

## An Introduction to Field Crop Production in the United Kingdom

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About a quarter of the total area of the United Kingdom /UK/ is used for the production of field crops, equivalent to the use of about 0.12 ha land per person for this purpose.

In the past 30 years, the UK has made significant advances towards self-sufficiency in agricultural production such that now about three-quarters of commodities required and capable of being produced in our temperate climate come from our nation's farms. In achieving this position the national yields of a number of important field crops have more than doubled /and similar success has been attained by the dairy industry/, whilst the workforce employed in the agricultural sector has been halved. The minimum four-fold increase in output per capita is accepted as being one of the best productivity successes in the UK economy.

Annual production of cereal grains /mainly winter wheat and winter and spring barley/ has reached about 25 Mt. The increase in winter wheat production has been particularly marked, and the crop now occupies about 2.0M ha; the national average yield now regularly tops  $6\text{t ha}^{-1}$ , with  $10\text{t ha}^{-1}$  being achieved in experiments and on occasional fields by farmers /and  $14\text{t ha}^{-1}$  being the highest recorded field yield/. Average yields for barley are a little lower at over  $5\text{t ha}^{-1}$ . Oats now occupy only a very small fraction /3% of the area devoted to cereals, and maize is grown only as a minor crop, mainly for forage /and some as sweet corn/. Potato yields have increased progressively since 1950; however, the demand for this commodity has fallen slightly, and so the crop is now grown on a considerably smaller area. The yield of sugar beet has not increased so markedly, and currently the national crop produces about 1.1Mt of sugar from about 200,000 ha. The financial incentives provided in recent years by the Common Agricultural Policy /CAP/ of the European Economic Community /EEC/ have led to a striking revival of interest in oil seed rape, and the area devoted to the crop increased from 13,600 to 220,000 ha between 1973 and 1983, and was 270,000 ha in 1985.

Rape is regarded both as an oil seed and a protein crop, but it still produces occasional problems for the compound animal feed industry. Peas and field beans /*Vicia faba*/ provide alternative home-produced protein crops, with interest at present turning more towards dry peas. Meanwhile,

field vegetables, especially brassica crops, have become more reliable in yield, quality, timeliness and uniformity.

In a collaborative investigation, many UK leading farmers worked in association with Imperial Chemical Industries /ICI/ to apply the best possible husbandry practices to their winter wheat crops. An aim was to show the yields of  $10\text{t ha}^{-1}$  or more could be achieved by farmers given favourable weather and soils, and the association became known as the Ten Tonne Club. Whilst a few farmers did obtain the target yield, most did not, but the average yield across the group was about  $1.5\text{t ha}^{-1}$  in excess of the national average yield /i.e. reflecting all farms in the UK/. When yields on individual sites were examined in terms of soil types /classified on the basis adopted by the Soil Survey of England and Wales/, then the spread of yields on particular soils was much less than that encountered nationally, and some soils clearly had a higher yield capability than others /see Fig. 1/.

A major factor contributing to increased crop yields has been varietal improvements stemming from the enlightened application of plant breeding methodologies. For example, with wheats 50-60% of the yield improvement achieved in the past 30 years may be so attributed, the remainder being ascribed to improved cultivation, nutrition and protection prac-

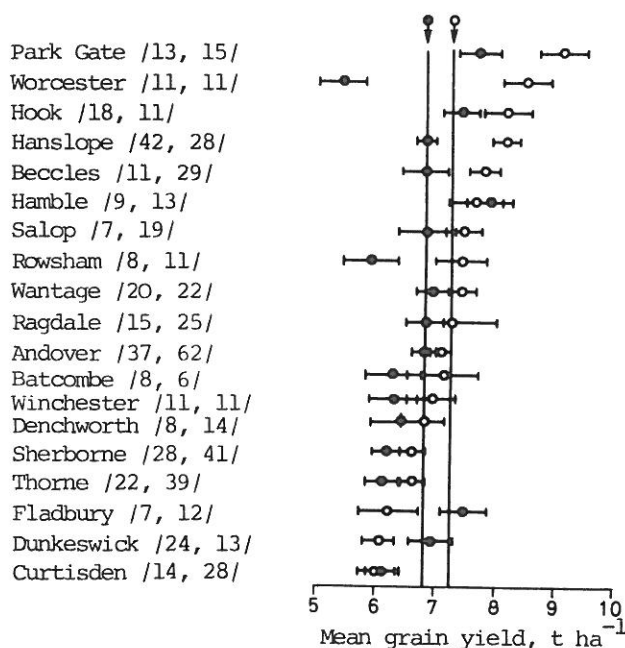


Fig. 1

Comparison of mean grain yields for soils of the most common series for 1979 /•/ and 1980 /○/. Note: the figures in parenthesis after each named soil type represent the number of sites for which yield data was available in 1979 and 1980 respectively

tices. Crop dry matter production is directly related to the amount of incident solar radiation intercepted by the foliage /provided the crop is free from major leaf diseases, and not water-stressed/: there is then advantage in breeding, if possible, for lines capable of early-season establishment and faster growth at relatively low ambient temperatures. Newer, high-yielding varieties of cereals introduced into UK agriculture have depended mainly for their success on an altered distribution of photosynthate in favour of the grain, and away from the vegetative parts of the plants, rather than upon the production of more total photosynthate. Such changes have complemented other gene selections modifying the habit or architecture of crops, their quality as judged by protein content and its influence on milling and baking properties or other attributes, their resistance to damaging pathogens and pest and, in the case of legumes, the efficacy of host-symbiont combinations in biological nitrogen fixation. My colleagues will elaborate on these achievements in later papers in the seminar.

Interest in the possibility of sowing and establishing field crops without the prior need for soil inversion /ploughing/ is not confined merely to recent years. Soil scientists at Rothamsted examined direct drilling and minimum tillage practices in the 1930s, but then the lack of suitable herbicides made such systems impracticable. With the advent of the bipyridyl herbicides, the development of minimum cultivation techniques became a real possibility, and research has provided the farmer with alternatives to ploughing that have gained an established position in agronomic practices. Direct drilling/minimum cultivation is recognised as being particularly valuable for certain heavier soil types in years when high autumn rainfall makes these soils especially difficult to plough: the techniques have the further attraction of reducing the energy expended in crop establishment. Comparisons of cereal yields, averaged over fields and seasons, obtained following conventional ploughing or minimum tillage trials in general have not shown marked, consistent differences. The UK delegation will present three further papers providing more detail of research and development concerned with soil cultivations.

The fertility of soils in respect of their nurturing of plants has long been a subject of both research and practical interest. Emphasis has naturally centred on the three principal nutrients /N, P and K/ almost invariably provided by compound fertilizers, and the amounts given to particular crops have increased steadily since 1950 as cultivars with higher yield potentials have come forward progressively from breeding. Since 1970, the increase in amounts of N applied to most crops, including grass, has been very considerable, but P and K applications to many crops appear to be levelling off /see Table 1/. Unlike P and K, reserves of mineral N do not build up in agricultural soils, and so it is important to ensure that adequate amounts of N are available for uptake by root systems at critical phases of crop growth. In consequence, considerable effort is now devoted to modelling the dynamic behaviour of N in soils during the growing season in an attempt to predict the amounts of nutrient-N available to roots at different levels down the soil profile, especially after the winter period as winter-sown crops commence a phase of renewed active growth in early spring. It is expected that the ability to model and predict soil-N with good accuracy will lead to computer-based systems for advising farmers how much fertilizer-N they should apply to their crops to achieve the target yields: if this can be achieved reliably, the farmer will benefit economically by obtaining better utilization of fertilizer-N, whilst con-

cern for the environment should diminish because less nitrate-N is likely to reach rivers, lakes or deep aquifers. Dr. GREENWOOD will extend these considerations in a later paper.

The marked increase in crop productivity achieved since 1950 has depended in part upon the greater awareness by farmers of the need for effective control of weeds, diseases and pests, and upon the provision

Table 1

Fertilizer use on arable crops and grassland: overall values for England and Wales /applications kg ha<sup>-1</sup>/

Crops and grassland	N		P <sub>2</sub> O <sub>5</sub>		K <sub>2</sub> O	
	1970	1985	1970	1985	1970	1985
Winter wheat	90	192	41	62	35	63
Spring barley	82	103	40	41	44	48
Winter barley	-	151	-	58	-	63
Potatoes /maincrop/	166	201	181	210	250	278
Sugar beet	161	127	117	60	191	138
Grassland:						
2-7 year leys	95	194	44	42	36	62
Permanent	51	130	28	32	20	38

through research and the efforts of the agrochemical industry of pesticides capable of maintaining clean and healthy crops. UK agriculture uses, in financial terms, more herbicides than fungicides or insecticides. However, fungicide applications to cereals have shown dramatic increases since 1970, from a position in which they were applied infrequently to one where now most crops receive one or more treatments during their growth.

A strong, coordinated programme of basic research, aimed at creating opportunities for the genetic engineering of crop plants, was begun in institutes of the Agricultural and Food Research Council /AFRC/ in 1978, and achievements in the following years have been both significant and exciting. Research appears to have opened up possibilities for the actual and potential transfer of selected genes, or groups of genes, between plants normally exhibiting sexual incompatibility, and progressively with time we may look to such techniques, when used in combination with established methods of plant breeding for the production of transformed plants in which introduced genes confer new and desirable traits /e.g., increased resistance to particular pests and diseases, enhanced tolerance of water or salt stress, improved nutritional quality, etc./. The benefits may become evident in agricultural practice in the later years of this decade, and should accrue increasingly during the 1990s.