TEN TONNES PER HECTARE IN THE U.K.

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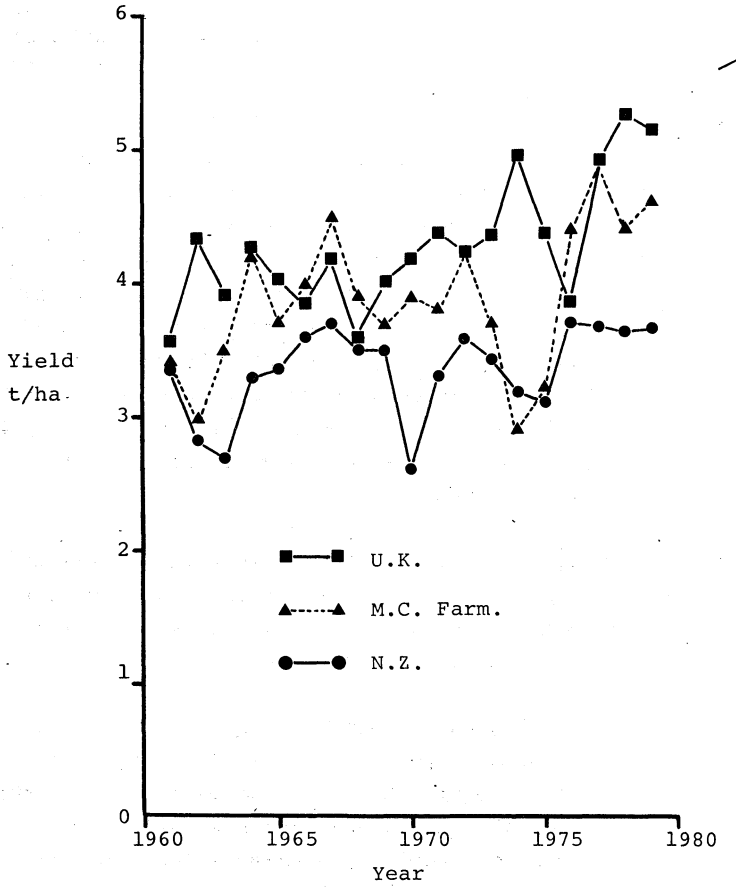
An outsider who read the title of this paper might be forgiven for assuming that the author was some visiting expert from the U.K. who had just breezed in to tell the locals how to grow ten tonnes of wheat per hectare. This assumption is not correct. However, as part of my stay in Britain in 1979 I did have the opportunity of looking at some excellent wheat crops, despite the fact that my main project was concerned with grain growth in barley. In this paper I shall try to compare wheat growing in the U.K. with N.Z., noting those areas where we might learn from the U.K. experience.

It is now a well established fact that wheat yields in excess of 10 t/ha have been grown in Britain on a farm scale, although the average yield is nearer half this amount at 5.14 t/ha for the 1979 harvest (Fig. 1).

To put these yields in perspective the average N.Z. wheat yield over the past 20 years is included in Fig. 1 together with yields from the Lincoln College Mixed Cropping Farm. Although all yields are rather variable due to seasonal effects some real differences and trends are apparent:

Fig. 1. Average wheat grain yield (t/ha) for the United Kingdom, New Zealand and the Lincoln College Mixed Cropping Farm 1961 - 79.



Sources of information: N.Z. Wheat Review No. 14; F.A.O. Production Yearbook Vol 26, 1977; British High Commission.

* The long term U.K. average wheat yield is above that obtained in N.Z. and the difference appears to have become greater since 1972.

* The N.Z. average wheat yield has not changed much in the last 15 years. The peak yields of the 1976 and 1977 harvests were also obtained back in 1967. The data of Hall & Unwin (1978) derived from a sophisticated mathematical treatment of yield trends showed a levelling off of yield increases in the 1960's. This trend seems to have continued in the 1970's.

* The Lincoln College Mixed Cropping Farm has usually produced yields above the national average, not surprising in view of the fact that a considerable proportion of the property is on a Wakanui soil type, an above average soil. What is more interesting is the fact that the margin of yield superiority enjoyed by the Mixed Cropping Farm has shown a more permanent increase since 1975.

The possible reasons for the yield differential between the U.K. and N.Z. will now be discussed under the headings of husbandry, cultivars and climate.

HUSBANDRY

It was my impression that the U.K. wheat grower was no better at implementing new technology than his N.Z. counterpart but that in the U.K. farmer interest in crop husbandry was greater than in N.Z. In many instances this interest has been kindled by a competitive spirit, often aided by commercial interests. Two examples will be described.

ICI publishes the results of detailed crop surveys carried out annually in a publication called "Pointers to Profitable Wheat". Farmers who have grown crops yielding 10 t/ha or more are entitled to become members of the ICI Ten Tonne Club. For the 1979 harvest, 16 crops achieved the magical heights of 10 t/ha or more, the highest yielding crop being 11.7 t/ha. The highest yielding crop in 1978 was also 11.7 t/ha but in that season 27 yields in excess of 10 tonnes were recorded compared with only five in 1977. Apart from yields, the ICI survey also publishes details on husbandry factors including previous crop, cultivar, sowing date and rate, fertiliser and chemical application.

Farmer interest and enthusiasm for details of crop husbandry was demonstrated by the fact that the "Barley '79" Field Day attracted several thousand agriculturalists over a three day period. This field day was organised by the Royal Agricultural College at Cirencester. Demonstrations and displays were presented by various government departments and private organisations, but the main attraction was the grower demonstration plots where again, on a competitive basis, one hectare plots of land were made available to the Ministry of Agriculture, Fisheries and Food, the Royal Agricultural College and two leading farmers. Having been allocated these plots it was then up to the individuals concerned to grow the highest yielding crop possible using whatever inputs were required, although detailed costings were prepared for each crop. Farmer interest in these plots was very intense and it was obvious that many of the farmers present had a good understanding of the observation, development and manipulation of the various yield components, weeds, pests and diseases.

Details of husbandry practices in the U.K. will be presented in subsequent papers but one aspect requires mention here. Despite the fact that the U.K. farmer relies heavily on

nitrogen fertiliser in his cropping programme, as rates in excess of 150 kg N/ha are not uncommon, there is no soil N test available to assist in the prediction of these requirements. With the high energy requirement of N fertiliser, the N.Z. wheat grower is indeed fortunate to have available the N soil test developed by the late T.E. Ludecke and his colleagues at Lincoln College.

CULTIVARS

There is no doubt that plant breeders have made a major contribution to the increase in wheat yields over the past 50 years. In the U.K. the release of Maris Huntsman in 1972 gave immediate yield increases, but the introduction of the semi-dwarf gene has been one of the major breakthroughs in recent times (Lupton, 1978), starting with the release of Maris Fundin in 1974 closely followed by Hobbit in 1975. Of the ten tonne wheat crops grown in the ICI survey for the 1979 season the main cultivars were Mardler with five, Hobbit with three and Huntsman with three 10 tonne yields. All the cultivars mentioned above have been bred at the Plant Breeding Institute, Cambridge but several commercial plant breeders are also active in this field.

In New Zealand the cultivars Kopara and Karamu were expected to increase yields by at least 10% (Hall & Unwin, 1978) probably more in the case of Karamu. The data in Fig. 1. suggest that on the national scene these increases have not occurred. It is too early yet to assess the contribution of Oroua and Rongatea but recent results with these cultivars are discussed in a later paper.

Before leaving the question of genotypes and plant breeding it should be pointed out that with very few exceptions, the yields of 10 t/ha in the U.K. are achieved with yield wheats i.e. wheats which have been bred and selected for

ld and so are unsuitable for bread making. Table 1
:s the results of an experiment grown at the Plant
:ding Institute where the yields of several yield
ıts were compared with those produced by bread wheats.

'ABLE 1. YIELDS (T/HA) OF BREAD AND YIELD WHEATS GROWN AT CAMBRIDGE (PUSHMAN & BINGHAM, 1976)

ıltivar	*Yield t/ha*	
s Hobbit	6.93	
s Nimrod	6.61	
s Huntsman	6.31	6.43 t/ha Yield wheats
s Templar	5.88	
s Freeman	5.61	
lle -Desprez	5.47	
-Desprez	5.27	5.31 t/ha Bread wheats
s Widgeon	4.90	

all the yield wheats achieved 21% more grain yield
the bread wheats. It is not unreasonable to assume
N.Z. could achieve similar yield increases if plant
ders here could disregard baking quality in their
ctions. The case for breeding yield wheats has been
ussed elsewhere (Smith & Marshall, 1973) and could
assume increasing attention for use as a carbohydrate
for ethanol production. Copp (1967) has pointed out:

"In this respect, the full potential of the hybrid lines produced by wheat breeders is not being explored".

ATE

ate, particularly rainfall is the factor which causes

much of the yield fluctuations between years and yield differences between districts. In trying to compare the climates of two countries on opposite sides of the world as they affect wheat yield, one is on very dangerous ground from a scientific point of view. Not only is climate itself a very complicated commodity but other factors of the environment are also different.

Table 2 lists the general timing of key physiological events of wheat crops grown at Lincoln, Gore and Rothamsted together with the mean monthly temperatures and evaporation for those same months. Gore has been included because Southland is situated in a latitude most similar to the U.K., and also because wheat yields of 10 t/ha have already been achieved on a paddock scale in Southland (D.S.C. Wright pers. comm.). From 1939 to 1952 a Southland grower held the world record wheat yield of 7.4 t/ha (Rankin, 1961).

Rather surprisingly, differences in temperature during the active growth of the wheat crop are very small. During early reproductive growth, it is cooler at Rothamsted and this probably gives some increase in the number of grains per ear (Thorne, Ford & Watson, 1968). The evaporation figures presented in Table 2 refer to evaporation from a free water surface and, as such, show the integrated influence of temperature, solar radiation and wind as they affect the amount of water that is "sucked" out of the wheat crop. Prior to anthesis, the rate of evaporation at Lincoln is about 45% higher than at Rothamsted, rising to a difference of nearly 80% during grain filling, with Southland being in an intermediate position. It is suggested that a significant proportion of the grain yield differences produced in these different environments is associated with differences in evaporation or physiological drought.

TABLE 2. TIMING OF WHEAT DEVELOPMENT IN RELATION TO TEMPERATURE AND EVAPORATION FOR LINCOLN, GORE AND ROTHAMSTED

A. Double Ridge - Anthesis

Lincoln			*Gore*			*Rothamsted*		
Time	*Temp °C*	*Evap. mm/month*	*Time*	*Temp °C*	*Evap. mm/month*	*Time*	*Temp °C*	*Evap. mm/month*
Sept.	8.9	65	Oct.	10.2	91	April	7.6	51
Oct.	11.2	115	Nov.	11.6	124	May	11.0	84
Nov.	13.1	157	Dec.	13.3	135	June	14.1	103
			B. Grain Filling					
Dec.	14.9	183	Jan.	14.7	145	June	14.1	103
			Feb.	14.4	119	July	15.9	108

Sources of Information:

Thorne & Blacklock (1971); Thorne (1973); Rothamsted Experimental Station Report Part 1 (1974-1978); N.Z. Meteorological Service Misc. Pub. 110 (1974-1978); N.Z. Meteorological Service Misc. Pub. 149; D.S.C. Wright (pers. comm.).

Research at Lincoln (Dougherty, 1973) has shown that the effects of "physiological drought" caused by high rates of evaporative demand cannot be fully alleviated by growing crops on soils of high moisture retention or by irrigation. In this regard it should be noted that a big research effort into the physiology of water stress in wheat in relation to breeding for drought resistance has been started at the Plant Breeding Institute. The data in Table 2 strongly suggest that there is an even greater need for such research in the N.Z. environment.

CONCLUSIONS

* The average wheat yield in N.Z. has not changed much in the last 15 years. It is suggested that the average farmer has not fully exploited established technology.

* The average wheat yield in the U.K. is above that obtained in N.Z. and the difference has become greater since 1972. Crops of 10 t/ha have been produced in the U.K. and in Southland.

* The yield differences between the U.K. and N.Z. are associated with differences in cultivars, husbandry and climate particularly the effects of "physiological drought".

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