IN FARRER'S FOOTSTEPS

FARRER MEMORIAL ORATION 1980

BY R.H. MARTIN

INTRODUCTION

I am very conscious of the great honour, entirely unexpected, in being selected as the 1980 Farrer Memorial Medallist. When I consider the stature of the man we commemorate, and the high calibre of previous recipients of the award, over half of whom I know personally, I really do feel unworthy.

Firstly, I should acknowledge the unstinted co-operation of many colleagues, both Departmental and non-Departmental, without whose help I would have been unable to prepare this address. I extend my appreciation to those of them - District Agronomists, plant pathologists, cereal chemistry staff, other breeders, head office personnel, staff at the Temora Agricultural Research Station and Agricultural Research Institute, Wagga, and others - who have laboured for years in assisting with the evaluation of new lines and who deserve a share in this Farrer Memorial Award. Mr. J. Kuiper has loaned many colour slides, also Dr. G. Murray and Mr. K.H. Davey. I am grateful to Mr. F. Tome for photographs, prints and slides, and Messrs. M. and S. Childe for preparing and arranging the photography of graphs and tables. For the last few months my wife has assumed more of the burden of running the home than usual, as well as helping directly in choosing photographs and editing.

Secondly, I would like to record my appreciation of those landholders who have provided labour, time and equipment to conduct wheat breeders yield trials - especially Mr. J.E. Semmler and Sons of Moombooldool, N.S.W., who have been growing plots for Temora wheat breeders for over 40 years. And Mr. P.J. O'Hare at Beckom. Co-operators of earlier years include Mr. W. Dixon and family at Quandialla and Mr. N. Thomson of Kildare, near Beckom.

In this address entitled "In Farrer's Footsteps" I intend to briefly outline the methods and individual characteristics which I think enabled William James Farrer to be so pre-eminent a wheat breeder - and then discuss wheat breeding progress since his time in the light of his example.

1. Farrer's Example

From the beginning of his wheat breeding work, Farrer was a man in a hurry. He was over 40 years of age in 1886 when he launched full-time on his self-appointed task. (Russell, 1949, P.39).

After barely 20 years (quite a short time by plant breeding standards) he had bred or selected nearly 30 varieties which came under commercial cultivation. Farrer varieties were prominent in Australian agriculture for over two decades after his death in 1906, his most popular production being Federation which in 1919 was estimated by his cereal chemist colleague, F.B. Guthrie, to occupy 80% of the total Australian acreage. (Quoted by Wrigley 1978). In addition he had produced no fewer than 180 lines that were named and used by himself and others for cross-breeding but which were not distributed for commercial culture.

To what can we attribute such successful and rapid breeding results? It seems to me that several factors contributed to Farrer's outstanding achievements.

> He was alert enough to recognise the need for wheat improvement, and the possibility of meeting the need through breeding. Once these were recognised, he had virtually an open field before him.
>
> He concentrated on a few major objectives, such as ability to yield well under dry conditions, better milling and baking qualities, bunt resistance, stem rust resistance (Farrer 1898).

He had a clear conception of the means by which he would attempt to fulfil these objectives, and independently of others, enunciated and demonstrated many of the basic principles of heredity.

He displayed vigour and zest in following through his ideas. He derived much satisfaction from his work, writing once that it was very pleasant to him, though the reverse of profitable, because he felt he was doing something of substantial value.

A large number of wheat lines were grown and assessed by him, and used in his crosses.

He was in contact with the leading cereal research of his day, and conducted a world wide seed exchange.

He was adaptable in changing the emphasis in his objectives when necessary. For instance, as the work progressed, he saw that ability to yield well under dry conditions deserved more attention than rust resistance. The resulting shift in emphasis contributed to the astonishing fourfold increase in the New South Wales wheat area between 1897 and 1915, and the extension of the wheat belt westward to roughly its present extent. Before Farrer, wheat growing was confined chiefly to the tablelands and cooler slopes on the eastern edge of the present wheat belt.

He showed versatility in investigating and meeting the problems facing him. He always sought out the facts in each case, and would reach sounder conclusions than some experts.

His crosses were of a complex nature which enabled him to bypass the more laborious methods of his day, as illustrated, and to build quickly on promising combinations detected by his careful observations.

He tested his material in several different environments each year.

He had an objective attitude, arising from his broad view of the industry and of agriculture as a whole.

Russell (1949) also tells us that once he decided on a course of action, he had great determination to carry it through.

I am sure anyone sufficiently interested to read Russell's biography (1949) of Farrer would agree with these points. Farrer's achievements will continue to inspire breeders, throughout the world.

2. In Farrer's Footsteps

Now we come to the second, main part of the address, in which I wish to outline some major developments in Australian wheat breeding since the time of Farrer, with reference to the influence of his career on this later work. First I will discuss breeding for resistance to disease, starting with the wheat rusts.

Breeding for Resistance to Disease

1) Wheat Rusts

Earlier work in breeding for resistance to four important diseases, Bunt, Flagsmut, Stem Rust and Leaf Rust, has been well covered by Professor I.A. Watson (1958). More recent research into wheat stem and leaf rusts was discussed by Dr. R.A. McIntosh in his 1976 Farrer Memorial Oration.

It was the challenge presented by destructive rust epidemics that first enticed Farrer into his life work, but he was not as successful in combating this menace as he would have wished. However, he probably went as far as it was possible to go, given his circumstances.

His initiative was followed especially in northern New South Wales and Queensland by later breeders, including W.L. Waterhouse, S.L. Macindoe and I.A. Watson, to name only three of many. (Macindoe and Walkden-Brown 1968). Backed up by fundamental research at the University of Sydney, the breeding effort has protected the rust-liable northern Australian wheat belt from serious rust damage since 1940, whereas southern areas, naturally less liable to rust, have suffered a number of epidemics in that period, notably in 1973. The cost of the north's protection has been the loss of effectiveness of a number of resistant genes as they fell before new rust strains. This has meant a fairly regular turnover of cultivars, but the rapidity of this turnover has been greatly reduced in the last two decades by combining several genes for resistance in the one cultivar. This strategy was first enunciated by Watson and Singh (1952).

Other recent changes in the approach to stem rust are the greater attention being given to post-seedling resistance (mature plant resistance) and the use of genes from other genera, such as secale (rye), agropyron and aegilops. Such gene transfers have been effected by cytogeneticists.

Australia is so far unique in the world in successfully incorporating the gene SR 26, translocated from *Agropyron elongatum* by Dr. D.R. Knott, of Saskatoon, Canada, in varieties acceptable for commercial culture. The breeding programme at Temora has produced two hard wheats, Eagle (named 1970), the most popular wheat in N.S.W. in 1974, and Kite, now widely grown in several States (400,000 ha in 1978), while the Wagga programme has bred the soft wheats Jabiru (1975) and Avocet (1979). These four cultivars are protected from stem rust by SR 26. We have found this gene easy to handle. It does tend to be associated with a slight depression in grain yield, which may explain why such a large breeding organisation as CIMMYT (International Maize and Wheat Improvement Centre) in Mexico, has failed so far to bring out a single cultivar carrying this gene, although I understand many crosses involving SR 26 have been fed into the programme. Selections with SR 26 would be automatically screened out in CIMMYT'S yield tests!

The gene SR 26 has remained effective on its own to all field races of stem rust in the world, and there have been hopes expressed that it is a 'super gene' that will maintain its resistance for all time and thus solve the rust problem completely. Such a hope seems doomed to disappointment, because recently a strain which attacks it in adult plants has been isolated in the glasshouse of the University of Sydney Plant Breeding Institute, Castle Hill (N.H. Luig personal communication). Dr. Luig advises that this laboratory rust strain is of a type that would not survive in the field, being unable to attack common cultivars, but it does show that SR 26 is not a 'super gene'. It seems that we should not depend on it too heavily, and that we should combine it with other genes as quickly as possible.

A great step forward in the control of rust has been the organisation of the National Rust Control Programme (NRCP) in 1975, largely at the instigation of Professor I.A. Watson enthusiastically supported by Dr. F.C. Butler, then Senior Deputy Director-General of the N.S.W. Department of Agriculture (Watson 1977). Aided by Wheat Research Council funds, this programme provides a testing service both in glasshouse and field, under the aegis of the University of Sydney, for all wheat breeders in this country. In addition, it undertakes to insure the industry against devastation by running a backcrossing project in which several genes for resistance are "added" to each prominent current cultivar.

The current aim of the NRCP is the development of a full range of stem and leaf rust resistant varieties for the whole of Australia by 1985. I hope this aim will be fulfilled. The present situation is dangerous - we are relying on too few sources of resistance in present cultivars.

I wish to pay tribute to the vision that conceived the NRCP. In making the proposal, the Sydney University wheat rust research team, perhaps the foremost in the world, showed that they were prepared to put all their expertise at the service of the industry, to translate their research findings into practical help. The scheme is right in line with the spirit of co-operation Farrer fostered, and we can be sure he would have vigorously supported it. It is a present day example of walking in Farrer's footsteps!

The NRCP was devised to control two rust diseases of wheat, namely stem rust and leaf rust. The most serious of these two is stem rust, but at least some resistance to leaf rust is desirable.

Last spring, the third rust disease of wheat appeared for the first time in Australia. This is stripe rust or yellow rust. Stripe rust is considered to be the worst of the rusts in parts of Europe and the U.S.A. Some crops of particularly susceptible varieties in the Victorian Wimmera district were seriously affected in 1979. Unfortunately, stripe rust has survived the last summer, which was unusually dry, so it seems it is here to stay. What its full impact will be in Australia remains to be seen. Meanwhile, preliminary moves to meet the new situation have been made. In the true Farrer tradition of co-operation, several workers in the three eastern Australian States have shared their observations and tested breeders' selections in field and glasshouse. Wheat Council funds are providing a new glasshouse at the University of Sydney Plant Breeding Institute, Castle Hill, for screening and investigative work. Many current Australian cultivars have more or less resistance to stripe rust. By the greatest of good luck, the cultivar Condor, one of the most popular, is quite resistant, and there is good resistance in most of the promising material we are importing from the Mexican CIMMYT programme. We were able to commence breeding for resistance at Temora last year immediately the disease appeared, because several well known resistant overseas cultivars had been introduced the year before in case the disease spread to this country.

11) <u>Common Bunt</u>

Common Bunt was the disease that Farrer combated most successfully, notably in the breeding of the cultivars Florence and Tenoa. Australian breeders since Farrer have also bred for bunt resistance, e.g. S.L. Macindoe in cultivar Eureka; A.T. Pugsley in cultivars Heron, Yande, Raven, Robin, and others, but generally bunt has been controlled by chemicals. Bunt causes a replacement of the grains in infected plants by balls of black spores which smell strongly of bad fish. A low level in a wheat sample makes it unfit for human consumption, so it is potentially very serious.

Farrer himself recommended chemicals means of control in articles in the Agricultural Gazette of N.S.W. (1900, 1901, 1905). There are now a number of different bunticides available which should ensure adequate control even if one or more become ineffective, as did hexachlorobenzene in Victoria in 1964 when a new race of the bunt fungus arose (Kuiper 1965). Bunt is rarely seen in Australia now, as it has been very effectively controlled by chemical treatment, through the work of plant pathologists rather than wheat breeders.

(111) <u>Flag Smut</u>

The success story of breeding for resistance to flag smut in Australia has been documented several times (e.g. Watson 1958, Macindoe and Walkden-Brown 1968). As its name implies, it is a smut affecting mainly the foliage, often preventing heading altogether. This disease did not concern Farrer, though recorded in his time. It increased to a serious threat in the 1920's when all the popular varieties were susceptible. It was the main cause for the decline of Farrer's variety Federation after about 1925. Interestingly enough, another Farrer wheat named Bunyip, was one of the most telling sources of resistance with which breeders defeated this disease within two or three decades after 1930. Flag smut is now rarely seen in commercial crops.

It is still policy in this State not to release varieties without a satisfactory degree of resistance. Occasional heavily infected crops still occur in N.S.W. where a susceptible variety has been grown for several years in succession. This shows that a return to the conditions of the 1920's could easily come about if susceptible wheats were widely grown. There has been little or no evidence of physiological specialisation in the causal fungus so far.

Probably some of the new fungicides will adequately control flag smut. Even so, breeding for resistance is so simple a procedure, and has been so effective, that it seems unwise to abandon it.

1V) Speckled Leaf Blotch

A second major disease that has attracted attention only since Farrer's day is speckled leaf blotch. The fungus responsible is Septoria tritici or more correctly Mycosphaerella graminicola. I mention this because it is often still called Septoria. It was probably often confused with a similar disease which can also be very destructive, until about 1970. This other disease is glume blotch, which usually develops under warmer conditions, therefore, later in the season and in more northern parts of the wheat belt, than speckled leaf blotch, which is probably the worst disease in southern New South Wales.

Comments as early as 1925 (Bartlett) on damage by speckled leaf blotch (and/or glume blotch) have been sighted. Particularly severe epidemics in the 1960's showed up the value of moderate resistance in a new Temora crossbred later named Teal, and promoted a breeding effort commencing in 1966.

In experiments over the years 1970-1974, Mr. J. Kuiper obtained yield increases of up to 315% at Wagga in the most susceptible varieties such as Summit by chemical control. These demonstrations of the huge losses caused by speckled leaf blotch really emphasised the importance of the disease and persuaded the N.S.W. Department of Agriculture to devote more attention to it. (Kuiper 1978. Martin et al 1976).

Concurrent with this quickening of interest in New South Wales was a resurgence of effort in other southern States, particularly Western Australia (Shipton 1966, Rosielle 1972). Indeed, there was a sudden world-wide awakening late in the 1960's to the importance of the two "Septoria diseases", now called speckled leaf blotch and glume blotch, though at first it was not always clear which one was referred to in the literature.

Prospects for success in dealing with speckled leaf blotch have been enhanced by the establishment of a special research team at the Agricultural Research Institute, Wagga, in 1976. This team consists of three plant pathologists, a cytogeneticist and two wheat breeders. Generous support has been given by the Wheat Council and Committee for glasshouses and other equipment, and for ancillary staff. Routine testing of material in the glasshouse has commenced, with prospects of greatly speeding up the breeding programmes. Backcrossing to incorporate resistance in a range of cultivars adapted to southern and central N.S.W. is also now feasible and in progress. In addition, more basic studies are in hand.

In many ways, the story of our attack on speckled leaf blotch has parallels with Farrer's work in combating rusts, but removed in time by about 50 years. In both cases, progress was limited at first largely by the lack of suitable screening techniques.

As in Farrer's day, time was wasted at first by confusion between two similar diseases. The world-wide intensification of the work on speckled leaf blotch in the last 15 years parallels the closer study of the rusts that occurred after Farrer's time.

The prospects for controlling speckled leaf blotch by breeding seem very good. Inheritance of resistance in studies to date has been simple. Whether or not there will be complications as has happened in the rust work, remains to be seen.

The special research team at Wagga has as an immediate goal the release of a rull range of resistant cultivars in N.S.W. by 1985. This will probably be achieved.

V) Other Diseases

We have now covered several diseases against which major breeding or other control measures are directed. There are of course many other diseases. We know that some could be controlled fairly simply by either breeding or fungicidal treatment if only resources could be made available. With others, there have been no resistant sources or no practical screening test for the breeder to use. Others again may not warrant much effort in this State.

At any time further research may discover means by which an intractable disease could be dealt with or so simplify procedures that it is worthwhile controlling some minor disease.

Breeding of Semi-Dwarf (Short-Statured) Wheats

I turn now to an exciting development of recent years, the breeding of the high yielding semi-dwarf or short-statured wheats.

In 1956, A.T. Pugsley first introduced the late maturing dwarf wheat Norin 10 Brevor selection 14, bred in Washington State, U.S.A. Norin 10 is a Japanese wheat with two genes for dwarfness, from which virtually all current dwarfs and semi-dwarfs of the Mexican and Australian programmes are derived.

Dr. Pugsley's introduction is unsuitable for commercial cultivation here, but was used in many Australian crosses, one of which produced the cultivar Kite. A later introduction from Mexico, called WW15, showed excellent agronomic characers under Australian conditions. Single backcrosses of WW15, made by J.R. Syme, and selected for white grain and better quality, gave rise to the cultivars Condor (hard), Egret (soft), and Oxley (hard). (Fisher and Martin 1973). (Syme et al 1975). Kite, Condor and Egret, released in 1974, were the first semi-dwarf cultivars grown in Australia.

So began a marked advance in yield potential in this country. I am indebted to Mr. R.W. Fitzsimmons (personal communication) for providing yield comparisons between semi-dwarf and the standard height cultivar Eagle in central and southern New South Wales over the years 1966-77 inclusive. They are shown in figure I. Yields in each of many trials were converted to percentages of Eagle, and then the percentages averaged over all trials for each variety. Eagle was chosen as the standard as it was similar to the semi-dwarfs in disease resistance over the years considered. The best yielding semi-dwarfs, Oxley, Egret and Condor, averaged 120% or more of Eagle. I will discuss the crossbred WW33G later on - it is a sister line of Condor, but has winter habit. Note that it has averaged 120% of Eagle, as has Condor (a spring wheat). The only standard height cultivar anywhere near the best semi-dwarf is Halberd, bred at Roseworthy College, South Australia. The remaining semi-dwarfs, Kite (closely related to Eagle), and Songlen are not outstanding for yield here, but like the standard cultivar Timgalen, they are better adapted to more northern areas.

It is true that the yield potential of the semi-dwarf is only fully expressed under good conditions, but it is also true that these new varieties withstood the droughts of 1977 and 1979 very well. In 1978, record commercial yields of over 100 bushels/acre (nearly 7 tonnes/hectare in metric terms) from large paddocks were harvested from the cultivar Egret in the Cootamundra, Harden and Cowra districts of New South Wales. Previously such yield levels were unheard of on non-irrigated country in the wheat belt of this State, and I am sure it would not have been possible with older cultivars. Yet we continue to hear silly statements that breeding has not increased wheat yields in Australia!

In 1978, N.S.W. had both a record production of 6,640,000 tonnes, and a record yield of 2.09 tonnes per hectare. This reflects the yield boost given by the semi-dwarfs.

Farmers were quick to recognise the superior yields of the semi-dwarfs as shown in figure 7. Within three years of their release, they occupied over 50% of the total N.S.W. wheat area, and it is estimated that in 1980 they had reached 84%. (R. Fitzsimmons, personal communication). Note that the combined area of the standard cultivars Olympic and Teal, also on the graph, has remained fairly constant at 10% or less over the period. This is because they fill an early sown niche for which none of the semi-dwarfs so far bred are suitable. Sown early, these standard cultivars are still able to compete in yield with the semi-dwarfs sown in their season.

The high yield of the semi-dwarfs seems to be associated with factors other than short stature (cf Syme 1972a, 1972b, 1974), which is desirable in itself because it helps to reduce lodging.

Further breeding to ensure continued protection against disease will be necessary to maintain the present yield levels of the semi-dwarfs. More rust resistant replacements of Condor and Egret have already been developed, and include the new cultivars, Cook, Avocet and Banks.

No doubt yielding ability under Australian conditions will be raised still further. This is most clearly foreseen for irrigated wheat in which even shorter stature than "semi-dwarf" may well be desirable to resist lodging at the high yield levels likely to be reached.

Breeding for Winter Habit

We have seen how Farrer did not have much success in one of his main breeding objectives, that of stem rust resistance. Let us now consider a similar situation with an important objective formulated since his time, that of winter habit. The concept of an early maturing winter wheat for Australian conditions was first put forward by Macindoe in 1937, but as yet the concept has been imperfectly translated into practical breeding results.

1) Characterisation of Winter Wheats

Winter wheats are characterised by their requirement of a period of low temperatures, between 0^{o}-10^{o}C, mainly 0-5^{o} before they can initiate ears and/or come into head normally without delay. The promotive effects of low temperatures on flowering are termed vernalisation, a word coined by Lysenko (1928), an early worker on this phenomenon. Wheats which are strongly winter may require up to 7 or 8 weeks of cold. Others are vernalised by a cold period as short as 3 weeks. Varieties needing less cold than this, or none at all, are classified as spring wheats, though those spring wheats with a distinct response to cold are sometimes called semi-winter or intermediate types.

It is interesting to note that many widespread Australian cultivars have been of this semi-winter type, including Farrer's Federation. Pugsley (1979, 1972) has studied the inheritance of the spring-winter habit of growth in wheat.

Tests at Temora (unpublished) have shown that winter wheats can be sown very early (February) and grazed, and still recover to give good grain yields, comparing favourably with oats in this respect. More importantly, as a grain proposition alone, they have compared well with spring wheats.

11) Association of Winter Habit with Semi-dwarfness and Insensitivity to Photoperiod.

Although breeding for winter habit has been an objective ever since World War II, no winter cultivar has yet been released in southern New South Wales. WW33G, a semi-dwarf winter wheat selected by A.T. Pugsley was mentioned earlier, and is a sister of the popular cultivar Condor.

WW33G is considerably earlier maturing than older winter wheats because it is less sensitive to daylength. It thus is a breakthrough in fulfilling Macindoe's concept of an early maturing winter wheat for Australian conditions, and it seems a good type on which breeders may build better quality and disease resistance.

Breeding for Better Milling and Baking Quality.

1) Farrer's Attitude

When Farrer began his work, flour from Australian grown wheat was generally regarded as too poor to bake satisfactorily for bread, and flour for bread was imported from overseas (Macindoe and Walkden-Brown 1968). Farrer was the first to recognise the need for improving the baking quality of Australian wheat. He regarded quality as more important than yielding ability (Russell 1949). His Comeback variety was one of the strongest wheats in the world and his Bobs, Jonathon, Cedar and Florence are also high quality. Although he was disappointed in the quality of Federation, this wheat made possible the extension of wheat growing into drier areas and thus helped to raise protein content.

There followed a period when Australia reaped the benefit of Farrer's quality improvement of white wheats, and they became recognised on the world's markets as the finest for blending purposes.

11) Decline and Renewal of Breeding Effort

Between Farrer's death and about 1930, plant breeders gave little attention to grain quality, and some very weak cultivars, some of poor flour colour, became dominant in the Australian crop. In addition, overcropping reduced protein levels. Repercussions on the world markets made it obvious by the early 30's that wheat breeders must concentrate on combining yield with baking quality. Macindoe (1976) gives an interesting account of his awareness of the problem in 1931. This emphasis on the production of stronger wheats led to a change from soft to hard wheat types, mainly in more northern wheat growing areas. Dramatic improvement was achieved in the dough strength of several new varieties, but some wheats with over-stable dough characteristics and/or high starch damage were selected. Gabo and its probable parent, Gular, were notable exceptions of the 1930-1960 period in that they could confer strength to a weak blend and at the same time produce excellent quality bread when used alone. In Gabo, W.L. Waterhouse and I.A. Waterson achieved what Farrer originally aimed to do in regard to the combination in one variety of the desirable characters of rust resistance, high yield and good quality.

Since about 1960, there has been more appreciation of the shortcomings of many empirical quality tests and greater use of test baking as a criterion of quality. This has reduced the probability of release of wheats with over-stable characters or excessive starch damage. On the other hand, progress resulting from sounder quality testing tends to be counter-balanced today by increasingly rigid specifications of some markets. Moreover, many cereal chemists may still rely too heavily on mechanical dough tests to rightly evaluate new crossbreds.

It is an interesting point that now most of our wheat exports are not used for bread at all, but for noodles, chappatis and the like. Australian plant breeders generally have not selected their material for adaptation to these other uses, but have hoped that wheat of good bread baking quality will also be suitable for a range of end products. Their hopes have been borne out reasonably well in practice but the day may come when specific tests for qualities not important to bread manufacture will have to be made.

111) Increasing Proportion of Quality Wheats

Nearly fifty years of following a policy aimed at lifting the baking qualities of wheat have been successful in markedly raising the proportinn of medium-strong to strong wheats in Australia. Medium-strong to strong varieties occupied only 3% of the area in 1932, but increased to 72% in 1978, while weak to very weak cultivars decreased from 75% to 16% in the same period of 47 years. (Table 1). Further, because some of the very weak wheat is marketed separately for special soft wheat flours, it no longer lowers the bread baking quality of standard samples.

Quick improvement in milling quality can be reported in southern New South Wales. In 1969 the average flour yield of six cultivars grown about that time was 68%, whereas in 1979 the corresponding average yield was 73%, an increase of 5%. The popular Condor is particularly free-milling, yielding about 76% flour.

1V) Impact of Recent Grading and Dockage Methods

The last two decades have seen the adoption of grading or segregation based on variety, grain hardness, and protein content.

The Temora wheat, Falcon, released in 1961, set a new standard for the combination of yield and quality in southern areas. In 1969, Falcon became the basis of the southern hard segregation class, operating under the aegis of the Hard and Soft Wheatgrowers Association. Up to 500,000 tonnes of this class has been segregated in one year, with premiums of up to $5.50 per tonne. Improvements on Falcon in milling quality have been made in Kite and Condor and their derivatives.

Australian standard white is at present the largest class of wheat, and is the residue after hard and soft grades have been segregated, but ideally it would be a definite type of intermediate hardness. Each of the other classes, except GP (general purpose, usually weather damaged) consists of varieties that have acceptable and closely similar milling and baking characteristics, so that the class name, especially if linked to its protein content, should represent a well known and consistent standard of quality which may command a premium in the market place.

The existence of such grades or classes serves to bring home to breeders the quality needed in the areas for which they cater, and also provides more openings into which new lines can be slotted.

Recent legislation which makes provision for dockages imposed by the Australian Wheat Board on varieties considered undesirable in quality for a particular group of silos, although these varieties may be acceptable in another silo group, will result in greater varietal control than was possible previously. It is unlikely that high yielding but poor quality wheats will ever again dominate the Australian crop.

This greater varietal control will be an incentive to the breeder to maintain or raise quality levels, for it will emphasise the importance of quality in the market place, and protect his high quality productions from undue competition.

Also of great importance to the breeder is the fact that premiums on the segregation classes, and dockages on inferior quality (in an inverse way) put a monetary value on quality. Therefore, they provide a means by which the breeder can demonstrate the value of his work for no one can deny that his efforts do improve quality. It is a different situation with grain yield - the breeders may know they have increased yields, but it is difficult to convince others who may not accept the evidence from trial plots!

About 10 years ago, the Australian Wheat Board instituted a special advisory service led by Mr. R. Cracknell. This is now giving guidance to breeders in regard to quality requirements.

All in all, recent marketing developments augur very well for the quality and salability of the Australian wheat crop. In part, this is because they foster a climate favouring quality improvement by breeding. Farrer would have been much gratified.

Conclusion

Time does not permit me to discuss any other developments, in the line of Farrer's work. I have mentioned only a few in which significant advances have occurred in Australia since Farrer's time, and with which I am familiar.

I believe the momentum of Australian wheat breeding is increasing, more help is coming from industry funds, links with overseas work are becoming stronger and particularly in the past decade or so team efforts like the National Rust Control Programme have grown. The breeder is no longer a lone individual on an isolated research station but more overtly than before, one of a group of scientists. This tendency would have had the blessing of Farrer, I'm sure, but he may also have warned of the danger that such teams may provide an opportunity to shirk individual responsibility to the wheat industry.

As to the future, we can face it with hope and enthusiasm, as did Farrer. New methods, tissue culture, haploid breeding, hybrid wheat, use of computers. etc.

could greatly alter the way breeding projects are tackled, but of one thing we can be sure: that wheat breeding will continue to be a powerful means of improvement in many aspects of the industry for as long as wheat is grown.

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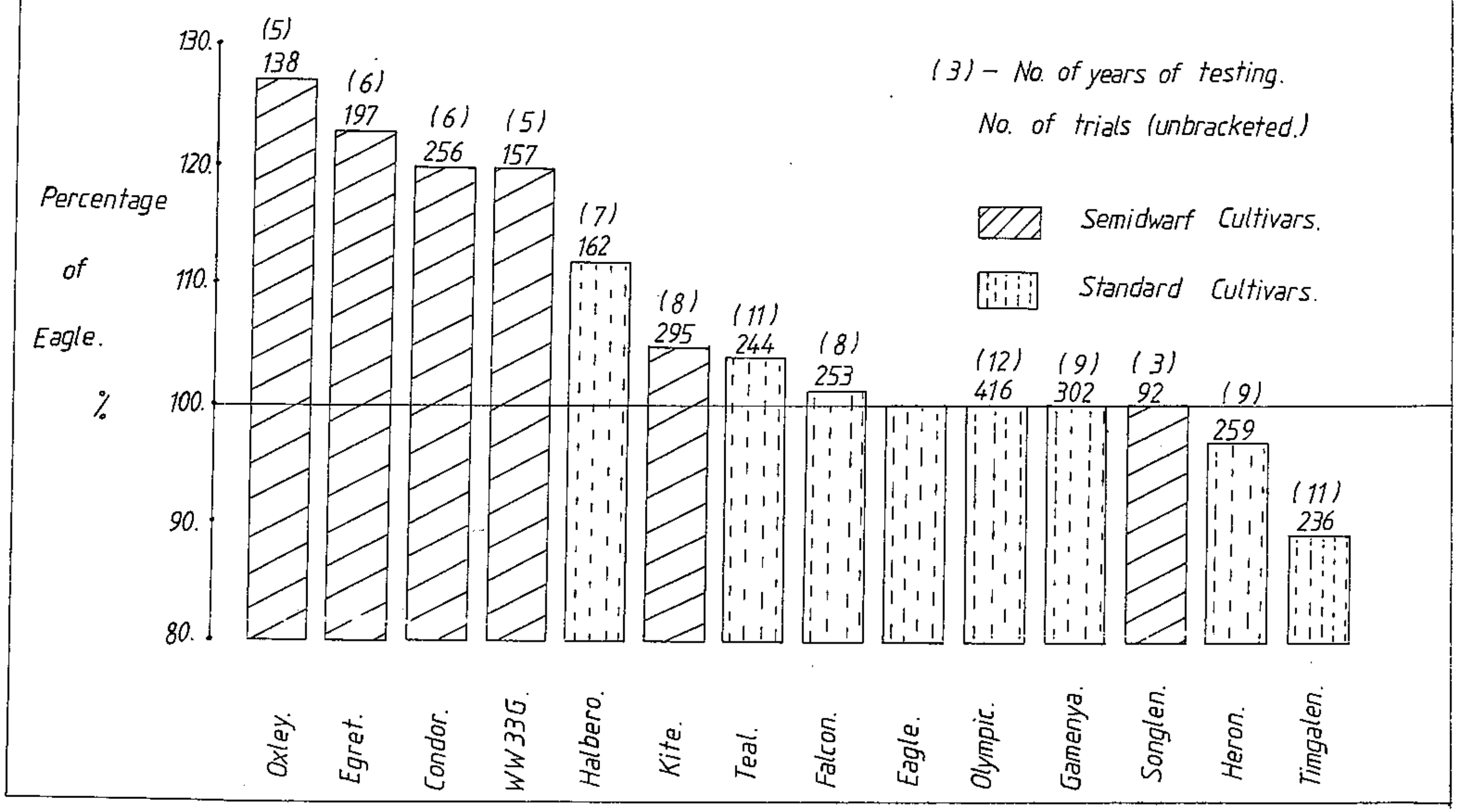
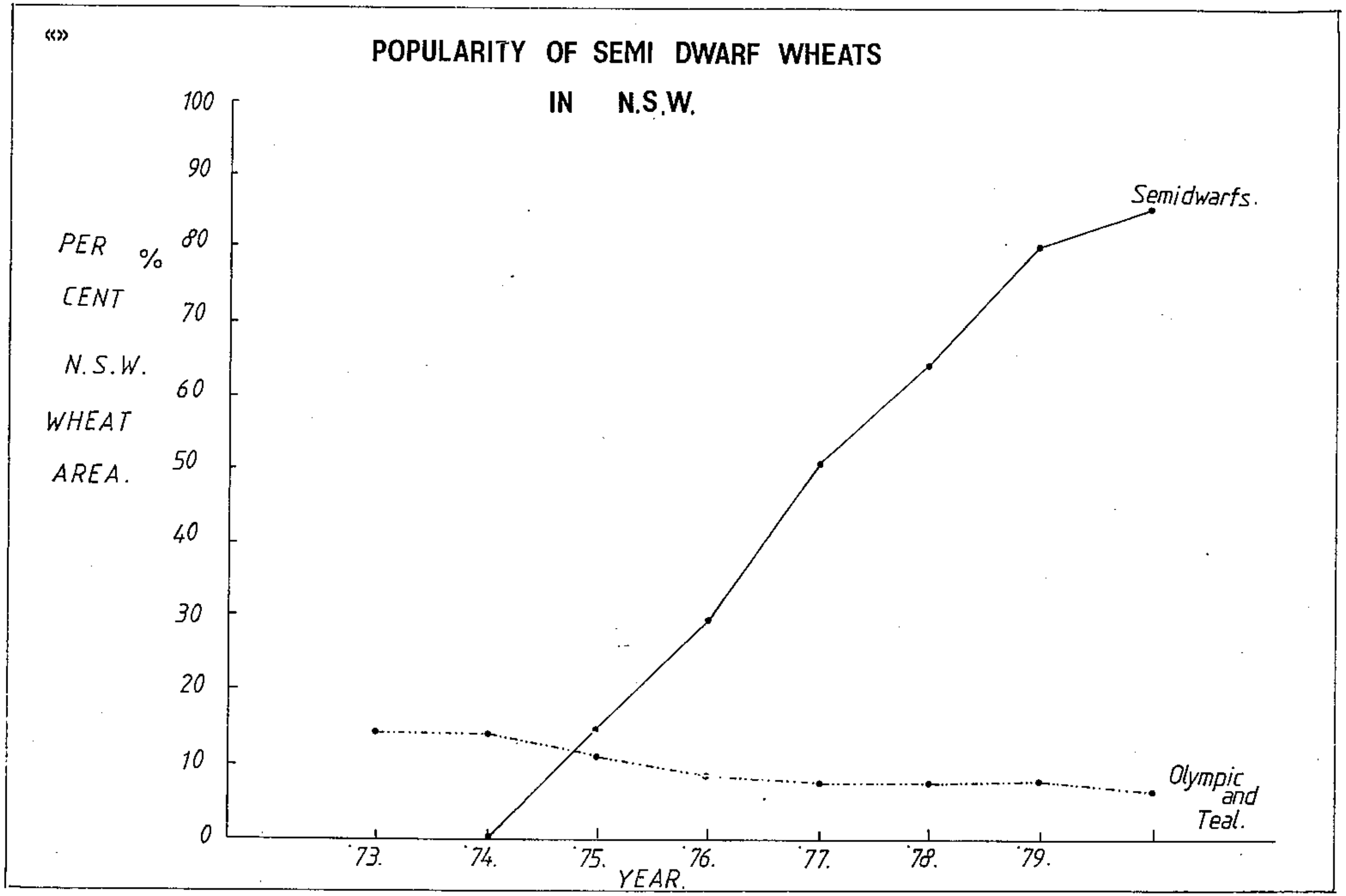
MEAN PERCENTAGES OF EAGLE IN CENTRAL AND SOUTHERN N.S.W.
1966 – 1977.




POPULARITY OF SEMI DWARF WHEATS
IN N.S.W.
PER CENT N.S.W. WHEAT AREA.
%
100
90
80
70
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Semidwarfs.
Olympic and Teal.

MEAN YIELDS OF WW 33 G IN THREE SOWING PERIODS WAGGA AND TEMORA 1974 — 78.

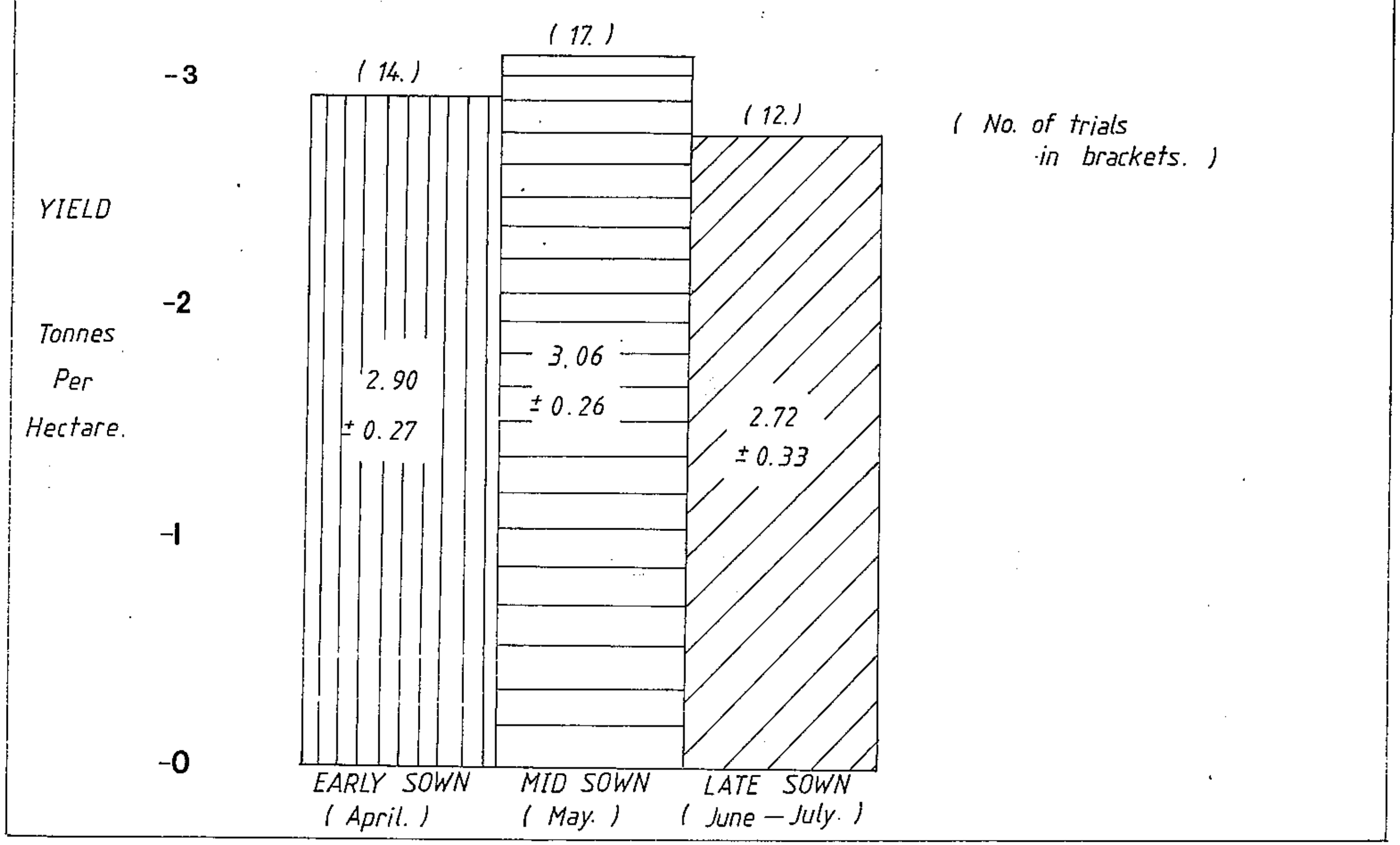

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TABLE I

Percentage of the Australian Wheat Area sown to different quality wheats.

1932 - 1978

Quality class	Percentage area of varieties				
	1932	1952	1965	1973	1978
Medium-strong to strong	3	25	35	66	72
Weak to very weak	75	67	55	24	16
Unspecified	21	7	10	9	12