

FARRER ORATION, 1946.

Although it is 60 years now since William Farrer began his epoch making experiments with wheat on his property at Lambrigg, there is no sign of any year passing without constant reminders of his work, and a realisation of its tremendous national value.

It is impossible to conceive that in this year of 1946, two events of great potential importance viz. the projected establishment of a Wheat Research Institute in N.S.W. and the holding of an Australian Conference on Wheat Breeding would be taking place if Farrer had not lighted a beacon which still continues brightly to illustrate the value of wheat breeding research and to illuminate the field of endeavour.

Previous Farrer orations have dealt rather exhaustively with the methods and achievements of this, probably the greatest of Australian benefactors, although repetition of reference to these aspects can never be made too often. This contribution will, however, essay to indicate directions in which further wheat research needs to be developed with the ultimate object of securing further improvement in some phases of the industry.

In common with much other agricultural research conducted in Australia during the war, wheat breeding research suffered very greatly. Practically the whole work of the N.S.W. Department of Agriculture in wheat breeding and investigational work had to remain in abeyance during the period owing to the enlistment of almost the entire staff engaged in this work. It was left to the Sydney University to carry on with its breeding work to produce stem rust resistant wheats.

One of the greatest conceptions in the solution of the rust problem which is still concerning us today as it was in Farrer's time was that it would be overcome by breeding resistant varieties. Sixty years ago when wheat growing in N.S.W. was largely confined to the Slopes and Tablelands, wet or humid conditions favouring the development of stem rust so reduced the total production that they nearly brought about a national disaster. Several Rust-in-Wheat Conferences with Australian wide representation were held and it is amusing today to read in the reports of these Conferences that some of the foremost practical agriculturists of the time seriously advocated dressing the land with common salt to prevent or mitigate the development of the scourge. Farrer alone advanced the conception that rust in wheat would be overcome by breeding resistant varieties. The newspapers of the day strongly attacked such an idea, but Farrer was able at least to demonstrate a great inherent difference in rust resistance between varieties of wheat, and to produce some varieties which had, under some conditions, a measure of practical resistance.

His greatest practical achievement in this direction was, however, derived from his observation that early maturity in wheats enabled them largely to escape stem rust. The early maturing varieties which he produced were not the best suited to the Tablelands and cooler parts of the Slopes, but they at once made possible the extension of the wheat belt of N.S.W. to hotter and drier districts. Even before the end of his life, Farrer was able to see the area of wheat in N.S.W. double itself through this development and had he lived another seven or eight years he would have had the gratification of seeing the original area quadrupled.

Although some improvement was effected in the rust situation in the more favoured rainfall districts, the problem largely remained in these districts in that late maturing wheats which yielded very well in these districts in normal seasons could never be grown without risk of loss in unusually wet seasons.

In the North West with its relatively high temperature and humidity combined, the most favourable conditions for the development of stem rust exist, and early maturing rust escaping varieties are of no avail in some seasons. There the solution of the problem becomes entirely a matter of inherent resistance in the variety.

No Australian varieties of wheat were found to possess high resistance to stem rust under these conditions and this part of the State remained subject to severe losses in epidemic years. Little or no progress in breeding rust resistant varieties of wheat suited to this region until varieties of high resistance were introduced from other countries. Dr. Waterhouse, of Sydney University, used as resistant parents the American varieties Hope and Webster and produced Hofed and Fedweb, but although these varieties had the necessary resistance to stem rust they do not meet other requirements for a suitable variety and they are not likely to be largely grown. The Department of Agriculture then set about combing the world for rust resistant wheats and obtained some Hope and Pentad Crossbreds from U.S.A. and Canada, and some unnamed crossbreds from Kenya Colony, Africa, as well as some wheats, including Gaza, from Palestine.

It is this foresight and endeavour which are fundamentally responsible for our being in such a good situation today in N.S.W. in the work of breeding of rust resistant wheats.

Dr. Macindoe of the Department of Agriculture used one of the Kenya wheats to produce Eureka and this variety rapidly became popular for a few years until it suddenly lost its high resistance to stem rust under certain environmental conditions of which the North Western wheat belt is capable. Biologists explain this loss of resistance as being due to a new physiologic form of rust.

During post graduate studies in America Dr. Macindoe found that another of the Kenya wheats had different resistance from the one he had used in producing Eureka. He had fortunately used this wheat to produce the more recent varieties Charter and Yalta. These wheats have proved highly resistant to stem rust under all field conditions. Dr. Waterhouse also used one of these Kenya wheats to produce the resistant variety Kendee.

Meanwhile Dr. Waterhouse also produced the variety Gabo using the variety Gaza from Palestine as the resistant parent. Using a strain known as Double Cross obtained from America as a parent Dr. Macindoe has recently produced the variety Celebration, which has also entered field trials.

So far these newer varieties viz. Gabo and Kendee of Waterhouse and Yalta, Charter and Celebration of Macindoe have proved under all conditions in the field to be highly resistant to stem rust and as they yield well and have other good qualities they will be rapidly increased and grown in the North West. They may also prove suitable for other parts of the State.

It has been shown that there are different fundamental reasons for the resistance to stem rust of certain varieties, and in the end success in breeding permanently resistant varieties may depend on effecting a combination of different kinds of resistance in an Australian variety.

New species of wheat allied to the common bread wheat such as *Triticum Timopheevi* have been introduced from Russia by the Department. This species has been found to have high resistance to many diseases including stem rust. It has already been crossed successfully by Mr. Pridham with some Australian varieties, and some good material may be developed from these crosses.

Before leaving the subject of stem rust it is of interest to note that a practical farmer in N.S.W. claims to be able by some practical method to control stem rust or its effects in wheat. His method is to be subjected to close scientific investigation.

Discussion on the proposed establishment of a Wheat Research Institute has been brought about by a long-felt dissatisfaction of millers and bakers with the general milling and baking qualities of N.S.W. wheat. These were qualities in which Farrer pioneered in the field of improvement, and it might appear from the complaints of millers and bakers today that little progress has been effected in the last 50 or 60 years in these qualities in the wheat produced in this State. As far as the milling quality is concerned, that may indeed be to some extent the case.

Good milling quality is largely the ability of the wheat to produce high percentage of flour of good colour. In the early days when wheat growing was largely confined to relatively cool districts, a well filled plump grain with a high percentage of soft starch was produced (when rust was not present) and such grain was of excellent milling quality. When Farrer extended the wheat belt of N.S.W. into hotter and drier districts, however, it was inevitable that there would be some lowering of the milling quality of grain produced under these conditions. The variety Federation was inherently good in its capacity to fill a plump grain, if it obtained any sort of an opportunity to do so. It might have been expected, however, that the relatively low soil moisture and the rapid ripening conditions of the hot western climate were too unfavourable to allow that translocation and prolonged deposition of soft starch in the grain necessary to fill a plump berry which occurs under cool slow ripening conditions with abundant soil moisture. This does not mean, however, that the handicap of environment on milling quality cannot be overcome, with limitations, through the development of a better inherent ability in the variety to fill its grain under such conditions. The fact that Nabawa is superior to Bencubbin in this respect inspires hope for some progress by breeding.

Baking quality in wheat is such a very complex character that there will always be room for improvement and research in this field. Reduced as far as possible to simple practical terms, it may be best indicated to depend largely on the quantity and quality of the gluten in the wheat. It is essential that the significance of these most important factors be fully appreciated in any approach which is made to wheat research. Some recapitulation of existing knowledge in this regard may not be out of place here.

While cool slow ripening conditions are favourable for the plump filling of the grain, they are also conducive to the development of soft starch and low gluten content. Quick ripening conditions, on the other hand, promote a relatively high gluten content, but such conditions are against good filling of the grain. Thus good milling quality and good baking quality are to some extent incompatible. Although nature is not easily circumvented, there is no reason why research should not make an effort to improve on her design.

Our present knowledge is that climatic conditions appear to be the most potent in determining the so-called flour strength or baking quality of wheat in so far as the gluten content is concerned but certain soil fertility factors are also influential in this regard. Gluten content is closely related to nitrogen content and the nitrogen intake of the wheat plant has therefore an important bearing on the gluten content of the grain. In its turn the nitrogen intake of the wheat crop is largely dependent on

the nitrogen content of the soil. It is a very little known fact that superphosphate has an adverse effect on the nitrogen or gluten content of the grain, but who would be so bold as to suggest that southern wheat growers should dispense with superphosphate. Much more research on the influence of the soil fertility factors on wheat quality is required.

Taking all these factors into consideration, it is suggested that Southern N.S.W. wheat will always have a strong general tendency to be of relatively poor quality and that we must look to the relatively quick ripening conditions of Northern and Western N.S.W. particularly to the rich high nitrogen soils of the North West for wheat of high baking quality.

It has been indicated that baking quality in wheat is also influenced by another important factor viz. the quality of the gluten. This character is considered in the state of our present knowledge to be more largely herital than to be influenced by environment, but we are still much in the dark on many aspects of this question and much investigational work will have to be undertaken before accurate knowledge will be available as to the exact relative influence of heredity and environment on the gluten quality of wheat as well as on the relative force of herital and environmental factors in determining the total quality as represented by quantity and quality of gluten in wheat.

At the present time there is a very strong inclination for millers and bakers to regard the matter of improving Southern wheat, where there is a strong natural environmental influence in keeping the gluten content at a low figure, as a simple matter for the plant breeder. No marked improvement against such forces of nature has been effected in any part of the world. Most attempts in this direction in N.S.W. have resulted in the production of mottled grain, which is largely nature's manifestation of her strong influence in reducing the gluten content of a naturally hard wheat to the approximate content of a soft wheat environment. It is understood that such a mixture of horny and soft endosperm in the same grain causes much trouble to millers in conditioning the wheat for milling, and that they would prefer to have the wheat grain uniform in this regard.

Whatever research is undertaken in a soft wheat climate in the field of endeavour to determine the relative influence of heredity and environment on the quality of wheat, it seems that the most practical results in evolving varieties of wheat suitable for the large section of country in which hard wheat of relatively high gluten content can be produced will be achieved by breeding work conducted under these conditions. It is a matter for regret that the funds available today for wheat research are appallingly low by comparison with those spent on research in other agricultural industries in Australia, such as wool, dairying, sugar, fruit etc. although the dividends already yielded from such investment have been truly remarkable. Research is indivisible but the greatest dividends will be paid from wheat research carried out along lines and under conditions in which there is most hope for substantial improvement and in which the results obtained are likely to have a wide practical application.

It may appear to some that stem rust and wheat quality are the only important fields necessary or desirable in wheat breeding research in N.S.W. or in Australia today. Flag smut is not now a serious problem and the part played by plant breeders in saving Australia from a national disaster in the control of this disease may not be fully realised. Bunt, loose smut, septoria leaf spot, foot rots, and cold injury are still capable of taking a severe toll of wheat crops, and all these troubles may eventually be eliminated by the production of resistant varieties.

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The greatest original conception in wheat breeding which has occurred in Australia since the days of Farrer is considered to be that made by Dr. Macindoe in the breeding of wheats of "winter" habit. Briefly a wheat of this type under Australian conditions is one which can be sown as early as desired in autumn and which will not make any attempt to head until it has experienced a definite amount of low winter temperatures. It is not difficult to visualise the high value such a variety would have in those districts, especially in the Northern Western part of N.S.W., where favourable autumn rains sometimes occur and where sowing of the present varieties cannot be made because of the risk of their heading before or during the winter with serious loss from frost damage.

The Department of Agriculture has been forced to undertake its wheat breeding work to produce stem rust resistant and winter type wheats of high baking quality particularly suitable for North Western conditions under the very great handicap of having no Experiment Farm in this region. This is the only part of the State with peculiar conditions of climate and soil differing so remarkably from the conditions obtaining in other parts of the wheat belt that it is considered that a large allocation of any funds obtained for wheat research must be made to enable the Department to establish a research station in this region in order to undertake breeding and other investigations in wheat production.

This part of the wheat belt of N.S.W. lends itself to large scale economic production of high quality wheat. This wheat will make up for any natural quality deficiencies of Southern wheat and when home requirements of strong wheats are met, as they will easily be, this production may be of very considerable economic importance in catering for the growing demand in export markets for a higher baking quality in Australian wheat.

If well provided for and expertly guided, there is every reason to believe that during the next decade or two, wheat breeding research will produce results of remarkably great national value in Australia as it has done in the past.

It is hoped that this contribution of thought will serve in some way to perpetuate the memory of William Farrer by indicating the foundation on which wheat breeding work in Australia is based, and, also, by indicating some of the needs, to provide some encouragement and inspiration for future wheat breeding research in this continent.