The potential for change in agriculture in the United Kingdom: technical aspects

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The present pattern of British Agriculture has been determined by the physical factors of climate, soil and topography, on which are superimposed technical and economic factors. In considering the potential for change we must work within the physical limitations, assume that an optimum balance of food nutrients supplied by home agriculture could be defined and that economic restraints would be removed. This may be a Utopian or an Orwellian situation but it provides a framework for this paper.

That British agriculture is capable of change is evident from the records of the past century and of the post-war period. There has been a considerable increase in food production and there have also been considerable changes in emphasis (Table 1), for example, the expansion in milk and meat, especially poultry meat, production, the decline in fodder roots, the expansion in vegetable production and in barley production.

Table 1. *Changes in agricultural areas (hectares* × 10⁶*) and in beef and milk production*

	Great Britain*		United Kingdom†, ‡, §			
Year ...	1875	1938	1944	1955	1965	1975
Wheat	1·35	0·71	1·30	0·79	1·03	1·04
Barley	1·01	0·41	0·79	0·93	2·18	2·34
Oats	1·08	0·87	1·30	1·04	0·41	0·23
Fodder roots	—	0·39	—	0·30	0·16	0·11
Field vegetables	—	0·12	—	0·18	0·15	0·20
Potatoes	0·21	0·24	0·49	0·35	0·30	0·20
Total crops	5·57	3·36	5·55	4·57	4·84	4·82
Temporary grass	1·76	1·44	1·71	2·48	2·64	2·14
Permanent grass	5·39	7·01	4·37	5·48	4·91	5·07
Animal production						
Milk (l × 10⁶)		7064		10019	11572	13284
Beef (tonnes × 10³)		569		676	790	1166
Imported concentrates (tonnes × 10⁶)		8·5‖		6·6	7·7	5·4

*Murray, 1955
†Cmnd, 1957
‡Cmnd, 1967
§Cmnd, 1977
‖Wright, 1940.

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Change is therefore possible. Change in many populations and forms of production assumes a sigmoid growth curve and optimistic predictions are often made when the linear phase occurs. However, diminishing returns are likely to set in although one hopes for technical developments to maintain the rate of growth. British agriculture was in the linear phase of growth in the 1960s but as Blaxter (1976) and Wragg (1977) have shown the rate of expansion in our most important products has declined in recent years. Whether it can be resumed probably depends not so much on technical but on practical and economic factors for, as I hope to show, there is still considerable scope for technical improvement.

The potential for growth: numbers

If an agreed policy were to dictate increases in certain products it is of interest to consider the possibilities. Change can be achieved either by increase in numbers of units or by increasing productivity per unit. Change in numbers depends, for crops, on the potential arable area, and for animals on the reproductive and productive capacity of the various classes of livestock, and on the availability of feed and other resources.

Various estimates of the potential for expansion of the arable area have been made (Cmnd, 1975; Blaxter, 1975; Holmes, 1975*a*; Mellanby, 1975). These all show that there is some scope for expansion, although it is salutory to note that the Government White Paper on Food from our own Resources (Cmnd, 1975) does not envisage a greater area under cultivation than in 1875. If we came under severe pressure to become self-sufficient in food supplies further expansion would be desirable. The recent NEDO report (1977) shows that there are some 9 000 000 hectares of land in the United Kingdom of grades 1, 2 and 3 compared with some 7 000 000 hectares at present under crops and temporary grass.

For livestock, the ruminants with low reproductive indices can expand in numbers only slowly, beef cow numbers doubled between 1965 and 1975, whereas poultry and pigs with high reproductive indices could increase very rapidly.

The potential for growth: yield

Changes in yield in recent years have been considerable (Table 2). In crop production better varieties, cultivation techniques, weed and disease control and

Table 2. *Changes in agricultural yields*

Year . . .	1875	1938	1955	1965	1975
Wheat (tonnes/ha)	2·07	2·57	3·36	4·08	4·30
Barley (tonnes/ha)	1·94	2·30	3·21	3·75	3·60
Oats (tonnes/ha)	1·71	2·07	2·63	3·01	3·45
Potatoes (tonnes/ha)	14·6	17·6	18·1	25·1	23·1
Milk/cow (kg)	1870	2530	3310	3780	4310
Eggs/bird	75	150	170	202	233
Net agricultural output	115*	100	156	221	258

*Estimate from Ojala (1952).

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harvesting equipment have all contributed. With livestock, improved genetic merit, better knowledge of nutrition, disease control and a fuller understanding of the physiological bases of good husbandry, have all played their part.

When we turn to potential, however, there is still scope for further increases in yield. For crop production it is possible to estimate with reasonable precision the maximal yields which are possible within the limits of the British climate. As Table 3 shows they are nearly double the yields now achieved by good farmers. For livestock production it is more difficult to estimate maximal yields on a rational basis. However, the values of Wilson (1973) are compared in Table 4 with good current levels; again there is still room for increase. There has been substantial genetic improvement in recent years in the productivity of some livestock, especially poultry and pigs which are both prolific and with short generation intervals. However, some improvements in farm animal productivity may merely reflect increases in size or in food consumption. As Table 5 shows, increases in production per animal may not result in any improvement in production per unit area required for feed (Holmes, 1975*b*).

Grassland provides the greatest opportunity for increases in production per unit area, but although a comparison of the findings of Wright (1940) and of NEDO (1975) suggests that a doubling of effective yield has been achieved, this still falls far short of the potential (Gordon, 1975; Holmes, 1975*c*). Unfortunately realizing the potential makes heavy demands on energy, capital, and management skills, rather scarce resources.

Introduction of new crops

Change may be reflected in the introduction of new crops. Perhaps the most striking in recent years, a result of improved technology and the Common

Table 3. *Potential crop yields compared with good practice in UK*

	Potential	Excellent farms	National average
Wheat (tonnes/ha)	12·5	7·0	4·5
Potatoes (tonnes/ha)	85·0	50·0	31·0
Grass (tonnes dry matter/ha)	25·0	12·0	6·0

Table 4. *Potential animal yields compared with good practice in UK*

	Potential*	Excellent farms	National average
Lactation yield per cow (kg)	18 000	7000	4200†
Eggs/bird per year	365	270	234†
Growth rate			
Pork pig (g/d)	910	700	550
Broilers (g/d)	46	40	32

*Based on Wilson (1973)
†Cmnd, 1977.

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Table 5. *Concentrated feed, forage and animal production**

Milk				
Concentrates per cow (kg)	Milk per cow (kg)	Forage area (ha)	Concentrates area (ha)	Milk (kg/ha)
610	3365	0·64	0·18	4103
904	3795	0·57	0·27	4518
1148	4080	0·57	0·34	4484
1392	4350	0·55	0·42	4484
1636	4520	0·54	0·49	4388
2088	4890	0·52	0·63	4252

Beef					
	Concentrates per animal (kg)	Carcass weight (kg)	Forage area (ha)	Concentrates area (ha)	Carcass (kg/ha)
Cereal beef	1880	218	—	0·57	382
18 month beef	1168	272	0·31	0·35	412
24 month beef	1016	277	0·40	0·30	396

*From Holmes, 1975*b*.

Agricultural Policy (CAP) price structure is the rapid increase in oil-seed rape production from 7000 to 48 000 ha between 1972 and 1976. But this is a crop adapted to cool temperate conditions. Attempts to introduce semi-tropical crops such as grain maize (*Zea mais*), soya beans (*Glycine max*), navy beans (*Phaseolus vulgaris*) and sunflower (*Helianthus annuus*) at Wye College have proved less successful, although maize is now a valuable silage crop in Southern England.

Combating the climate

This experience with semi-tropical crops has emphasized the importance of climate and the fact that it is a major contributor to risk in agriculture. Temperature limitations may be combated by protected cropping under glass or plastic, but this is applicable only to high value crops. Experience with maize (Milbourn, 1975) emphasized the importance of choice of site for crops at the limit of climatic tolerance. Water shortage can be combated at a cost by irrigation but this is again practicable only for high value crops. A novel development in fruit growing has been the recent exploitation of hormone sprays to induce parthenocarpy in apples, pears and cherries and thus reduce weather dependence at pollination (Goldwin & Schwabe, 1974). And in forage farming the adoption of silage making in preference to hay making reduces, although it does not eliminate, the farmer's dependence on weather.

Introduction of new animals

The scope for new farm animals is more limited. The production of eggs and meat from poultry has been industrialized in recent years, but in a consideration of potential productivity of farm animals, Holmes (1977) indicated that there was no other farm animal with unrecognized or unexploited potential for major production in Britain.

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Introduction of new systems

There remain the possibilities of some increase in the productivity and efficiency of crops and animals by the rigorous evaluation of the components of the system and the operation of an optimal system in the field. This may result merely in a change of practice, e.g. a more intensive crop rotation, the acceptance of bull beef, of beef produced from young females which have borne one calf, or from the adoption of earlier weaning practices in pig production. At a higher level of technology it might result from the controlled induction of twinning in sheep or cattle. A more detailed application of systems methods may indicate the optimum combination of resources to maximize yield and limit the degree of risk associated with a particular system (Newton & Brockington, 1975).

Changing the nature of the product

The geneticist and plant breeder have played an important part and will no doubt do so in the future. High-lysine maize, the possibility of high-lysine barley, better bread wheats, Faba beans of high protein content, grasses with different digestibility characteristics have all been produced in recent years (Cooper, 1971).

With animal products feed-conversion efficiency is fairly highly heritable but so difficult to measure in the field that gross productivity is usually accepted. The application of rigorous selection methods based on rational measures is likely to result in further improvements in animal productivity. However, when the composition of animal products is considered homoeostasis has a much more important part to play. While a high-protein low-fat milk may be nutritionally desirable, to breed for it would be a long and probably unrewarding task (Johannsen, 1961). Similarly the likelihood of achieving any genetic change in the composition of meat animals is low.

If genetic change is impracticable technology must be harnessed. For milk, the fat can of course be extracted to yield a low-fat, high-protein product. It is also possible for the composition of the fat to be altered by the feeding of 'protected' lipids to the cow so that a higher proportion of poly-unsaturated fats appears in the milk fat (Keen & Kroger, 1975). A similar process can be adopted in meat production from ruminants, but these methods involve high technology and expense and the simpler method is to take the animals at a less advanced stage of maturity when their natural fat content is much lower, or to trim the fat carcase severely before it is eaten. The production of meat at a lower fat content also improves efficiency of feed conversion.

Implementation of a food policy

The food goals outlined by Truswell (1977) indicate that some increase in the contribution of bread grains, vegetables and fruit to the diet and some reduction in the intake of animal products, in particular animal fats, would be desirable. Such changes might demand an increase in the arable area and a reduction in the use of grains for animal feed. These are technically feasible, the greatest problem would be the provision of poly-unsaturated oils, but the changes would have major effects on the cost and profitability of farming and on the ancillary industries.

Moreover, even if the financial situation was made favourable there remain the problems of achieving the changes on the farm. British agriculture is an industry with some 166 000 full-time farmers of widely varying abilities and indeed ambitions. The Survey of Farm Incomes in England and Wales, 1974–75 (MAFF, 1976) refers to a somewhat elite population of some 2400 farms since the co-operators were prepared to provide the necessary records for the survey. Nevertheless there was still considerable variation in performance. The upper 25% showed outputs of £122 to £177 per £100 input while the lowest 25% even of these selected farms were achieving outputs of only £86–£108 per £100 input. A detailed analysis of the components of these differences and of the possible incentives and advice necessary to achieve improvements is needed before any attempt to implement a food policy is likely to be successful. The magnitude of within-farm variability is not widely appreciated. Blaxter (1976) showed that on one farm the interaction of field on years accounted for 59% of the total variation in barley yields. A similar analysis which he made on data from Wye College farm yielded almost identical results (Blaxter, personal communication).

Structural changes

Much play is made in the Common Agricultural Policy of the need for structural changes in agriculture. In the Continental European context the concern is with the many small farms. However, in Britain 94% of the farm businesses provide work for at least one full-time man and some 15% of the businesses which are large produce rather more than half the total output (Cmnd, 6703, 1977). While the Farm Management Survey referred to, shows that these surveyed farms demonstrate a slight increase in output per £100 input with increased farm size. Britton & Hill (1975) found little evidence for increase in farm productivity in farms with a work force greater than two or three men. The suggestion will be challenged by efficient large-scale farmers, but one wonders whether if high productivity per hectare were required by a hungry nation, it would not be better achieved by a large number of two to three man farms where individual enterprise can be harnessed, than on very large farms were problems of management and supervision may outweigh the economies of scale from mechanization. The structural problem in Britain may be less a matter of low productivity on very small farms but rather the maintenance of incentive and efficiency on the large farms.

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