a crisis in scientific recruitment, fewer students are opting for scientific training, preferring the more financially rewarding, but unproductive, options of law and economics. If it is difficult to recruit scientists, how much more difficult will it be to get them interested in agricultural science with its relatively low profile. Professor Frank Larkins has suggested that we have to raise the level of scientific literacy in the community. And that to attract young people to scientific careers we have to promote a greater community awareness of the central role of science in providing the fundamental basis for future national prosperity.

How do we convince students that not only is science intellectually stimulating, it is fun and that the application of science to practical problems, as in agriculture, can be just as stimulating as the most esoteric basic science.

Personally, the challenge of applying the emerging molecular techniques towards crop improvement are an exciting prospect. But, we need more than excitement to attract students to science. There have to be rewards commensurate with other professions and a career structure for young scientists. Three year projects are not a career.

The following, from a recent letter in the Australian from Dr. Graig Johnson, illustrates the problem 'After a minimum of 10 to 12 years study (bachelors degree, Ph.D. and postdoctorial appointment), the bright and ambitious postdoctorate in Australia is faced with several options. To follow the academic route in Australia with its poor salaries and working conditions, little or no security, no built in incentives or career structure and often little chance of obtaining funding from research (particularly from the ARC). Or to go instead to universities or industries overseas at better than 150 percent of Australian academic salaries with ample facilities, excellent working conditions and well defined incentives, security and career structures'.

The final challenge to be discussed is that of research possibilities to further improvement of the Australian barley crop. Targets can be defined by consultation with the whole industry, the partnership mentioned earlier. A detailed specification would not be in order here, suffice to say that for almost any character of the barley plant there are possible genetic modifications so that future prospects for barley improvement are still considerable.

Cultivated barley has a great natural diversity still to be tapped, its progenitor the Middle Eastern wild species *Hordeum spontaneum* is also proving to be a useful source of genes. These can be transferred to barley by traditional breeding methods. Whilst the more

sophisticated cytogenetic methods can be used to transfer characters from the more distantly related *Hordeum* species.

The barley breeders of 90 years ago, 60 and even 30 years ago did not have many aids to manipulation and selection. In the last few years these aids through biotechnology have increased enormously. The further challenge over the next 30 years then is to use this enhanced tool kit to the practical end of improving the Australian barley crop.

Barley is a diploid species with seven pairs of chromosomes, it is genetically simpler and more easily manipulated than wheat. There are already reasonably well documented maps of the barley genome, but these are now being greatly enhanced by the mapping of molecular markers. These markers can be used to tag genes of economic importance and to detect their presence in hybrid progeny thus circumventing more laborious selection techniques.

In North America, a Barley Mapping project is under way which illustrates the strength of cooperation in publicly funded science. It currently involves 25 barley scientists in 12 laboratories in the USA, 20 scientists in 11 laboratories in Canada and collaboration with mapping projects in Europe and in Australia. In the USA there is a budget of $US 2.2 million over five years with a little under half coming from industry including such firms as Anheuser Busch, Coors Brewery and the Great Western Malting Company.

All data, mapping and analysis techniques, DNA probes, double haploid lines, resultant maps and breeding materials provided by the project will be public and freely available.

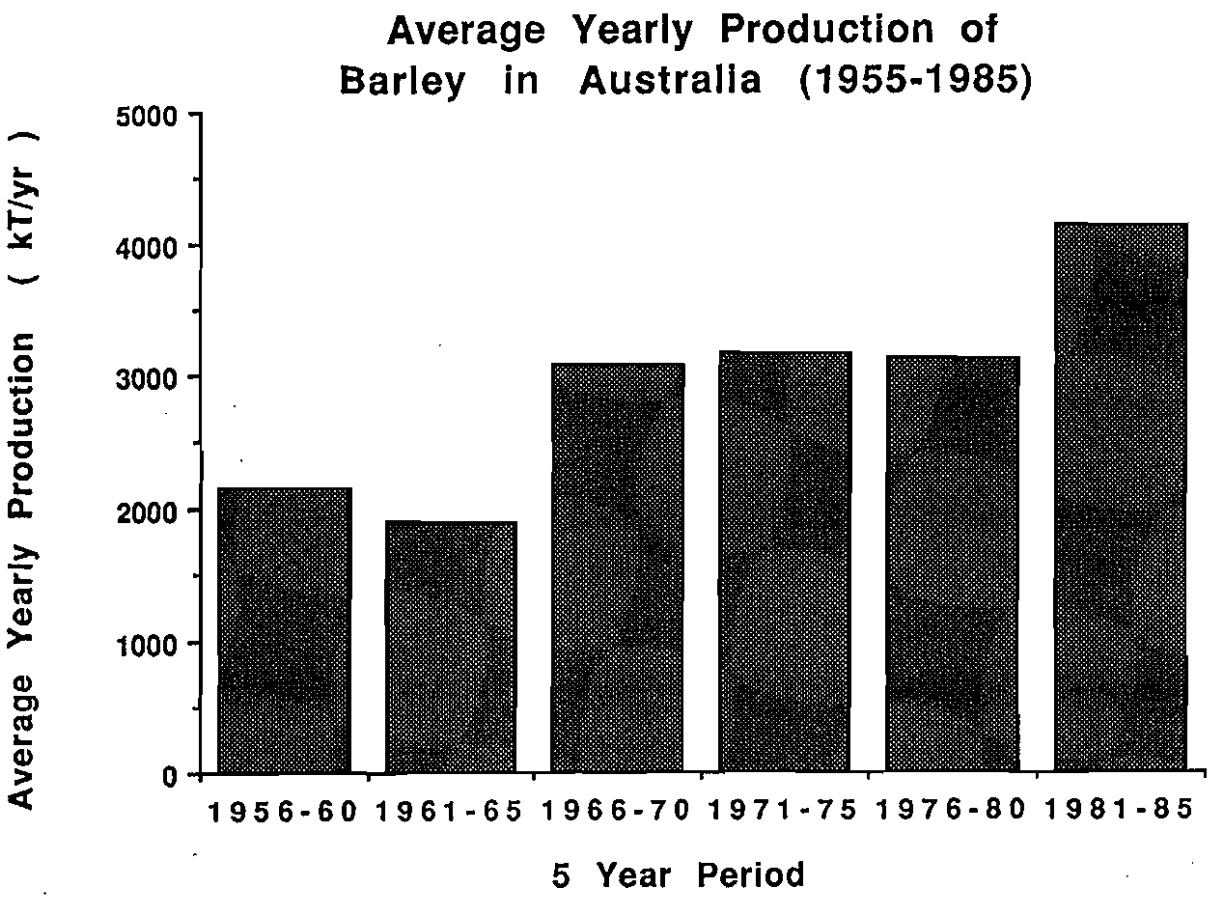
The Holy Grail of plant biotechnologists is genetic transformation. The insertion of foreign genes into an established variety to give it a particular property without altering its inherent qualities. Techniques for transforming several crop species are available but with the cereals, only in rice has this been achieved, barley could well be next if it has not already been done, but yet to be published. But, transformation is not an end in itself, but a means to an end

that could be a powerful tool for crop improvement. The challenge is to decide which genes from what sources could be useful and feasible to insert in barley.

Truly there an exciting future for barley.

I hope you will agree with me that in Australia, barley need no longer be in the shadow of wheat. Writing 200 years ago, Robert Burns had no doubt as to the status of barley.

Let husky wheat the haughs adorn,
An' aits set up their awnie horn,
An' pease an' beans at een or morn,
Perfume the plain;
Leeze me on thee, John Barleycorn,
Thou King o' grain!


Average Yearly Production of
Barley in Australia (1955-1985)
Average Yearly Production (kT/yr)
5000
4000
3000
2000
1000
0
1956-60
1961-65
1966-70
1971-75
1976-80
1981-85
5 Year Period

Average Disposal of Barley : 1982-89