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WYE COLLEGE
(University of London)

An Agricultural Land Budget for Britain 1965—2000

by

A. M. EDWARDS and G. P. WIBBERLEY

SCHOOL OF RURAL ECONOMICS AND RELATED STUDIES
1971

STUDIES IN RURAL LAND USE

REPORT No. 10

An Agricultural Land Budget for Britain 1965—2000

An attempt to forecast the demands for land for growing food and providing living space by the end of the twentieth century

by

A. M. EDWARDS and G. P. WIBBERLEY

Copies of this report may be obtained, price 75p post free, from Publications, School of Rural Economics and Related Studies, Wye College, Nr. Ashford, Kent.

March, 1971

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Land for New Towns. By Robin H. Best. (Town and Country Planning Association, London, 1964. 10s. 6d.)

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THE PROBLEM

The argument which follows in this research report is designed to provide an answer to a question which is usually put in simple terms: "How much land will be needed for food production in Britain by the end of this century?"

This question is being asked with increasing urgency by people who are impressed and alarmed by the continuing urbanization of the countryside. The alarm is felt and expressed partly because of a lack of knowledge as to the amount and character of rural land that will be needed in the future for home food production. It may be that, as a nation, we are using up at too fast a pace our reserves of land suitable for the production of crops and livestock products. On the other hand it could be that changes and improvements in our ability to produce food are resulting in substantial economies in the use of land so that we can accept the changes taking place in urbanization, in outdoor recreation, in regional development and in afforestation without undue concern about the overall land budget.

These are some of the reasons why research into the future uses of rural land has been pursued at Wye College over a number of years. Dr. Robin Best has been making a continuous study of the national and regional aspects of the changes taking place in the land being used and planned for urban growth. This kind of study is valuable but it is also important to know whether we can meet, satisfactorily, in the future the demands of both the urban and agricultural sectors or whether the needs of the one can only be met at the expense of the other.

The first studies on the future needs of land for food production were made by Ruth Gasson (1965) during her period as a research worker at Wye. This work related to the period 1960 to 1970 and because of the interest which the study aroused it was decided to extend the work to cover a longer time period. This has been the research endeavour of Angela Edwards, the main author of this research bulletin. Her study looks at the period from the mid-1960s up to the end of the twentieth century.

It has been necessary to identify and measure the factors most likely to affect the demands of the British agricultural industry for space. Some affect the demand for food products, others influence the supply of them. The future growth of population is a crucial factor as, in addition to creating additional demands for food, it contributes to the areas and types of land moving out of food production

into urban and recreational uses. A forecast of the likely increase in the population of the United Kingdom is therefore fundamental to the study. Given an estimate of the size of population at the end of the century the next step is to determine what the demand for food products will be. Initially, this involved forecasting the growth of personal incomes between 1965 and 2000 as these provide an estimate of consumers' purchasing power. The precise relationship between income level and the demand for food per person is, however, a complex one. The relationship between income and the demand for food products at the farm level is therefore analysed in some detail. The demand for food per person in the year 2000 is then forecast, using a consumption function which, in our judgement, accurately describes the change in food expenditure per person which will occur between 1965 and 2000.

The United Kingdom is, by experience and tradition, a food importing country and it is possible that food supplies to meet existing or future needs will come predominantly from abroad. If, however, the proportion of food which is home supplied changes, this will have a significant impact on the agricultural industry. The question of food supplies from abroad is discussed in relation to technical and economic possibilities in order to provide an estimate of changes in the level of self-sufficiency which could occur during the period of study.

These four factors affecting the demand for agricultural products produced in the United Kingdom (population growth, changes in personal incomes, the demand for different foods and supplies of food from outside the country) are then combined in a simple deterministic model to forecast the level of demand for agricultural output in the year 2000.

As to the probable supply of food products from home resources two principal considerations have been taken into account; growth in agricultural output and permanent land use changes involving agricultural land.

The agricultural industry of the United Kingdom has increased its output during most of this century, the expansion of output being particularly marked since the outbreak of World War II. Yet this has occurred over a time when the area under agricultural use in the country has been gradually diminishing. The industry is clearly not dependent on more land in order to increase production, as the use of alternative factors of production and the application of new technology has made growth in output possible without an extension of the agricultural area. This will be important in the future in terms of land planning and land competition. The growth of agricultural output is therefore discussed in relation to opportunities for expansion

and the likely rate of output growth between 1965 and the end of the century.

Agriculture faces competition for land from three main sources; urban growth, afforestation and outdoor recreation, and while agriculture has sustained a loss of land and increased output at the same time, land losses do put an additional burden on the industry. The impact of these activities on agriculture during the study period has therefore been estimated in terms of both land area and agricultural production potential.

The last stage in the research has been to combine the forecasts of supply and demand in the agricultural sector and so analyse what this means in terms of future land planning decisions. The implications form the last section of the work. Inevitably there is a good deal of personal judgement involved in forecasting growth rates for each of the various elements. In each case, however, a range of rates is presented so that some degree of flexibility is built in to the final forecasts and readers may choose the growth rates they prefer. The final forecasts present a range of possibilities and again judgement is required to interpret them and discuss their land planning implications. Presenting the evidence in this form does seem to be an essentially fairer way than giving one isolated figure which may be invalidated by the deviation of one factor from the trend forecast for it.

Finally, we suggest that our calculations and comments are valid no matter what happens in relation to the extent which this country becomes less or more fully integrated into the general economy of Europe. All European countries are facing similar problems to a greater or lesser degree in conscious and unconscious decisions as to how their land surface should be used. Part of our continuing work in rural planning in the University of London will be to note and measure the effects in the British land budget as changes in European integration became more clear cut and can be measured in a satisfactory manner.

It is hoped that this study will bring forward comment, criticism and, perhaps, more reliable data. It is intended to be a contribution to a continuing debate, not a once and for all statement of fact.

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Chapter 1

FUTURE CHANGES IN BRITAIN'S POPULATION

The demand in the future for most things is intimately bound up with the changes expected in the number of people in any society.

Population growth is in fact the major determinant of future demand. This demand covers the industrial production of goods and services, including food, and the health, welfare and educational services provided by the public sector (J. Willis, 1968). At the same time population growth creates new spatial demands which in the United Kingdom are of great significance. This demand for space is not confined to urban accommodation for the population, it also includes all the associated forms of land use such as reservoirs, roads, airports and playing fields. In addition, still more land is required for leisure and recreation in the countryside away from urban centres.

The influence of population growth on rural land use is twofold. First, it affects the demand for food and hence the required output from the agricultural industry either at home or overseas. Secondly, in its demand for space, population growth creates competition for land between agricultural and non-agricultural uses. The starting point in drawing up a "land budget" has therefore been an attempt to determine likely growth rates of the United Kingdom population during the period 1965–2000. In spite of the crucial implications of population growth for the economy, population change remains, however, notoriously difficult to predict correctly or confidently. Nevertheless, it is essential to have a reasoned estimate with which to work. Unfortunately, official population projections have fluctuated so widely from year to year (*Annual Abstract of Statistics*, 1960–9), that it has been found necessary to make an independent assessment of future growth possibilities instead of relying only on official data.

Initially, the history of population growth in the United Kingdom was investigated in order to determine whether any long-term trends were apparent which might be useful in estimating future numbers. Studies of population growth from the earliest times have been made by Colin Clark (1968) and these throw considerable light on the historical scene. Clark concludes that under medieval conditions an agricultural community would increase its numbers at the rate of 0·3 per cent per annum, while in seventeenth-century England the average rate of population growth was 0·25 per cent. per annum. These rates of growth persisted until the eighteenth century, the first

fifty years of which were marked by an almost static population. A very marked acceleration in population growth occurred around 1750 and this persisted and reached a peak in the first two decades of the nineteenth century (P. Deane and W. A. Cole, 1962). This period of rapid population growth was remarkable in two respects, the first being that a rate of population growth was achieved in Great Britain which has never since been exceeded, and, secondly, that since that period the population has shown no tendency either to stagnate or decline. Since 1801 official census data have been collected in the United Kingdom and so population growth rates up to the present time can be determined. Table 1 sets out this data, with earlier population estimates, so that long-term population changes can be observed.

The high rate of population growth initiated in the second half of the eighteenth century continued throughout the nineteenth century. At the beginning of the twentieth century this high growth rate subsided and there followed a period of relatively slow growth until the end of the 1950s. A closer look at year-to-year changes in population growth since 1930 (Table 2) makes several phases apparent. From 1931 until 1940 population grew at around 0·45 per cent. per annum. The war years, 1940–6, showed some fluctuations but, overall, the rate of growth was slow. There was a rapid but short-lived acceleration in population growth from 1947–50 as a result of a sharp increase in births after the war. During the period 1950–9 population grew steadily and the growth rate increased from 0·20 to 0·59 per cent. per annum between these years. After 1959 there was a very sharp upturn in the growth rate and between 1960 and 1962 the United Kingdom population increased by almost 1·0 per cent. per annum. Subsequently, there was a slight decline in the growth rate and it is now in the region of 0·6 to 0·7 per cent. per annum.

How far can changes in population growth since the seventeenth century be explained? Up to 1750 some degree of population equilibrium was brought about by birth rates and death rates fluctuating directly with one another at a high level. Hence, a high mortality rate was accompanied and counteracted by a high birth rate. The rapid acceleration in population growth from 1750 was caused by a change in the balance between birth and death rates, since after 1750 there was a marked decrease in death rates and yet no decline in the birth rate. In the period 1800–20 the birth rate actually rose while death rates continued to fall and this gave a period of exceptionally fast population growth. The expansion of economic opportunities and improvements in medicine and hygiene are thought to be the major factors contributing to the rate of population growth during the nineteenth century. The first half of the twentieth century

TABLE 1

Population Growth in the United Kingdom, 1701–1968

Year	Population of the United Kingdom* (thousands)	Growth Rate (% per annum compound)	Population of England and Wales	Growth Rate (% per annum compound)
1701 ..	9,406		5,826	
1711 ..	—		5,981	·2
1721 ..	—		6,001	·05†
1731 ..	—	·2	5,947	—·05†
1741 ..	—		5,926	—·05†
1751 ..	10,515		6,140	·3
1761 ..	—		6,569	·7
1771 ..	—	·7	7,052	·9
1781 ..	13,000		7,531	·7
1791 ..	14,500	1·1	8,247	·9
1801 ..	15,962	·9	9,156	1·00
1811 ..	18,103	1·3	—	—
1821§ ..	21,007	1·5	—	—
				—
1821 ..	15,472			
1831 ..	17,825	1·4		
1841 ..	20,183	1·3		
1851 ..	22,259	1·0		
1861 ..	24,525	·9		
1871 ..	27,431	·9		
1881 ..	31,015	1·3		
1891 ..	34,264	1·0		
1901 ..	38,231	1·1		
1911 ..	42,082	·9		
1921 ..	44,027	·4		
1931 ..	46,038	·4		
1941‡ ..	48,216	·5		
1951 ..	50,225	·4		
1961 ..	52,709	·7		
1968‡ ..	55,283	·7		

* Between 1701 and 1821§ the estimates for the United Kingdom include the whole of Ireland. From 1821 onwards they refer to Great Britain and Northern Ireland census data.

† Approximate.

‡ Mid-year estimates.

Sources: Deane & Cole 1962. *Annual Abstract of Statistics* 1960–9.

showed some evidence of a steadying of population increase, but two world wars and a major economic depression obscured the picture. It is the experience of the years 1959–68 which has proved atypical of the general twentieth-century trend. Some degree of explanation can be found, however, for this phase. The high birth rate may be attributed to earlier marriages and the "echo" effect of the post-war "baby-bulge". At the same time there was a sharp increase in net immigration in the early 1960s. There is no real evidence, however, as

TABLE 2

*Population Growth in the United Kingdom, 1931–68**

Year	Population (thousands)	Growth Rate (% p.a. compound)
1931	46,038	
1932	46,335	·65
1933	46,520	·40
1934	46,660	·31
1935	46,869	·44
1936	47,081	·45
1937	47,289	·45
1938	47,494	·43
1939†	47,762	·56
1939	47,991	
1940	48,226	·50
1941	48,216	—·02
1942	48,400	·38
1943	48,789	·80
1944	49,016	·47
1945	49,182	·34
1946	48,217	·07
1947	49,570	·72
1948	50,065	1·00
1949	50,363	·60
1950	50,616	·50
1951	50,290	
1952	50,431	·20
1953	50,592	·32
1954	50,765	·34
1955	50,947	·36
1956	51,184	·47
1957	51,430	·48
1958	51,652	·43
1959	51,956	·59
1960	52,372	·80
1961	52,807	·83
1962	53,314	·96
1963	53,637	·61
1964	54,008	·69
1965	54,361	·65
1966	54,654	·54
1967	54,978	·59
1968	55,283	·55

* Mid-year estimates.

† Population actually in the country.
1939–50 includes members of the forces overseas and merchant seamen at sea.

Source: *Annual Abstract of Statistics* 1950–69.

to whether these were essentially short-term phenomena or whether we were entering a prolonged phase of rapid population increase.

In an effort to clarify the situation population growth is split into its three main elements—migration, death rates and birth rates. Each is then considered separately.

Migration

For the purpose of this work only migration into or out of the United Kingdom is considered and not movements within the country. Net migration is made up of two flows—a flow of United Kingdom residents out of the country and a flow of persons from other countries into the United Kingdom. Net migration is the difference between the inward and the outward flows. The main historical movement of importance is one of net outward flow from the United Kingdom (Table 3). From 1871 to 1931 almost 4 million people left and were not replaced by immigrants. During the 1930s and the war years there was a large net inflow but immediately after the war there was a return to net emigration which persisted until about 1957. Then two changes occurred to alter the balance; emigration fell from over 200,000 to just over 100,000 a year, and a year or so later, immigration began to increase. The result was a substantial increase in net immigration which continued until about 1964. Since then government legislation, designed to limit immigration, has steadied the inward flow while emigration has increased significantly. The years 1964 to 1968 proved to be examples of net outward flow (Table 4).

As Beckerman (W. Beckerman and Associates, 1965) points out, net immigration is difficult to predict, for both elements, inward and outward flow, are liable to change. There is no foreseeable lack of potential immigrants to the United Kingdom and there should be sufficient employment opportunities within the United Kingdom for immigrants. What is likely, however, is that social rather than economic pressures will be responsible for the control of immigration. Emigration is even less easy to predict. Australia, New Zealand, Canada and South Africa offer opportunities for persons leaving the United Kingdom

TABLE 3

Migration in the United Kingdom, 1871–1966

Period	Net gain (+) or loss (−) by migration (thousands)	Annual Average (thousands)
1871–1881	−415	− 41·5
1881–1891	−960	− 96·0
1891–1901	−190	− 19·0
1901–1911	−820	− 82·0
1911–1921	−919	− 91·9
1921–1931	−672	− 67·2
1931–1939	+507	+ 63·3
1939–1948	+195	+ 19·5
1949–1951	−237	−118·5
1951–1961	+ 12	+ 1·2
1961–1966	+ 74	+ 14·8

Source: *Annual Abstract of Statistics* 1969.

TABLE 4

Estimated Emigration, Immigration and Net Migration for the United Kingdom, 1953–68 (thousands)

Year	Emigration	Immigration	Net Migration
1953	n.a.	n.a.	— 74
1954	n.a.	n.a.	— 32
1955	n.a.	n.a.	— 10
1956	220	203	— 17
1957	230	158	— 72
1958	142	187	+ 45
1959	130	174	+ 44
1960	124	206	+ 82
1961	124	294	+170
1962	127	263	+136
1963	n.a.	n.a.	+ 10
1964	273	214	— 59
1965	288	211	— 71
1966	304	222	— 82
1967	321	236	— 85
1968	278	222	— 54

n.a. = not available.

Sources: 1953–63, *Annual Report of the Oversea Migration Board* 1965
1964–8, *Annual Abstract of Statistics* 1968.

and there are no restrictions placed on United Kingdom residents leaving this country. The factors which influence emigration are somewhat volatile—"like the stock market it can be affected by the interplay of a variety of factors, some political, some economic, and sometimes by world events and sometimes by the inexplicable whims and hunches of individuals" (Oversea Migration Board, 1960). Emigration is encouraged by a combination of dissatisfaction with conditions within the United Kingdom and the attraction of other countries where conditions and opportunities seem favourable. There is some evidence to suggest that in the past the "push" factor has been stronger than the "pull" factor (B. Thomas, 1954). This may have been borne out more recently by events in 1964–6. These years were ones of increasing economic stringency in the United Kingdom and emigration began to rise significantly. A satisfactory rate of economic growth and a rapidly rising standard of living in the United Kingdom between 1965 and 2000 could well slow down the rate of emigration.

Migration will be much less important in the future in terms of its effect on population growth than it has been in the past, for it is thought that no large-scale immigration will occur unless official policy is reversed. Also, unless the improvement of social and economic conditions in the United Kingdom is severely checked, emigration will not be great. The latest official estimate published in 1969 suggests

a modest long-term net outward flow (see Appendices). In conclusion, it would appear that migration has made a significant contribution to population growth in the past and in the period 1959–63 was a major factor in pushing up the population growth rate.* In future this effect will not be so important and this will tend to depress the population growth rate to a level below that of the early 1960s.

Death rates

Like migration, the historical impact of changes in the death rate has been substantial. It was the rapid fall in the death rate after 1750 which set off the rapid population expansion of the nineteenth century. Death rates have been falling since then (see Figure 1 and Table 5), but their absolute importance in determining population changes has declined. The past fifteen years have shown only a very gradual improvement in mortality rates. No rapid change is expected and the

TABLE 5

Changes in the Death Rate, 1701–1968

Year	England and Wales Death rate per thousand population
1701–50	32·8
1751–80	30·4
1781–1800	27·7
1801–30	22·5

Year	United Kingdom Death rate per thousand population	
	Males	Females
1870–2	23·3	20·8
1880–2	20·8	18·6
1890–2	20·7	18·6
1900–2	18·4	16·3
1910–12	14·9	13·3
1920–2	13·5	11·9
1930–2	12·9	11·5
1940–2†	15·5	11·9
1950–2	12·8	11·3
1960–2	12·4	11·2
1966–8	12·2	11·0

† Based on civilian deaths only.

Sources: Deane and Cole 1962. *Annual Abstract of Statistics* 1969.

* It has been suggested that immigrant families tend to be large and hence the existence of large numbers of immigrants in the United Kingdom will push up the birth rate. Evidence, however, shows that first generation immigrants do follow the family pattern of their country of origin but second generation immigrants conform to the pattern of this country. In the long run, therefore, this will not seriously affect the birth rate.

official assumptions regarding the death rate are assumed to hold good. These implicitly allow for gradual improvements in medical technique and application but not for major and dramatic advances in knowledge.

"At ages under forty for males and under fifty for females death rates are assumed to decline over the period until after forty years they are about half the rates now being experienced. Above these ages the assumed rates of decline became progressively smaller" (*Annual Abstract of Statistics*, 1968).

There have been quite striking changes in mortality rates in specific age groups over the last hundred years. This is particularly true of the age groups 1 to 40/45 years where death rates are now extremely low and life expectancy levels correspondingly high (*Annual Abstract of Statistics*, 1968). Once the danger period of early infancy is over, death from natural causes is relatively rare until middle age is reached. Deaths due to accidents and suicide, however, have assumed much greater importance particularly among children and young adults.

The birth rate

The most significant part in the determination of population growth rates is played by the birth rate. In the late eighteenth century it was the buoyant birth rate which reinforced the decline in mortality rates to give rapid population growth. The birth rate remained high until about 1880 after which it began to decline (see Figure 1 and Table 6). The decline lasted until the 1930s when the birth rate steadied at 15·3 to 15·4 births per thousand population per year. After this steady phase the birth rate fell marginally in 1940–2 and then began to climb to give a period of high birth rates which reached a peak in 1947. The birth rate then fell until 1950, remained fairly steady from 1950 until 1956, and then began to rise slowly. 1959 marks the point when a period of high growth rates was initiated, and a peak was reached in 1964. Since then the birth rate has declined but remains at a relatively high level.

In spite of the importance of the birth rate as a major determinant of population growth it remains difficult to forecast with confidence. Changes in the birth rate are bound up with a complex of interrelating social, economic, psychological, and religious factors which it is impossible to untangle. Several determinants of the birth rate can be isolated, however, and these serve to illustrate how both demographic factors and individual behaviour and attitude can influence the birth rate. Clearly the birth rate in one period is related to the number of women of child-bearing age in the population at that time. Once this is established it is fertility which plays the most important part in determining the birth rate. Although illegitimacy is not negligible,

FIG. 1

Birth rates, death rates and population growth rate, 1870–1970.

A. Death rate per thousand population—females.
B. Death rate per thousand population—males.
C. Birth rate per thousand population.
D. Population growth rate.

TABLE 6

Birth Rate per Thousand Population, United Kingdom, 1870–1968

Year	Birth Rate	Year	Birth Rate
1870–2	35·0	1947	20·7
1880–2	33·6	1948	18·1
1890–2	30·6	1949	17·0
1900–2	28·6	1950	16·2
1910–12	24·6	1951	15·8
1920–2	23·1	1952	15·7
1930–2	16·3	1953	15·9
1932	15·8	1954	15·6
1933	14·9	1955	15·4
1934	15·3	1956	16·0
1935	15·2	1957	16·5
1936	15·3	1958	16·8
1937	15·3	1959	16·9
1938	15·5	1960	17·5
1939	15·3	1961	17·8
1940	14·6	1962	18·3
1941	14·4	1963	18·5
1942	15·9	1964	18·7
1943	16·6	1965	18·3
1944	17·9	1966	17·8
1945	16·2	1967	17·5
1946	19·4	1968	17·3

Source: *Annual Abstract of Statistics* 1969.

fertility is closely connected with the number of women who marry during their child-bearing period. Not only is the proportion of women who marry increasing, but the trend is for women to marry younger, at ages where their fertility is relatively high. "Completed" family size is the practical expression of fertility; it is influenced by both physical and sociological characteristics in the population. Women who married in the middle of the nineteenth century had an average of six live born children. At the beginning of the twentieth century "completed" family size was down to 3·5 and the fall continued to the late 1920s when family size levelled out at a little over two. At the end of the 1930s it fell to two children per family which is below the population replacement level. Family size began to increase again after World War II and is currently estimated to be 2·4 children per family. Family patterns now differ from those of pre-war for there are fewer families consisting of none or only one child, more of two or three children and fewer very large families (J. Thompson, 1969).

Information such as this does not make it possible to state categorically what fertility patterns or average family size will be in the future. There are fewer economic restraints on early marriage and family size, yet at the same time improved methods of birth control

make family planning a reality. One must remember, however, that family size was limited successfully without these aids from as long ago as 1860. In the difficult economic times of the late 1920s and the 1930s family size was reduced to two. Family size might conceivably become a question of fashion which is quite unpredictable. A recent study of fertility patterns summed up the position as follows (S. Teper, 1968).

> "What is going to happen to family size; are families going to be built at earlier ages and is the spacing between children going to be closer; to what extent will the practice of birth control spread, and what basic way is it used for family buildings; are there going to be more childless women, either through infertility or through the desire to remain economically active; how will changes in the relative numbers of males and females affect the average age difference between husbands and wives; how much further can we expect the average age of marriage to drop; to what extent will young women entering their second marriage build two separate families?"

In the face of the great uncertainty about the birth rate and about the average completed family size of the future, population estimates have become purely speculative. It is interesting to look at a series of population forecasts made recently (Table 7). Estimates published in 1960 and based on data available in 1959 suggested a population growth rate of 0·3 per cent. per annum which would give a population of 60 million in 1999. Five years later this estimate had been revised to suggest a population of 74·6 million in the year 2000, implying a growth rate of 0·9 per cent. per annum. In the last two or three years the estimate has been reduced and the latest figure suggests a population of 68·2 million in 2000. It appears that the high forecasts of 1965 and 1966 were influenced considerably by the very high birth rates of 1964 and 1965 and the more recent decline in the birth rate has been principally responsible for the downward revision of the forecasts.

Data on birth rates seem to suggest that there could be a slight long-term upward trend. This, however, will not be dramatic although quite severe fluctuations like those of 1945–9 and 1960–6 could occur around the trend.

The population growth rate

While the foregoing analysis of long-term trends in population growth through changes in the birth rate, death rate and in migration, does not provide a direct answer to the question—"how fast will population grow between 1965 and 2000?", it does give some pointers as to the likely trend. A growth rate of 0·6–0·7 per cent. per annum

TABLE 7

Population Forecasts

Year of Publication	Year of Estimation	Size of population (thousands)	Forecast Year	Growth Rate (% p.a. compound)
1960	1959	60,115	1999	·3
1961	1960	63,822	2000	·5
1962	1961	67,904	2001	·7
1963	1962	72,369	2002	·8
1964	1963	71,581	2000	·8
1965	1964	74,666	2000	·9
1966	1965	74,574	2000	·9
1967	1966	72,059	2000	·8
1968	1967	70,339	2000	·7
1969	1968	68,190	2000	·7

Source: *Annual Abstract of Statistics* 1960–9.

would be in line with past trends of population growth while allowing for the birth rate to rise slowly. Although this rate has been exceeded since 1960 there are sound reasons for thinking that this period of high growth rates is a short-term phenomenon. Therefore, for the purposes of this study population growth is forecast to be of the order 0·6–0·7 per cent. per annum (compound growth).

This rate of growth is considered as an average for the period 1965–2000 since there will obviously be year to year changes in the rate. By the year 2000 the population of the United Kingdom will, therefore, have increased by between 23·3 and 27·7 per cent. to give 67·3 to 69·7 million persons. In order to contrast the chosen rates of growth with other possible rates Table 8 sets out the range of results for a series of different growth rates. The slowest rate gives a population of 65 million while the highest rate gives a population of almost 75 million. The rates of growth forecasted could conceivably overestimate the population by three million or underestimate it by five million.

Estimates of total population are not a complete guide to consumer requirements, particularly with regard to food consumption. The composition of the population in terms of age and sex will have an influence on consumption too. Children of under 14 years and adults over 65 years consume less than adults and young persons between the ages of 14 and 65. Also, women tend to eat rather less than men. A rapidly growing population will have greater proportion of its population in the age groups 0–14 years and therefore could be expected to give less "consumer units" per thousand population than the base year population.

The change in "consumer units" in the population between 1965

TABLE 8

United Kingdom Population in the Year 2000

Rate of Growth (Per cent. per annum compound)		Population (millions)	% increase in population	% increase in terms of Consumer Units
	·5	65,006	119·1	119·1
	·55	66,147	121·2	121·2
Forecast Range	·6	67,310	123·3	122·1
	·65	68,489	125·5	124·2
	·7	69,691	127·7	126·4
	·75	70,913	129·9	128·5
	·8	72,158	132·2	129·5
	·85	73,419	134·5	131·8
	·9	74,702	136·8	133·4

and 2000 was determined by using a weighting procedure (M. Lipton, 1968) (see Appendices). "Consumer units" per thousand population in 2000 were compared with those in 1965. It was found that the lowest rates of growth on Table 8 gave no change in "consumer units" per thousand population, the forecast rates of 0·6–0·7 per cent. per annum produced 99 per cent. of the 1965 level of "consumer units" per thousand population and growth rates of 0·8–0·9 per cent. per annum gave "consumer units" 98–97·5 per cent. of the 1965 level.

Adjustments to the total population figure were made to represent the increase in population in terms of "consumer units". A population growth rate of 0·6 to 0·7 per cent. per annum produced an increase in population of 23·3 to 27·7 per cent. between 1965 and 2000 but "consumer units" per thousand population are reduced. Hence the population increase in terms of "consumer units" is 22·1 to 26·5 per cent.

A likely rate of increase in the population of the United Kingdom

It has been found necessary to estimate population increases for the period of the projection and since official estimates are variable an independent assessment of growth prospects has been made. Following a study of the available data on population the most likely average rate of population growth between 1965 and 2000 has been chosen as 0·6–0·7 per cent. per annum and this gives an increase of population in terms of "consumer units" of between 22·1 and 26·5 per cent. These estimates have been used for subsequent calculations in this study.

References

Annual Abstract of Statistics (1960–1969). H.M.S.O.

Annual Abstract of Statistics (1968). H.M.S.O.

Beckerman, W. and Associates (1965) *The British Economy in 1975.* Cambridge University Press.

Clark, C. (1967) *Population Growth and Land Use.* Macmillan.

Deane, P. and W. A. Cole (1962) *British Economic Growth 1688–1959.* Cambridge University Press.

Lipton, M. (1968) *Assessing Economic Performance.* Staples Press.

Oversea Migration Board (1960) Sixth Report. Cmd. 1243. H.M.S.O.

Oversea Migration Board (1965) Statistics for 1964. Cmd. 2861. H.M.S.O.

Teper, S. (1968) *Patterns of Fertility in Greater London.* Greater London Council Occasional Paper No. 1.

Thomas, B. (1954) *Migration and Economic Growth.* Cambridge University Press.

Thompson, J. (1969) *The Growth Phenomenon.* Institute of Biology Symposium.

Willis, J. (1968) *Population Growth and Movement.* Centre for Environmental Studies.

Chapter 2

THE GROWTH OF PERSONAL INCOMES

Though it is the absolute size of a human population which determines the potential demand for many goods the demand that is effective in the market place is governed by changes in the level of both national and personal incomes. The estimate of future population growth made in Chapter 1 was a first step in forecasting the United Kingdom demand for food by the year 2000. The next stage, tackled in this chapter, is the determination of the rate of growth in the *real* incomes* of consumers between 1965 and 2000. This will provide a measure of the spending power of the population and this can then be related to their demand for food and, later, to their demand for space.

Since the growth of personal incomes depends upon the overall growth of national income and so upon economic growth, this chapter is principally concerned with the growth prospects of the economy of the United Kingdom. Its measurement may be taken as the *real** growth of Gross National Product (G.N.P.), regardless of population size; or as G.N.P. per head of population, or, alternatively as the rate of growth of real G.N.P. per head of the employed labour force. Each of these is a useful measure, the last being an indicator of productivity; the second is a rough guide to changes in welfare.†

The preoccupation of economists with economic growth is of relatively recent origin. A principal concern of economists in the years since the original Keynesian model was introduced in the mid-1930s has been with stabilizing the economy and preventing large-scale unemployment and recession (P. D. Henderson, 1966). High levels of employment have now existed for a number of years and there has been no recurrence of "the trade cycle" as such. With variable employment, as experienced in the 1920s and 1930s, national product could fluctuate from year to year by significant amounts. In this situation increases in employment and demand brought about increases in national product. At the present time the United Kingdom

* "Real" incomes mean the purchasing power of consumers rather than simply the size of their incomes in money terms.

† Real economic welfare has been suggested to be the growth in real Net National Product (N.N.P.) per equivalent adult male (E.A.M.). Thus any increase in N.N.P. is divided by E.A.M. units in the population to measure the increase in welfare. (M. Lipton, 1968.)

economy, with almost full employment, is largely dependent on economic growth, derived from productivity, to give a greater national product. What might seem to be a small change in the growth rate of, say 1 per cent. a year, now has a considerable impact on the economy. Thus the emphasis in economic planning is on achieving a faster rate of economic growth.

What average rate of economic growth will the United Kingdom experience in the years 1965 to 2000? This is no easier to determine than the population growth rate; it is, however, subject to government intervention. All political parties are committed to encouraging the growth of the United Kingdom in economic terms, providing that this does not conflict with other aims such as full employment, stable prices, a balance of payments balance, more equal income distribution, and improved output, competition, and choice. Michael Lipton (1968), in an important study of British economic performance, analyses the interaction of growth with these other aims and suggests that, although in certain cases growth might seem to conflict with several of these aims (or vice versa), there appears to be no real reason why it should do so.*

Britain's economic performance

The long-term growth prospects of the United Kingdom can be explored in two ways. First, how has recent performance compared with the historical record; secondly, how has performance compared with that of other countries?

In terms of her historical record, the United Kingdom is doing

TABLE 9

Rates of Economic Growth in Britain in the Nineteenth Century (Real Product)

(Annual compound rate)

	Total Growth of National product	Growth of National Product per head of total population	Growth of National Product per head of occupied population
1801/11–1831/41 ..	2·9	1·5	1·5
1811/21–1841/51 ..	2·9	1·5	1·4
1831/41–1861/71 ..	2·2	1·0	0·9
1841/51–1871/81 ..	2·5	1·3	1·4
1851/61–1881/91 ..	3·2	1·9	2·0
1861/71–1891/1901 ..	3·3	1·7	2·2

Source: Deane and Cole, 1962.

* For an alternative statement see E. J. Mishan (1969).

no worse than she has in the past with the exception of a period during the nineteenth century (about 1860–90), when growth rates were unusually good (P. Deane and W. A. Cole, 1962). The broad conclusion which may be drawn from Tables 9 and 10 is that post-war economic growth in Britain has been good by historical standards. It has been argued by Knapp and Lomax (1964), that the long-term trend of economic growth may be a true indication of the growth potential of the United Kingdom economy and in this case the growth rate cannot be said to be bad. If there is some intractable feature of the British economy which permits only this rate of growth, then the United Kingdom will fall further behind other countries which have a greater growth potential. This view is not altogether shared by other economists and it has been suggested that higher growth rates can be achieved (A. Maddison, 1966; W. Beckerman and Associates, 1965; R. E. Caves and Associates, 1968; M. Abrams, 1968).

TABLE 10

Increase in Output and Productivity in the United Kingdom 1870–1967

	Growth of Gross Domestic Product (annual average compound growth rate)	Growth of output per man employed (annual average compound growth rate)
1870–1913*	2·1	1·0
1913–38*	1·1	0·7
1938–55*	1·9	1·2
1955–64*	3·1	2·6
1950–60†	2·7	2·0
1960–7†	2·9	2·5

Sources: * Maddison, 1966.
† Derived from *National Income and Expenditure.* H.M.S.O., 1968.

If a comparison of recent British economic growth is made with other countries, particularly those in Western Europe, the position looks less satisfactory (Tables 11 and 12). In the long term, too, the United Kingdom has proved to be a consistent "slow grower". Most of the countries whose long-term performance has been good, for instance Canada, and the United States, have shown relatively low growth rates in the 1950s and 1960s, while countries such as the Netherlands, France and Germany, with poor long-run records have shown high post-war growth (Knapp and Lomax, 1964). The United Kingdom performed rather better than the United States, Canada, Australia and New Zealand in the 1950s and 1960s but very much worse than her European neighbours (see Figure 2); it is the latter "gap" which is the cause for concern. If the differences in

performance can be explained then either the United Kingdom can take positive steps to improve the growth rate or it will be clear that basic differences exist between the United Kingdom economy and those of Western Europe which make faster growth out of the question. A number of economists, notably Beckerman *et al.* (1965), Maddison (1964 and 1966), and Denison (1968) have explored the possible explanations for the comparatively poor growth performance of the United Kingdom and their conclusions are now summarized.

TABLE 11

Rates of Growth of Output and Productivity in Selected Countries 1950–62

(average annual compound trend rate)

	G.N.P. %	G.N.P./head of population %	G.N.P./head of labour force %
Germany	7·2	6·2	5·1
Italy	6·3	5·7	4·7
Austria	6·0	5·8	4·9
Netherlands	4·9	2·7	3·4
France	4·4	3·5	4·2
Denmark	3·8	2·9	3·2
Sweden	3·7	3·1	3·2
Canada	3·6	0·9	1·9
United States	3·0	1·3	2·0
Belgium	2·8	2·2	2·5
United Kingdom ..	2·6	2·1	2·0

Source: Adapted from Beckerman and Associates, 1965.

Factors influencing economic growth

A characteristic feature of the faster growing countries of Europe has been the extremely high level of aggregate demand which has been maintained through the 1950s and 1960s. Although demand has not been slack in the United Kingdom there has been a cyclical volatility of demand in the economy as a result of government measures to improve the balance of payments situation. Businessmen are sensitive to current demand when making their investment decisions. A period of high and steady expansion of demand, with no periods of recession, will increase their confidence in the future and induce them to increase investment to expand capacity. This confidence in the future clearly existed in Europe but in the United Kingdom businessmen were influenced by the "stop-go" policy of the government. Maddison (1964 and 1966) suggests that the balance of payments situation, largely responsible for "stop-go" policies of demand management, has been aggravated by a number of factors other than the obvious one of Britain's competitive position. The role of sterling

as a reserve currency, the burden of the defence programme and the level of capital exports have, in his opinion, contributed to the poor British growth record. None of the faster growing European countries were hampered by such constraints.

TABLE 12

Rates of Growth of Productivity in Selected Countries, 1955–64

	Growth of Domestic Product (Annual average compound rate)	Growth of Output per person employed (Annual average compound rate)
	%	%
Japan	10·4	8·8
U.S.S.R.*	6·1	—
Germany	5·6	4·4
France	5·0	4·7
Denmark	5·0	3·8
Italy	4·7	5·7
Sweden	4·3	—
Norway	4·2	3·9
United Kingdom	3·1	2·6
U.S.A.	3·1	1·9

* 1955–63.

Source: Maddison, 1966.

A strong pressure of demand is only one side of the story. The ability of an economy to meet this demand is equally relevant to economic growth. Here, too, Britain's European neighbours have had considerable success. A number of factors which have contributed to the post-war growth of several European countries have been absent from the United Kingdom economy. Some, too, are short-run factors which although they have contributed to economic growth in the past will not be of continuing importance and offer the United Kingdom no growth opportunities for the future. There are, however, a number of growth determinants which are of long-term significance and future prospects for the United Kingdom depends upon these to a great extent.

Short-term factors will be dealt with first. Many countries in Europe had to recover from the war and its aftermath. The theory that this recovery, or catching up, accelerated growth for a long period is considered by most economists to be largely a myth (Lipton, 1968; Maddison, 1964 and 1966; Beckerman, 1965; Denison, 1968) but a well-argued alternative view has been put forward by Knapp and Lomax (1964). By the mid-fifties Italy, France, and Germany had all attained their pre-war level of output per man and they have subsequently maintained their high rates of growth. Maddison states

that "the specifically post-war recovery elements were eliminated from the growth of all countries except Japan by 1955". There appears to be no positive correlation between deviations from the long-run trend in 1950 and the growth rate which can explain the rapid growth of all countries with a good performance (Beckerman, 1965).

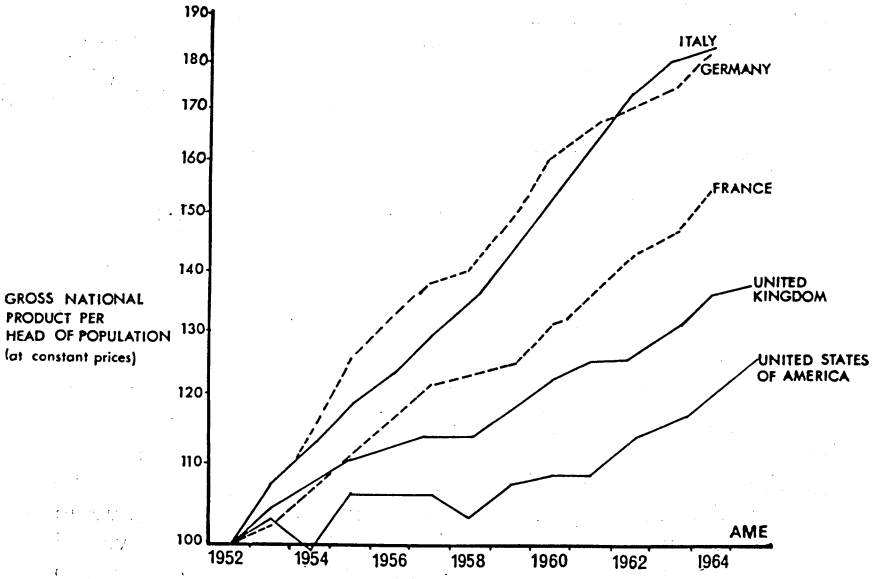

FIG. 2
National Economic Growth Rates.

It has been suggested that before 1939 the United Kingdom had a more stable economy than Italy, Germany or the United States and so the application of Keynesian ideas has had a smaller impact on her economy than it has on the others. Similarly, the poor performance of the United States in the 1950s may be explained by the slow uptake of Keynesian ideas in that country (Lipton, 1968).

Another possible explanation for comparatively slow British growth, in the short run, is concerned with the growth of capacity. Britain, in contrast to her European neighbours, particularly Germany, entered the 1950s with little spare capacity (in terms of productive equipment and manpower). Since then, capacity has, if anything, increased rather faster than total output. Thus Britain's growth performance would appear slightly better if growth of capacity rather than of output was the criterion.

The fast post-war economic growth rate in Europe, as compared with North America, can be associated with the gap in absolute productivity levels between the two regions. This gap represents opportunities which can be exploited by the relatively backward region to give higher productivity. In continental Europe the high level of demand has been concentrated on the manufacturing sector where productivity gains are more easily achieved, while in North America demand has been focused on the service sector. It is possible that in Britain rather more was required from the service sector than in other European nations and this had a depressing effect on productivity. In addition, Britain has not benefited from economies of scale to the same extent as her European neighbours. It is also generally acknowledged that the failure of the United Kingdom to join the European Common Market at its inception was unfortunate in terms of economic growth. This might, of course, be remedied, but it does represent a lost opportunity for growth in the 1950s and 1960s.

Several factors, responsible for accelerated growth in several European countries, were not present to anything like the same degree in the United Kingdom. It was therefore not within the power of the United Kingdom to obtain economic growth from these sources. In a number of countries, notably Germany, Denmark and the Netherlands, employment increased substantially in the post-war years and made a significant contribution to the growth of output. In the United Kingdom a comparable increase was not possible due to low unemployment rates, a relatively slow natural increase in population and the lack of substantial immigration. The most important aspect of the labour supply, however, has been the elimination of resource wastage by the reallocation of the labour force. The movement of labour out of agriculture and, to some extent self-employment, into industry, has been an important factor in the post-war growth of many countries. The reallocation of unproductive labour in these countries has meant that a ready supply of relatively mobile workers was available for expanding industry. It raised overall productivity, for workers moving out of agriculture and self-employment went into sectors with higher productivity. The impact of this reallocation has been considerable and it is certainly one of the reasons for the acceleration of economic growth. Britain, however, was unable to match this reduction in wastage, largely because there was much less waste to be eliminated. In 1950 only 5·4 per cent. of the employed labour force in the United Kingdom was engaged in agriculture. The proportion was 11 per cent. in Belgium, 12 per cent. in the United States, 14 per cent. in the Netherlands, 24 per cent. in Norway, 25 per cent. in Germany, 28 per cent. in Denmark, 29 per cent. in France, and 43 per cent. in Italy. In spite of a large drop in

agricultural employment in all these countries the agricultural labour force still remains relatively large and further reallocation will occur. Gains from the reduction in self-employment have followed a similar pattern, the United Kingdom again having less opportunity to reduce wastage than other countries.

There are a number of areas where the United Kingdom seems to have failed to maximize opportunities for economic growth. The sources of growth in question include quality aspects of the working force, capital investment, and what is described by Denison as residual productivity.* Other countries have succeeded in securing growth from one or more of these sources and the failure of the United Kingdom to do so has clearly influenced her growth rate.

While there was little the United Kingdom could do to increase her labour force or eliminate disguised unemployment the quality of the labour force could have been improved. Although working hours in the United Kingdom are not low, work effort and efficiency are. One of the aims of industry must be to increase working efficiency without further reducing hours. It is also essential for Britain to increase the education level of the working force. In this respect she has fallen behind the United States, though not other European countries. Evidence seems to suggest that efforts are being made in this direction and educational opportunities are being increased quite rapidly.

In the United Kingdom both the share of Gross National Product (G.N.P.) devoted to capital formation and the return on invested capital, have been lower than in the faster growing European countries, the United States, and Japan. Not only has the share of total investment in the G.N.P. been lower but also the share of enterprise investment has fallen short of that in other countries. Between 1947 and 1963 the absolute amount of investment in structures and equipment in the United Kingdom was less, per person employed in 1964, than it was in the United States or any European country except Italy. Consequently the average British worker is supported by a relatively small amount of capital (Denison, 1968). No clear reason for this low level of investment has emerged. The volatility of aggregate demand may have been partially responsible. It is also possible that the acceleration of economic growth, caused in other countries by improved resource allocation, gave rise to increased

* Residual productivity, as defined by Denison (1968), refers to "the net effect of changes not directly measured—for example, changes in the skills and initiative of managers and entrepreneurs, in the adequacy of Government services that affect productivity in the private sector, in the degree to which resource allocation departs from the optimum in respects other than those analysed and in legal and other institutional obstacles to the efficient use of resources".

investment. Faster investment is associated with higher productivity for new investment brings productivity gains because it embodies new technology. Also, a fast growing country has a smaller burden of capital replacement to carry than a slow growing one. On the whole, however, there seems little excuse for the low level of capital investment in the United Kingdom and thus no reason why greater investment should not be possible in future.

The level of productivity, or output per unit of input, is closely connected with the level of knowledge in both technology and business management. Advances in knowledge make productivity gains possible. Frequently, it is found that average practice is some way behind the best-known methods available at any time so that productivity gains will be made by narrowing this gap as well as pushing back the frontiers of knowledge. Factors which contribute to increasing productivity in this manner are largely unquantifiable and are treated by Denison (1968) as "residual productivity". He thus distinguishes between the determinants of growth such as capital and labour input, resource allocation and economies of scale which can be measured, and these "residual" sources. The level of residual productivity is higher in the United States than in any European country but it is lower in the United Kingdom than in the other European countries. Among the causes of this gap are: imperfect communication of technology and ideas, particularly in the management field, the legal and institutional setting in which management works, labour unions, restrictive practices, labour hoarding and the British attitude to work, and the misallocation of labour and capital between industries and regions (excluding the reallocation of labour from agriculture and self employment). By "catching up" on production techniques and management expertise the level of productivity can be raised. Improving efficiency and increasing "residual productivity" therefore offers the United Kingdom an important source of growth.

Prospects

The brief summary of economic growth determinants indicates areas where the United Kingdom has shown poor performance but it does not suggest that improved growth rates are impossible. On the contrary, there are a number of areas where the problem of low growth can be tackled positively. No one solution has emerged but several measures would make a positive contribution to economic growth.

The situation is neatly summed up by Abrams (1968), commenting on the growth performance of the United Kingdom in relation to other countries.

"Fortunately, however, we are now becoming aware of the many circumstances responsible for this gap—insufficient total capital investment, misdirected investment, inadequately trained management, overmanning in many basic industries, too many small scale production plants, lethargy in translating scientific and technical advances into widely diffused commercial practice. Over the next fifteen years (1968 to 1983) irrespective of the political party in power the necessary remedial stems are likely to be taken."

Given that there are improved growth prospects for the United Kingdom it is not appropriate to assume that the growth rates of the 1950s and 1960s will persist until the end of the century. On the other hand the United Kingdom cannot emulate the post-war growth performance of countries such as Germany where special conditions which accelerated growth have existed. It remains to decide, within these limits, how fast the United Kingdom economy can grow over the period 1965 to 2000.

The National Plan (1965) gave a figure of 3·4 per cent. per annum growth in output per man as a long-term possibility and Maddison (1966) broadly agrees with this. Beckerman *et al.* (1965), after suggesting that an annual productivity increase per employee in the range 3·0 to 4·5 per cent. per annum would be feasible, decided on a 3·5 per cent. per annum increase in both productivity and Gross National Product in the period 1966 to 1975. Lipton (1968), assessing British growth prospects in terms of real economic welfare (measured as growth in Net National Product divided by growth in equivalent adult male consumer units), concluded that a rate of 4 per cent. per annum would not be unreasonable. Another estimate made by Ball and Burns (1968) on "what can reasonably be expected rather than what we would like to see", gave an economic growth rate of 3·5 per cent. per annum for the 1970s. Abrams' (1968) view was that an annual rate of growth of at least 2·5 per cent. per annum is certain for the period 1968 to 1983, while 4 per cent. per annum growth might be achieved at best. His final suggestion was "roughly half way" between the two, i.e. 3·0–3·5 per cent. A dissenting view has been expressed by Knapp and Lomax (1964) who feel that it may not be possible for the United Kingdom to achieve faster rates of growth than those of the post-war years.

The general opinion, however, is that the United Kingdom can improve on her recent performance and grow at an average rate of 3·5 per cent. per annum in terms of both total G.N.P. and productivity, over the next 10 to 15 years (Table 13). It seems likely that if this rate, or something like it, can be achieved in the next decade or so then it should be possible to maintain at least this rate up to the end of the century.

TABLE 13

Forecasts of the Likely Rate of Economic Growth in the United Kingdom

	Time Period	Rate/annum
The National Plan (1965)	The long term	3·4% output per man
Beckerman *et al.* (1965)	1966–75	3·5% G.N.P. and productivity
Lipton (1968)	The long term	4·0% Growth in N.N.P. per E.A.M.
Ball & Burns (1968)	1970s	3·5% G.D.P.
Abrams (1968)	1968–83	3·0–3·5% G.D.P. and productivity
Knapp & Lomax (1964)	The long term	2·0–2·5% G.D.P.
Maddison (1966)	The long term	3·0–3·5% output per man

The influence of economic growth on personal incomes

If, in fact, a growth rate of 3·0–3·5 per cent. per annum in G.N.P. is maintained, the National Product in 2000 will be about three times its 1965 level. In terms of income per head the growth will be less rapid due to the increase in population expected between 1965 and 2000. In addition, the share of public expenditure in G.N.P. seems likely to increase to provide for greater investment, social reconstruction, education, and so on. The increase of real disposable income per head, therefore, will be somewhat more modest than the increase of Gross National Product or productivity.

In accordance with this evaluation, three levels of real income growth per head have been used for this study, an optimistic one of 3 per cent. per annum (compound growth), a more conservative one of 2·5 per cent. per annum and a rather pessimistic rate of 2·0 per cent. per annum. At a 2·0 per cent. annual rate of growth of real income per head the standard of living or real purchasing power doubles in the 35 years between 1965 and 2000. If income grown at 3 per cent. per annum purchasing power is almost trebled by the year 2000.

TABLE 14

Real Personal Disposable Income Per Head in 2000
(1965 = 100)

% annual average compound rate of income growth	1·0	1·5	2·0	2·5	3·0	3·5	4·0
Real income in 2000	141·7	168·4	200·0	237·3	281·4	333·4	394·6
	Low		Most Likely Range			High	

In order to make comparisons of the selected rates of income growth with other rates, Table 14 gives a range of different growth rates and the corresponding levels of real purchasing power which they will produce in the year 2000.

Conclusion

A study of economic growth prospects between now and the end of the century suggests that real disposable income per head in the United Kingdom is likely to increase at an average rate of 2·5–3·0 per cent. per annum. To allow for a disappointing economic growth rate, however, a rate of 2·0 per cent. has been included in the range of possibilities. Even at the lowest rate of growth, consumers would find their standard of living doubled by 2000 and, therefore, if the rate of economic growth falls within the range thought to be likely the overall demand for goods and services could increase by two to three times in the period 1965 to 2000. This will clearly have an impact on the demand for food and this is analysed in the next chapter.

REFERENCES

ABRAMS, M. (1968) "Britain: The next fifteen years". *New Society*, November 1968. No. 319.

BALL, R. J. and T. BURNS (1968) "The Prospects for Faster Growth in Britain". *The National Westminster Bank Review*, November 1968.

BECKERMAN, W. and ASSOCIATES (1965) *The British Economy in 1975.* Cambridge University Press.

CAVES, R. E. and ASSOCIATES (1968) *Britain's Economic Prospects.* George Allen and Unwin.

DEANE, P. and W. A. COLE (1962) *British Economic Growth 1688–1959.* Cambridge University Press.

DENISON, E. F. (1968) In R. E. Caves and Associates, *Britain's Economic Prospects.* George Allen and Unwin.

HENDERSON, P. D. (editor) (1966) *Economic Growth in Britain.* Weidenfeld and Nicholson.

KNAPP, J. and K. LOMAX (1964) "Britain's Growth Performance: The Enigma of the 1950s". *Lloyds Bank Review.* October 1964.

LIPTON, M. (1968) *Assessing Economic Performance.* Staples Press.

MADDISON, A. (1964) *Economic Growth in the West.* George Allen and Unwin.

MADDISON, A. (1966) "How fast can Britain grow?" *Lloyds Bank Review.* January 1966.

MISHAN, E. J. (1969) *The Costs of Economic Growth.* Penguin Books.

The National Plan (1965) H.M.S.O.

Chapter 3

THE DEMAND FOR FOOD

The growth of real income postulated in the last chapter means that by the year 2000 consumers will have command over many more goods and services than they did in 1965, and, if they choose they can increase their purchases of food. The effect of income on the demand for food is one of the principal concerns of this study since the demand for food produced in the United Kingdom is an indirect demand for farming land itself. The change in demand for food per head, combined with population growth, will therefore provide an estimate of overall demand for food in the year 2000.

With changes in income, personal expenditure patterns change and the proportion of income devoted to one product will rarely remain constant. Thus an estimate of income growth alone will give little indication of the actual changes which will occur in the demand for food.

Income is only one of the more important factors influencing a person's demand for food. A number of other factors of a social, demographic, educational and technological nature are all relevant. These do not lend themselves to systematic analysis and in consumption studies, where possible, attempts are made to exclude their influence. In this study the income/food relationship only will be investigated although it is accepted that over a period as long as 1965–2000 these other factors may have an impact.

Sources of data on food consumption in the United Kingdom

An annual analysis of personal consumption and expenditure is given in the National Income and Expenditure blue books (Ministry of Labour, 1965–8) in which expenditures on food as a whole and on particular groups of food products are included, in terms of both current and constant prices. Data showing the share of food in total expenditure in recent years can be found from this source and, for the first half of the century, from the *British Abstract of Historical Statistics* (Mitchell, B. R. and P. Deane, 1962).

The Board of Trade publishes annually the estimates made by the Ministry of Agriculture, Fisheries and Food of the total supplies of food per head moving into consumption in the United Kingdom in the previous year, with comparisons of supplies in earlier years (Board of Trade, 1967 and 1968). Similar data are available in the

Annual Abstract of Statistics (1965). Other estimates, such as calories consumed per head per day and protein supplies, are also provided by the Ministry of Agriculture and published by the Board of Trade. These data are in an aggregated form and they do not give a very accurate picture of individual consumption levels. On the other hand, they do provide the only estimates available of total supplies going into consumption.

By far the most comprehensive set of data is provided by the Annual Report of the National Food Survey Committee, *Household Food Consumption and Expenditure* (Ministry of Agriculture, Fisheries and Food, 1965 and 1966). This originated during World War II as a nutritional survey based on a limited number of household types, but in 1950 its scope was widened and it began to cover all types of households in Great Britain. Although the survey was intended originally to investigate levels of nutrition there has been, since the time of food derationing, a change in emphasis from nutritional to economic factors and, since 1955, income elasticities of demand have been estimated for a wide range of foods. This survey, as its name implies, is essentially concerned with food use in households rather than total food consumption.

Further information can be found in the annual reports of the *Family Expenditure Survey*, published by the Ministry of Labour (1965 and 1967). This source has an advantage over the National Food Survey in the number of income groups used and in the fact that average household income is used rather than the income of the head of the household. On the other hand, the *Family Expenditure Survey* does not record quantities and its commodity groupings are very broad.

The use of statistical material from household expenditure surveys is discussed in Nicholson, *Economic Statistics and Economic Problems* (McGraw-Hill, 1969) and the economics of consumption generally are dealt with in *Consumption Economics* (Burk, M., John Wiley & Sons, 1968). A great deal of this book is devoted to food consumption and it provides a comprehensive treatment of the subject. The precise relationship between income and food consumption has been analysed by Goreux (1960) using household survey data, time series and inter-country comparisons. Goreux introduces the appropriate consumption functions, used in income/food consumption studies, which are discussed later in this chapter. The budget data approach to food consumption studies has been discussed by Slater (1969) who used N.F.S. data for this work.

Trends in the consumption of food

Any statistical relationship between income and food consumption per head must be based on observable trends and *a priori* expectations as to changes which will occur. At the outset a distinction must be made between consumption in terms of physical quantities of food and consumption in terms of expenditure. Two trends will therefore be examined, the one relating to changes in the quantity of food

TABLE 15

Food Supplies Moving into Consumption in the United Kingdom
lb/Head/Annum

	Pre-war	1960	1963	1966
Dairy products (as milk solids) ..	38·4	54·6	56·0	56·4
Meat (as edible weight)* ..	118·9	122·0	131·1	129·1
Eggs and egg products (shell egg equivalent)	28·3	33·1	33·1	34·3
Oils and fats	47·1	48·6	50·2	50·4
Sugar and syrup	106·4	115·1	115·3	113·3
Fruit (as fresh equivalent) ..	138·4	145·3	141·9	145·6
Pulses and nuts	9·5	11·6	12·3	12·3
Potatoes	190·0	223·7	229·0	225·1
Other vegetables	106·9	104·9	101·1	113·5
Grain products	210·1	180·2	176·7	168·8

* All meat, including canned, etc.

Sources: *Board of Trade Journal, 1967*; *National Food Survey, 1967.*

consumed per head over time and the second to changes in the expenditure on food.

In terms of quantity the broad pattern of food consumption in the United Kingdom has shown considerable stability over the last decade or so. Overall levels of nutrition have scarcely changed since 1960 and changes in the consumption of individual food products have generally been small, although definite trends can be picked up in the case of some commodities. In order to show any important changes through time in consumption levels a comparison was made of food consumption per head in the immediate pre-war period and consumption per head in the period 1960–6. A summary of the data used can be found in Tables 15 and 16 which were derived from the *Board of Trade Journal* (1967 and 1968), the *Annual Abstract of Statistics* (1967) and the *National Food Survey* (1966 and 1967). Each commodity or commodity group was considered separately since individual foods show different characteristics and do not necessarily follow the same pattern as food as a whole.

It is clear from Tables 15 and 16 that there has been an improvement in nutritional levels since the pre-war period. The energy value of the diet has increased from 3050 to 3150 kcal and the proportion of protein provided from animal sources has increased by 8·5 g, while the intake of carbohydrate has shown, if anything, a small decline during recent years. An inter-country comparison suggests that the energy value of the United Kingdom diet of the 1960s is typical of the level attained in high income countries, for instance, the United States (Food and Agricultural Organization of the United Nations, 1967). The stability of energy intake per head during recent

years would indicate that it has reached a level where little increase is likely. As far as protein from animal sources is concerned the period 1960–6 shows some signs of a levelling-off of intake. This does not accord well with inter-country comparisons since annual protein intake in the United States and Australasia is well in excess of that in the United Kingdom. Fat intake would appear to be increasing marginally but the experience of other countries indicates that it has almost reached saturation level. Carbohydrate intake is falling and this agrees with data from international studies which show that as income levels improve the carbohydrate content of the diet falls. The level of vegetable protein in the diet has been stable during the 1960s at a level similar to that of the pre-war period.

TABLE 16

Nutrient Equivalent of Supplies Moving into Consumption in the United Kingdom (per head per day)

		Pre-war	1960	1963	1966
Energy value	(kcal)	3050	3130	3180	3150
Protein total	(g)	79·1	85·0	86·7	86·7
animal	(g)	43·1	50·0	51·7	51·6
vegetable	(g)	36·0	35·0	35·0	35·1
Fat	(g)	131	138	143	144
Carbohydrate	(g)	414	414	412	402

Source: *Board of Trade Journal, 1967.*

The consumption of dairy products is now greater than pre-war, but saturation levels appear to have been reached for a number of products within the group, thus the 1960s have shown little if any change in the consumption of liquid milk, cheese and condensed and dried milk. The exceptions among milk products are cream and yoghourt where there have been significant increases in consumption. The consumption of cream should rise still further as it has a relatively high income elasticity of demand.

Taking meat and meat products as a whole, consumption per head in the 1960s has been marginally above pre-war levels. Significant differences are apparent, however, between individual products. Beef and veal consumption has fluctuated through the 1960s, showing no marked upward trend in spite of the fact that consumption levels are well below pre-war levels. The supplies of mutton and lamb moving into consumption in the period 1960–6 were little changed from pre-war, and it is thought that there is an underlying downward trend in the demand for this meat, but its availability and relatively low price compared with those for beef and pork have maintained

consumption. The consumption of pork, like beef, has been influenced in recent years by available supplies but it is well above pre-war levels and there is a trend towards increased consumption. The most marked changes have been observed in the consumption of poultry meat. Already a good deal higher than pre-war, the consumption of this meat is rising rapidly. There seems to be a tendency for the consumption of bacon and ham, offal and meat products to level off.

The period 1960–6 showed little change in the number of eggs consumed per head but there was some increase over pre-war consumption levels. The same is true for fats considered as a group but among the different products butter and cooking oils have shown an upward trend at the expense of margarine, lard and compound cooking fat. Sugar consumption per head is declining now although it is still higher than it was before the war. The consumption of potatoes, although higher than in the pre-war period, has remained relatively stable over the last few years mainly as a result of the demand for potato products. Surprisingly, there has been little or no change in the consumption of fresh fruit or of fruit products during the 1960s and, while the consumption of fruit products is currently above pre-war levels, consumption of fresh fruit is not. More fresh vegetables are eaten now as opposed to before the war mainly as a result of the demand for green vegetables and salads. The consumption of canned vegetables has shown some increase over both the pre-war period and the early 1960s.

Among cereal products the consumption of flour, bread, oat products, and rice is falling; consumption of prepared foods such as cakes and biscuits has just been maintained and there has been a small increase in the consumption of breakfast cereals.

The overall impression is of little upward movement in the supplies of food per head going into consumption in the period 1960–6. There are, of course, exceptions and poultry-meat is the best of these. The lack of buoyant demand for a number of products, for example beef and veal and fresh fruit, is surprising, as these are products where an upward trend should be observed. On the other hand, the reduction in the consumption of cereals is very much in line with expectations. The general stability in the quantities of food going into consumption is reflected in the trend of "real value" of food purchases. Over recent years, once price changes have been eliminated, the real value of the majority of foodstuffs purchased shows little change. Poultry-meat and pork have shown an increase and bread, sugar and margarine a decrease. For other products change has been small.

Expenditure on food

Expenditure, rather than quantity consumed, is often used as a

parameter in consumption studies. It has the advantage of reducing all products to a common unit of measurement, but, on the other hand, expenditure does embody both price and quantity and changes in either or both may affect it. Since investigations made by Engel were published in 1857 it has been accepted that as people became richer the proportion of their income which is spent on food declines. In a low income group family food expenditure therefore accounts for a large proportion of income, but with growing affluence this share diminishes. Table 17 adapted from *National Food Survey* data shows that households in high income groups spend relatively little more on food than those in lower income groups. For instance, families in Group A with 3½ times the income of group D spend only one-third more on food. Observations made at a national level accord well with this, for expenditure on food per person has fallen in relation to both personal disposable incomes and total expenditure since the first half of this century. Table 18 indicates that until 1950 food purchases accounted for about a third of all consumers' expenditure while in 1965 the proportion was a quarter and more recently it has fallen to one-fifth. While the index of total consumers' expenditure rose by 18·2 index points between 1956 and 1961 and by 27·1 points between 1961 and 1966, the index of food expenditure rose by only 10·2 and 17·2 points in the respective periods (both in current terms) (M.A.F.F., 1967). The relative decline since the first half of the twentieth century is emphasized by the fact that it occurred over a period when home grown food supplies were being replaced by purchased supplies.

TABLE 17

Expenditure on Food by Income Group, 1964

Group	A	B	C	D
Index of income level	340	241	156	100
Index of household expenditure on food per week	131	111	107	100

Source: *National Food Survey, 1965.*

While food expenditure is losing ground in relation to other types of purchase it is still increasing in absolute terms. In fact actual expenditure per head on food has decreased for very few foods in recent years and the only obvious example of a product where expenditure had really decreased is margarine. For other products the growth in expenditure between 1960 and 1966 ranged from 92·6 index points for poultry-meat to 1 point for sugar. Much of the increase in expenditure which has occurred has been associated with

changes in price rather than quantity. To the extent that a rise in the price paid reflects short supply then it represents a loss in welfare to consumers. On the other hand if rising prices reflect real changes in the quality of products and the services, such as packing and processing associated with them, the consumer will consciously purchase these attributes in addition to the basic food product. Therefore expenditure on food is not wholly associated with quantity and its relationship to income will not be identical to that of quantity only.

TABLE 18

The Share of Food in Personal Expenditure, 1900–66

Year	1900	1930	1950	1956	1960	1966
At current prices (%) ..	32·6	31·8	31·1	30·9	28·1	25·1
At constant prices (%) ..	27·1	30·4	33·0	30·2	28·3	26·0

Sources: *National Income and Expenditure, 1967.*
Mitchell and Deane, 1962.

In the case of almost every food product changes in retail expenditure in response to income change are composed of movements in price paid and quantity and quality purchased. The income elasticity of demand with respect to expenditure is the sum of the income elasticity of demand with respect to quantity plus an amount which represents the income elasticity with respect to quality in as much as this is reflected by the price. The way in which this works may be illustrated as follows. Person A has an income elasticity with respect to quantity of −0·1 for cereals but an income elasticity with respect to expenditure of +0·1. If his income is 10 per cent. greater than that of person B he will include 1 per cent. less cereals in his diet but will spend 1 per cent. more on cereals than B. In fact A is paying 2 per cent. more per pound for the cereals which he buys than does B.

This element of "price" or "quality" gives food expenditure, therefore, a relationship with income which is unlike that of income with quantity consumed per head. In choosing an appropriate relationship for these two measures of consumption the following point must be borne in mind. In terms of expenditure per head on food a general increase is expected over time due principally to the non-farm content of retail food supply. As far as quantity consumed per head is concerned there will be little overall increase. There is likely to be some product substitution but it is probable that a saturation level will be reached.

The relationship between income and the per caput *demand for food*

Income growth causes changes in food consumption per head and the broad trends of food consumption have been discussed in the

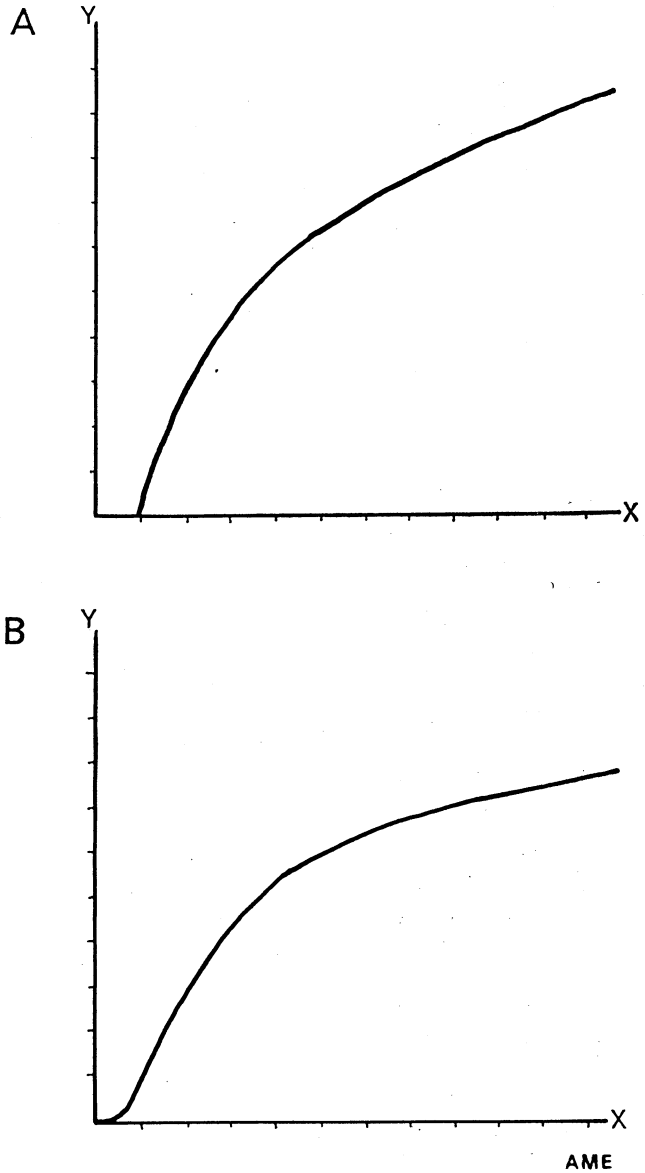

FIG. 3

Curves representing the functions used in the Demand projections.

A. Semi-logarithmic $y = a+b \log_e x$

B. Log-inverse $\log_e y = \frac{a-b}{x}$

y = *per caput* consumption.
x = *per caput* income.

previous section of this chapter. For the purposes of the projection of demand, however, a more precise statistical relationship which relates food consumption per head to income is necessary. Furthermore, this relationship must allow demand to be measured at the farm level as well as at retail for it is the demand facing the farmer which determines his demand for various factors of production, including the amount of land he would like to use.

Studies which have attempted to measure income/food relationships have been based on household surveys, on the growth of income over time within a country, and on inter-country comparisons where a range of incomes can be observed. Although it is specifically the growth of income over time and its relationship to food consumption which is relevant to this study, the experience of all three types of approach has been used in this research.

The influence of income on food consumption per head can be measured by deriving a "consumption function".* The most common, and hence familiar, method of describing such a function is to use the income elasticity coefficient which measures the percentage change in consumption corresponding to a 1 per cent. change in income. This coefficient is the logarithmic derivative of the consumption function and has the advantage of being a non-dimensional number that is independent of units of measurement. Thus income elasticity coefficients may be compared directly for different commodities and different countries (Goreux, L. H., 1960).

The income elasticity of demand for food

The first stage in the projection is to find the appropriate income elasticity coefficients for the United Kingdom. These are largely derived from *National Food Survey* data (M.A.F.F., 1966 and 1967). The *National Food Survey* elasticity estimates are computed from cross sectional data at one point in time. Because the income range considered within one year is so narrow, a double log function which implies constant elasticity is used. It is noticeable, however, that there have been significant changes in the *National Food Survey* elasticity coefficients between years, the coefficient having fallen from 0·3 in 1955 to 0·2 in 1967. In this study where comparatively large income changes are projected the double log function is not appropriate. However, Goreux (1960) points out that, within the income range of the observations taken in consumption studies, a number of functions fitted to the data come very close together and around the mean the elasticity estimates are similar. Elasticity estimates derived from

* A consumption function is an algebraic or graphical description of the relationship between consumption per head and income.

the *National Food Survey* were therefore used as the best estimates of income elasticity of demand for 1965.*

The *National Food Survey* produces two sets of elasticity estimates, one of income elasticity with respect to expenditure at the retail level and the other of income elasticity with respect to quantity purchased. For individual products the difference between the two elasticities roughly corresponds to the elasticity of demand for quality changes. Generally, the expenditure elasticity is higher than the quantity elasticity. In high income countries the difference between the income elasticity of demand at the retail level and that at the farm gate is quite large. Inter-country comparisons have shown that as income or total expenditure rises so the difference between the elasticity at the farm gate and that at retail increases. This is due to the increase in marketing services which are associated with retail food purchases. At present in the United Kingdom it is estimated that marketing services account for 50 per cent. of the value of retail food purchases. The farmer's share of the retail price therefore averages 50 per cent. although it varies from over 60 per cent. in the case of liquid milk and eggs to 10–15 per cent. for cakes and biscuits. If marketing margins were to remain proportionately the same up to the year 2000, then farm gate elasticity would not change in relation to that at retail. Marketing margins are, however, expected to increase still more, reflecting the consumers' demand for better packing, processing and preparation of food. This trend is already apparent in the *National Food Survey* data relating to "convenience foods". Taking an index of the real value of food purchased, purchases of "convenience foods" increased from 92·0 in 1955 to 122·8 in 1966, while "all foods" moved only from 99·6 to 106·5 during the same period (M.A.F.F., 1967). Convenience foods now account for one-fifth of total household food expenditure and they may well amount to as much as one-third by the year 2000. Some impression of the future in the United Kingdom may be gained from the experience of the United States where currently only about 36 cents out of every consumer dollar spent on food goes to the farmer (Burk, 1968). It seems logical to expect that the disparity between expenditure at the farm gate and that at retail will increase.

Bearing these points in mind two income elasticity coefficients were derived. The first was the income elasticity of demand for food products with respect to expenditure at retail. The estimate differed slightly from the *National Food Survey* estimate since tropical products

* The O.E.C.D. (1969), using time series data on food consumption, obtained results which differed significantly from those of the National Food Survey. Their estimates did, however, include the effect of prices and other factors in addition to income changes over time.

TABLE 19

Income Elasticity Coefficients for the United Kingdom

	1957–9	1961–3	1965
N.F.S. income elasticity with respect to expenditure on all food	0·28	0·27	0·23
F.A.O. income elasticity with respect to farm value	0·24	0·19	0·165*
Difference	0·04	0·08	0·065

* Estimate derived in present study (not an F.A.O. estimate).

and fish were excluded and a slight adjustment was made for total as opposed to household consumption. The elasticity for 1965 was estimated at 0·20. The second was an income elasticity of demand with respect to the farm value of food products. This was of greatest relevance to the present study since it connected income growth with changes in demand at the farm level which is the relevant factor in the demand for farmland. The elasticity was derived by weighting the income elasticity with respect to quantity for each food product by its contribution to gross farm income. A correction was made for food imports into the United Kingdom. The income elasticity of the farm gate value of food was computed at 0·165. The procedure was in line with estimates made by the Food and Agriculture Organization of the United Nations in the past (F.A.O., 1962 and 1967) and the coefficient derived fits well with these (Table 19).

The consumption function

No one consumption function has been found which is adequate to describe all aspects of the income/food relationship. There are marked differences between foods, countries, points in time and according to the range of incomes used. Generally a function is chosen according to the economic interpretation of the function and the statistical accuracy of the fit, with the rider that computation should not be too difficult (Goreux, L. H., 1960, and Slater, J. H., 1969). In the present case consumption functions are required which will be adequate to describe the change in food consumption in terms of farm gate value and in terms of expenditure per head at retail which will occur as a result of changes in incomes between 1965 and 2000.

While the choice of function over a narrow income range is not crucial it is essential for long-term projections to choose the appropriate function. The choice was made with reference to the broad trends observed earlier and to studies made by the Food and Agriculture Organization of the United Nations (F.A.O., 1962 and 1967). For

the projection of retail expenditure per head a semilogarithmic function was used. This fits in well with *a priori* reasoning regarding retail expenditure since it implies a decline in the relative value of the income elasticity coefficient proportional to changes in consumption though it does not reach any level of saturation. The log-inverse function was chosen for the projection of demand in terms of farm value. This function implies a decline in the absolute value of the elasticity coefficient proportional to the increase in *per caput* income. When income tends to infinity the income elasticity tends to zero and consumption is at saturation level. The characteristics of the two functions are shown in Figures 3A and B and the relevant formulae for each in Table 20.

TABLE 20

Consumptions Functions Used

	(a) Semilogarithmic	(b) Log-Inverse
Function	$y = a + b \log_e x$	$\log_e y = a - \frac{b}{x}$
Marginal Prosperity to consume	$\frac{b}{x}$	$b\frac{y}{x^2}$
Coefficient of Elasticity*	$0{\cdot}4343\frac{b}{y}$	$2{\cdot}3026\frac{b}{x}$
Increase in Demand†	$\frac{y^1}{y} - 1 = 2{\cdot}3026\, n \log_{10}\frac{x^1}{x}$	$\log_{10}\frac{y^1}{y} = 0{\cdot}4343\, n\,(1-\frac{x}{x^1})$

* In terms of $\log_{10}$. If Napierian logarithms are used the formulae for the two functions are (a) $\frac{b}{y}$ (b) $\frac{b}{x}$ for the elasticity coefficient.

† and (a) $\frac{y^1}{y} - 1 = n \log_e \frac{x^1}{x}$ (b) $\log_e \frac{y^1}{y} = n\,(1-\frac{x}{x^1})$ for the increase in demand.

x = *per caput* income in base period.
y = *per caput* consumption in base period.
n = elasticity coefficient.
x^1 = *per caput* income at end of projection.
y^1 = *per caput* consumption at end of projection.

Source: F.A.O., 1967.

The demand projections

The value of *per caput* demand in the year 2000 as an index of demand in 1965 was derived from the appropriate demand formulae in Table 20 combined with the elasticity coefficients and the levels of income growth chosen in Chapter 3. The results appear in Table 21. While the level of real income in the year 2000 is estimated to be 2–3 times its level in 1965, relatively small changes are projected in the demand for food per head. Retail expenditure grows more quickly than the farm value of food, being between 14 and 21 per cent. greater than in 1965 depending on the income assumption made. The

increase in demand for food valued at the farm gate level is only a little over half that at retail, ranging from 8·6 for the low income growth rate to 11·6 for the highest one. This implies that increased real incomes will have little impact on farmers in terms of overall demand. There will be product substitution and the demand for meat is likely to be strong while that for cereals going into human consumption will be declining.

TABLE 21

Demand for Food Per Head in the Year 2000

(1965 = 100)

Income growth rate (% per annum compound)	2·0	2·5	3·0
Per caput income in 2000 ..	200·0	237·3	281·4
Per caput retail expenditure ..	113·9	117·3	120·7
Per caput demand in terms of farm gate value	108·6	110·0	111·6

The level of total demand expected in 2000 is calculated by multiplying the *per caput* demand in that year by the population size projected for that year, corrected for a change in consumer units. The levels of total demand generated can be seen in Table 22. According to the rates of population and income growth chosen the demand projections range from an increase of 32·6 per cent. to one of 41·0 per cent. The greatest part of this demand is produced by population growth alone.

TABLE 22

Demand Projections for the Year 2000 Combining Population and Income Effects

(1965 = 100)

	Rate of Income Growth (% per annum compound)		
Rate of Population Growth (% per annum compound)	2·0	2·5	3·0
0·60	132·6	134·3	136·3
0·65	134·9	136·6	138·6
0·70	137·3	139·0	141·0

An increase in the demand for farm products increases the demand for agricultural land. If one were to assume no resource substitution or technological advance then by the year 2000 between 32 and 41 per cent. more land would be required to feed a larger and more affluent population.

References

Annual Abstract of Statistics (1966) H.M.S.O.

Board of Trade Journal (1967) *Food consumption levels in the United Kingdom in 1966.* June 1967.

Board of Trade Journal (1968) *Food consumption levels in the United Kingdom in 1967.* July 1968.

Burk, M. C. (1968) *Consumption Economics.* Wiley.

Central Statistical Office (1965–8) *National Income and Expenditure.* H.M.S.O.

Food and Agricultural Organization of the United Nations (F.A.O.) (1962) *Agricultural Commodities—Projections for 1970.*

Food and Agricultural Organization of the United Nations (F.A.O.) (1967) *Agricultural Commodities—Projections for 1975 and 1985.* Vols. 1 and 2.

Goreux, L. H. (1960) "Income and Food Consumption". *Monthly Bulletin of Economics and Statistics.* Vol. IX, No. 10.

Ministry of Agriculture, Fisheries and Food (M.A.F.F.) (1966 and 1967) "Household Food Consumption and Expenditure". *Annual Report of the National Food Survey Committee.* H.M.S.O.

Ministry of Labour (1965–7) *Family Expenditure Survey.* H.M.S.O.

Mitchell, B. R., and P. Deane (1962) *Abstract of British Historical Statistics.* Cambridge University Press.

Nicholson, R. J. (1969) *Economic Statistics and Economic Problems.* McGraw-Hill.

Organization for Economic Co-operation and Development (O.E.C.D.) (1969) *Demand and Supply Projections for Agricultural Products in the United Kingdom.*

Slater, J. H. (1969) "Regional Consumer Expenditure Studies using National Food Survey Data". *Journal of Agricultural Economics.* Vol. XX, No. 2.

Chapter 4

FOOD SUPPLIES FROM ABROAD

For over a century the United Kingdom has been a major importer of food and other agricultural products. Imports of food, which started relatively slowly after the repeal of the Corn Laws in 1846, built up rapidly as the agricultural potential of North America, Australia and New Zealand was realized and improved transport facilities brought the food quickly and easily to the United Kingdom. The share of home production in total supplies gradually dwindled and by the 1930s over 60 per cent. of United Kingdom food supplies came from abroad (Ministry of Agriculture, Fisheries and Food, 1968). These years coincided with an overall agricultural depression in the United Kingdom and it was also a period when the area of land moving from agriculture to urban use ran at a very high level (R. H. Best, 1968).

The relative unimportance of home agriculture in the total supplies of wheat and barley, beef, veal, mutton and lamb, pig meat, cheese, butter and eggs in the years between 1900 and the outbreak of the Second World War can be seen in Table 23.

There was an improvement in the level of self-sufficiency of a number of products during the last war but in some cases, for instance beef and veal, this was due to an overall reduction in consumption

Table 23

The Share of Home Production in Total Food Supplies in the United Kingdom 1900–45

(Home production as a % of the total supplies)

	1905–9	1924–7	1936/7–8/9	1944/5
Wheat	24·8	21·0	22·7	44·8
Barley	59·8	57·3	46·2	100·0
Sugar	—	6·2	17·9	23·5
Potatoes	92·0	88·0	95·9	100·0
Beef and Veal	52·6	43·2	49·1	65·4
Mutton and Lamb	51·5	44·2	35·9	25·3
Pork	35·8	32·1	77·7	10·4
Bacon and Ham			29·3	26·9
Butter	13·0	13·0	8·9	9·7
Cheese	24·2	23·1	24·1	7·5
Eggs	32·4	44·6	61·2	43·7

Source: M.A.F.F. 1968, *A Century of Agricultural Statistics.*

rather than a substantial increase in home production. Pig meat production was actively discouraged during the war and this accounts for the large drop in self-sufficiency.

After the war the domestic agricultural industry continued to increase its contribution to total food supplies in spite of the steadily growing demand for food due to population growth, derationing and a number of other factors. Table 24 indicates how the share of home agriculture in total supplies has improved. A recent analysis of food and agricultural imports into the United Kingdom also indicated a gradual improvement in self-sufficiency over the period 1955–67 (A. H. J. Baines and L. J. Angel, 1969). In spite of this improvement, food from abroad still makes up a very important part of the national food supply and imports of agricultural raw materials are substantial. The United Kingdom depends on agricultural land abroad for a good deal of food and, in a sense, is using large areas of land abroad as a substitute for agricultural land at home.

TABLE 24

The Share of Home Production in Total Food Supplies in the United Kingdom 1953/4–1967/8

(Home production as a % of total U.K. Supplies)

	1953/4	1960/1	1965/6	1967/8
Wheat	40·9	39·8	47·2	49·0
Barley	66·8	81·7	97·7	98·8
Sugar	19·4	29·5	28·5	30·0
Potatoes	97·8	96·2	96·2	95·3
Beef and Veal	65·8	65·4	72·1	78·6
Mutton and Lamb ..	35·4	38·4	44·4	54·1
Pork	88·3	95·2	96·9	97·4
Bacon and Ham ..	43·0	32·6	46·4	34·3
Butter	9·2	10·6	8·2	9·3
Cheese	27·5	47·3	43·8	40·6
Eggs	80·2	92·5	96·4	96·4

Sources: M.A.F.F. 1968, *A Century of Agricultural Statistics.*
M.A.F.F. 1969, *Annual Review and Determination of Guarantees.*

There has always been controversy as to the part home agriculture should play in the economy. Arguments for an agricultural expansion and greater self-sufficiency have been matched by those claiming that a small agricultural industry and greater supplies of foreign food, releasing more resources for export industries, would serve the economy best (E. A. G. Robinson and R. L. Morris, 1950; A. Winegarten and T. Josling, 1969). Current thinking, largely influenced by the balance of payments situation, favours a selective agricultural expansion so that home supplies will make up a greater part of total food supplies. A number of recent economic analyses

seem to support this view but any quantitative study is hampered by a lack of evidence as to changes which could occur in our terms of trade, the elasticity of demand for our exports and the changing productivity of resources moving from agricultural to non-agricultural sectors (L. Moore and G. H. Peters, 1965). It is clearly a complex situation in which all the economic implications have not been fully worked out. Nevertheless, the National Plan (1965) and more recently the Select Committee on Agriculture (1969) and the E.D.C. report "Agriculture's Import Saving Role" (1968) have supported a selective expansion programme for British agriculture. The E.D.C. report went into the technical details of such an expansion but it neglected existing British international food-buying commitments and any repercussions which might occur in the international market for both food and non-food products by greater British food self-sufficiency.

Any expansion programme implies the use of more resources in the home agricultural industry and this has obvious implications on the use of rural land. Some of these are dealt with in this chapter.

The present pattern of food imports

About 40 per cent. of all the imports entering the United Kingdom have their origin in agriculture but many of them are industrial raw materials such as wool, hides and skins, textile fibres, crude rubber and tobacco rather than the food or feed products with which this study is mainly concerned. The level of food and feed imports into the United Kingdom in 1965 and 1966, which will be taken as a base period, can be seen in Table 25.

TABLE 25

United Kingdom Imports of Food, Feed and Live Animals

	Value (£m.)	
	1965	1966
Live animals (ex. horses)	38·1	40·1
Meat and meat preparations	367·7	374·3
Dairy products and eggs	208·0	195·0
Fish and fish preparations	67·6	62·0
Cereals and cereal preparations ..	231·7	221·6
Fruit and vegetables	288·0	312·6
Sugar, sugar preparations and honey..	102·6	106·5
Coffee, tea, cocoa and spices	155·6	159·9
Feedingstuffs for animals (ex. unmilled cereals)	75·8	68·7
Miscellaneous food preparations ..	26·4	22·6
Total (ex. fish)	1494·0	1501·2

Source: *Annual Abstract of Statistics* 1967; and *Overseas Trade Accounts* 1966.

Total imports of food and feed (excluding fish since it is of non-agricultural origin), amounted to £1,500 millions in 1965/6 (*Overseas Trade Accounts*, 1966; *Annual Abstract of Statistics*, 1967). In terms of net foreign exchange cost the figure is a little lower since some of the freight and insurance cost is payable to British carriers. An addition should be made, however, for the share of imported animal oils and fats which go into human food and for the products of the oilseed crushing industry which make a significant contribution to animal feed. This gives a total food and feed import bill of about £1,540 m. which represents 27 per cent. of the total imports entering the United Kingdom.

This figure is often compared directly with the gross output of United Kingdom agriculture which, when adjusted for government subsidies and non-food products, amounted to £1,506 millions in 1965/6 (*Annual Abstract of Statistics*, 1967). On this basis the United Kingdom imports somewhat over half her total food requirements. Such a comparison, however, tends to understate the contribution of home agriculture for the following reasons. There are exports and re-exports of food and feed products from the United Kingdom. These totalled £155 millions in 1965 and £169 millions in 1966 (*Overseas Trade Accounts*, 1966). Re-exports contain little or no processing extra to that which they contain on importation, but United Kingdom food exports are to a great extent highly processed and their agricultural value is thereby overstated. Adjustments made for this factor suggests that the United Kingdom exports or re-exports of food products were worth £75–£80 millions at farm value in 1965–6. This reduces the cost of food imports to a net figure of £1,460–£1,465 millions. Some imported products are, in fact, processed to some degree, for instance, butter and cheese, canned meat and fruit, refined sugar and so on. They are, therefore, not strictly comparable with United Kingdom farm gross output valued "at the farm gate". A certain amount of grain, both home produced and imported, goes into malting and distilling and is therefore not contributing to the supply of food; in addition, large quantities of spirits are exported each year.

In spite of these corrections the United Kingdom is still only a little over 50 per cent. self-sufficient in food products. Superficially there appear to be plenty of opportunities for home producers to improve their share of the total market for many individual foods. On examination, however, these opportunities are not as great as they appear at first sight (Table 26).

Replacement possibilities

Initially there are a large group of food products which cannot

be replaced by home agriculture either directly or by the substitution of a home produced product. In this category are tropical fruits and vegetables, coffee, cocoa, tea, spices, and rice—net imports of which totalled £300 millions in 1965/6. Therefore, while there is an effective demand for these products in the United Kingdom, they must be imported.

The products which are imported for animal feed form an important and interesting section. First, wheat, barley, oats and cereal offals (imports of which for animal feed alone totalled £21·1 millions in 1965/6) can be replaced directly by home production. The remain-

TABLE 26

Replacement Possibilities for the United Kingdom Agricultural Industry

1965/6	£m.
Net imports of food and feed	1,460–1,465
Tropical products:	
Fruit and vegetables	165
Coffee, tea, cocoa and spices	130
Rice	6
Oil seeds and oil nuts	35
Oil cake	40
Non agricultural:	
Fishmeal	20
Total non-indigenous products	396
Potentially replaceable imports of food and feed	1,065–1,070
Replacement possibilities:	
Maize	66
Other cereals (soft wheat, offals, barley, oats)	70
Beef and veal	75– 80
Mutton and lamb	5– 10
Poultry meat and pork	6
Bacon and ham	135
Other meat and meat products	70
Dairy products	200
Live animals for food	20
Fruit and vegetables	50– 60
Miscellaneous food preparations	21
Sugar, honey, mollasses, etc.	105
	823–843
Replacement difficult due to seasonality and quality differentials:	
Maize	11
Hard wheat	72
Lamb (from Australia and New Zealand)	60– 65
Meat products	15
Fruit and vegetables	80
Miscellaneous food preparations	4
	242–247

ing cereals imported for feed are maize and sorghums, both of which are non-temperate grains and unlikely, as yet, to be grown in the United Kingdom in significant quantities. These grains can be replaced by home-grown wheat and barley and thus the £70 millions of maize and sorghums used for animal feed in 1965/6 is potentially replaceable. Imported oilcake, and oilcake from the United Kingdom oilseed crushing industry form an important source of vegetable protein animal feed. In 1965/6 £40·4 millions of oilcake was imported, providing about three-quarters of all the oilcake used for animal feed in that period (M.A.F.F., 1964). This kind of high protein feed is rather difficult to replace by a home-produced farm product, since, for example, neither field beans nor oilseed rape quite suit the requirements of feed compounders. The other main protein source, particularly important in pig meat production, is fish meal and fish flour. In 1965/6 375 thousand tons of this were used for feed of which 300 thousand tons, worth £20 millions, were imported. The possibilities for substantial import replacement of either oilcake or fish meal by the products of United Kingdom agriculture are small. Synthetic amino acids are relatively expensive and the feeding of urea, as a nitrogen source, to ruminants is still little further than the development stage. The oilseed crushing industry itself is running down as the oilseed-producing countries are developing their own crushing capacity. Thus initially any replacement of imported high protein feed by home resources will be to replace reducing supplies of home-produced oilcake. In the long run, the continuing world protein shortage will force countries to look for protein sources other than traditional ones. The petroleum industry is beginning to find ways of producing protein from the by-products of oil refining and this could be an important source of protein for the future (T. R. Morris, 1968). Basically, however, the agricultural industry itself will not be able to replace completely imported high protein feeds.

Although sugar is often thought of as a tropical crop, the United Kingdom sugar beet industry now supplies one-third of the sugar requirements of the United Kingdom. Imports of sugar and similar products cost around £100 millions per year, yet replacement possibilities are not as great as they may seem. In the first place, the United Kingdom has a trade agreement with Commonwealth sugar producers which guarantees them a market. This commitment, together with home production, accounts for most of the sugar market. Secondly, although over the years the United Kingdom sugar beet industry has become very much more competitive in relation to traditional sugar suppliers such as in the West Indies, in future it will be facing growing competition from highly efficient producers in Australia and Africa. The part which the home sugar

beet industry will play in future depends as much on political as technological factors. There could be some import replacement but anything approaching complete self-sufficiency is unlikely.

All of the remaining categories of food imports are, or are produced from, temperate crops and, in theory, they could be produced in the United Kingdom. In some cases, however, there are important quality and seasonal differentials between home and imported products which makes import replacement difficult.

The total value of imported unmilled wheat, barley and oats in 1965/6 was £115 millions. There were exports of barley totalling £5 millions in 1965 and £24 millions in 1966, and these make the net import figures rather lower. Practically all the imports of barley and oats go into livestock feed, together with £13–£14 millions of wheat, and they can therefore all be replaced, in theory, by home-grown grain. The £95 millions of unmilled wheat and £8–£9 millions of wheat flour are used for human food. Wheat is divided into categories according to its suitability for breadmaking. "Hard" wheat possessing the properties required by the baking trade is grown principally in North America and cannot be produced in the United Kingdom in large quantities due to the unsuitable climatic conditions. Until the baking trade can replace some or all of the "hard" wheat they use, it has to be imported. "Hard" wheat imports in 1965 were valued at £82 millions and in 1966 at £68 millions.

Almost £20 millions of maize were used for purposes other than animal feed of which brewing and malting accounted for £9 millions, and starch, breakfast cereals, and glucose production for £11 millions. The £9 millions going into brewing and malting could probably be replaced but the balance would present more difficulties. Imports of cereal preparations cost about £5 millions in 1965/6 and these would be largely replaceable.

In spite of the fact that the United Kingdom has been facing overproduction of milk and eggs for a number of years, dairy products and eggs accounted for almost £200 millions of net imports in 1965/6. Butter and cheese make up the bulk of imports, while other milk products and eggs account for only a very small proportion. Butter imports in 1965/6 ran at £140 millions. The United Kingdom share of the home butter market is only 8–9 per cent., and she produces 45 per cent. of total cheese supplies. This is certainly an area where home-produced supplies could gain a greater share of the market, although this would imply some reorganization of the home dairy industry. The United Kingdom has recently given assurances to the countries principally supplying her with dairy products that there will be no great encouragement of the United Kingdom dairy industry. It is assumed, however, that any expansion of home production would

be gradual and the impact on suppliers would not be too great.

The production of more meat to replace imports offers considerable scope to the United Kingdom agricultural industry as net imports in 1965/6 were worth around £350 millions. Very little pork or poultry meat is imported so little import replacement is possible in these sectors. But, with beef imports costing £75–£80 millions in 1965/6, mutton and lamb £65–£70 millions, offals £30 millions, bacon and ham £135 millions and other meat products £45–£50 millions, opportunities for some replacement are obvious. In addition, live cattle are imported either fat or in store condition and these could also be replaced. There are, however, some barriers to replacement due to seasonality of supplies to the market. For example, New Zealand and Australian supplies of lamb phase in well with English supplies and appear in the shops when little English lamb is available. Thus some £60–£65 millions of lamb would be difficult to replace without some reorganization of production and marketing.

At present the bacon market sharing agreement exists between Denmark and the United Kingdom but this should not prove to be a barrier if additional bacon supplies of the right quality are forthcoming from home sources.

Imports of all fruit and vegetables totalled approximately £300 millions in 1965/6 but of these £165 millions were tropical products. The remaining £135 millions are not all replaceable since the seasonality of supply of certain imported products is crucial. Apples from Australia and New Zealand, early supplies of new potatoes, and out-of-season tomatoes, are examples of such products. Replacement possibilities confined to temperate imports entering the United Kingdom in the home marketing season are valued at £50–£60 millions.

In the section named "miscellaneous food preparations" the bulk of imports consist of lard and margarine. Home production could largely replace imports of these products costing £21 millions in 1965/6.

Overall replacement possibilities are summarized in Table 26. Initially almost £400 millions of food and feed imports are non-temperate leaving a little over £1,000 millions as potentially replaceable. If products which would not be readily replaced due to seasonality, quality and so on are excluded approximately £820 millions of food and feed imports remain as potentially replaceable, if all sugar is included. Excluding sugar, £720 millions are replaceable.

Increased self-sufficiency in relation to the demand for farm land

In 1965/6 the United Kingdom, although it imported half of all food supplies, was 60 per cent. self-sufficient in temperate or replace-

able food products. A greater degree of self sufficiency has been proposed as being politically and economically desirable and also technically feasible (in as much as home-grown products would be complete or acceptable substitutes for many imported ones). Any increase in self-sufficiency does, however, imply a greater demand for agricultural resources and hence creates extra pressures on farm land.

In the National Plan (1965) the broad strategy for greater self-sufficiency was that home agriculture should attempt to meet any increases in demand which occurred as a result of growth in both population and incomes. This would raise the overall level of self-sufficiency and at the same time it would avoid the possibility that actual cutting back on existing imports of food might produce difficult trading repercussions in overseas countries. As this approach is linked with specific increases, it does put a ceiling on the level of food self-sufficiency which can be attained. In practice, however, it makes little difference as to how the increase in self-sufficiency is derived since the impact on the agricultural industry will be the same in either case. For example, if the United Kingdom level of self-sufficiency in temperate food products is to rise from 60 per cent. to 63 per cent. home agriculture will be faced with a 5 per cent. increase in demand. Taking 60 per cent. as our bench mark for 1965 we can estimate the effect of increased self-sufficiency on the demand facing home agriculture, using the demand projections derived at the end of Chapter 4. The results appear in Table 27.

To illustrate the impact of increased self-sufficiency Table 27 shows only three levels of demand, high, medium and low, as generated by population and income growth between 1965 and 2000. (A more detailed table can be found in the appendices.) A modest improvement

TABLE 27

The Impact of Greater Self-Sufficiency on the Likely Demand for Home Farm Output

(As a proportion of the situation in the year 1965)

Assumptions	Low	Medium	High
Income Growth ..	2·0	2·5	3·0
Population Growth ..	0·60	0·65	0·70
Demand Generated ..	132·6	136·6	141·0
Degree of Self-Sufficiency in food supplies in the year 2000			
60	133	137	141
65	144	148	153
70	155	160	164
75	166	171	176
80	177	183	188

in self-sufficiency of 5 per cent. would create an additional demand for farm output of 11–12 per cent. so making an overall increase of 44–55 per cent. by the year 2000. If self-sufficiency in food were to attain a level of 75 per cent. (which would in fact imply meeting all the increase in demand between 1965 and 2000 plus cutting back a little on base year import levels), then the overall increase in demand would be 66–76 per cent., of which 33–35 per cent. would be the result of greater self-sufficiency. If we assume that substantial increases in the United Kingdom level of self-sufficiency will probably not be attained, it would be more realistic to look at the range of 65–70 per cent. self-sufficiency in temperate and replaceable food and feed products. This suggests that the demand for home farm output would grow by around 50–65 per cent. between 1965 and 2000.

Any marked replacement of imported food and feed by home agriculture will clearly create quite substantial pressures on agriculture in addition to those that will be produced by population and income growth alone. This will inevitably have an effect on the demand for agricultural land and the intensity with which it is used.

References

Annual Abstract of Statistics (1967). H.M.S.O.

Baines, A. H. J., and L. J. Angel (1969) "The measurement of self-sufficiency in food and agricultural products". *Economic Trends*, No. 190.

Best, R. H. (1968) "The extent of urban growth and agricultural displacement in post-war Britain". *Urban Studies*, Vol. 5, No. 1.

Economic Development Committee for Agriculture (E.D.C.) (1968) *Agriculture's Import Saving Role.* N.E.D.O.

Ministry of Agriculture, Fisheries and Food (1968) *A century of Agricultural Statistics.* H.M.S.O.

Ministry of Agriculture, Fisheries and Food (1969) *Annual Review and Determination of Guarantees.* H.M.S.O.

Ministry of Agriculture, Fisheries and Food (1964) "Developments in the feedingstuffs manufacturing industry and in the production and utilization of concentrate feedingstuffs". *Economic Trends.* No. 130. (Updated to 1966 in a private communication.)

Moore, L. and G. H. Peters (1965) "Agriculture's balance of payments contribution". *Westminster Bank Review.* August.

Morris, T. R. (1968) "Synthetic Protein—a promise or a threat?" *Poultry Industry.* January.

Overseas Trade Accounts of the United Kingdom (1966). H.M.S.O., December.

Robinson, E. A. G. and R. L. Marris (1950) "The use of home resources to save imports". *Economic Journal.* March. Vol. LX, No. 237.

Select Committee on Agriculture (1969). H.M.S.O.

The National Plan (1965). Cmnd. 2764. H.M.S.O.

Winegarten, A. and T. Josling (1969) "Agriculture and Import Saving". *Occasional Paper No. 5.* Hill Samuel and Co. Ltd.

CHAPTER 5

THE GROWTH OF AGRICULTURAL OUTPUT— THE GENERAL POSITION

The earlier chapters of this study have predicted, within a certain range, the demand for farm output in the year 2000. The level of demand predicted is significantly higher than demand in 1965. The increase has so far been related to the pressure on farm land as though it were possible to increase the agricultural area of the United Kingdom should demand conditions warrant it. This is clearly not the case, for the agricultural area of the United Kingdom cannot be expanded significantly. Furthermore, it is likely to diminish since land is required for a wide range of non-agricultural activities.

The problem that is posed is one of increasing agricultural output with less land at the disposal of the agricultural industry.

There are two main components in the contribution of land to agriculture. The first is that of area or space and it is in this sense that we refer to land resources in the United Kingdom being already fully utilized. An individual farmer may extend the area of his farm but he can only do so by taking over land which is in some form of agricultural use already. The second attribute of land is its potential for intensification. This is a measure of its ability to combine with greater quantities of other resources to produce increasing amounts of product. This is the factor which will be most relevant to the future of the agricultural industry facing "a land shortage", for by increasing the intensity with which land is used it is possible to expand output without relying on further land being available.

The intensification of land use in agriculture is no new phenomenon for British agriculture. It has been a feature of the industry for most of the twentieth century, although it has been particularly marked in the period since the outbreak of the 1939–45 war. The pattern of intensification up to date provides a useful guide as to what will be involved in any future agricultural expansion.

The demand predictions have implied that the annual output of British agriculture should increase, providing that food imports do not meet demand increases. In addition the expansion of output should be accompanied by some degree of change in the direction of production if the composition of output is to satisfy demand.

This chapter is concerned with the sources of greater agricultural

output in theory and the following chapter discusses the more practical implications of output growth.

The expansion of production in theory

The level of production or output is a function of the total resources which are available and the physical relationship between input and output known as productivity. The growth of output therefore depends on an increase in the volume of resources and/or technological change. Looking at production in a "real world" setting, a further precondition is essential. This involves the financial incentives and assurances given to producers to provide the economic climate which will stimulate activity and output growth. Looking at agriculture specifically such assurances should be long-term considerations and whether they are created by market mechanism or by government intervention they are implicitly assumed in this chapter since technical possibilities are meaningless unless there is the economic motivation to put them into practice.

In a sense the economic conditions surrounding agriculture are written into past rates of output increase, productivity growth and the uptake of technology. In the period which will principally be used for looking at trends, that is from the end of the war in 1945/6 up to the present time, financial incentives have generally been good. They were particularly advantageous from 1945 to the late 1950s. More recently perhaps there has been cause to feel that incentives to the industry have not been so good. The agricultural price index has declined relative to the retail price index, and net farm incomes, deflated by the retail price index, made little progress during the 1960s. It is not within the scope of this study to forecast the economic conditions surrounding the agricultural industry other than to suggest that there will be a strong demand for agricultural products. This chapter will therefore look at technical factors and assume that there will be no general depression or lack of incentive in the agricultural industry during the period of study.

The volume of resources

Resources fall into four groups, land, labour, capital and management. The economic history of the United Kingdom since the seventeenth century has noted a growth of the total labour force in terms of numbers and of quality, capital stock increasing enormously and its quality generally improved and, more recently, there has been a rise in the contribution of management. The supply of land has not expanded in the same way, although there was probably an extension of the area of land in agricultural use up to the end of the nineteenth century (M.A.F.F., 1968). During the twentieth century there has

been a gradual erosion of the supply of agricultural land in terms of area, although until the outbreak of the 1939/45 war this had little, if any, impact on food supplies. While other resources are fairly mobile between occupations, particularly in the long run, land rarely moves from a strictly non-agricultural use into an agricultural one. Agriculture occupies such a large proportion (about 80 per cent.) of the land area of the United Kingdom that any additions are likely to be of a very marginal nature. It is, therefore, only sensible to anticipate the use of a greater volume of resources other than land in order to increase agricultural output. Extra output will thus be the result of applying more labour, capital or management, or a combination of the three, to the given area of agricultural land.

Land may be scarce in the physical sense but the other resources may be equally scarce in an economic sense. Agriculture represents only one of many claims on the labour force, management expertise and capital stock of the nation. The volume of resources which flow into agriculture will depend on the competitive position of agriculture in relation to other industries. The power to attract resources is linked with the financial incentives, discussed above, for profit levels and confidence in the future will be relevant factors in determining the level of resource procurement by agriculture.

No measure of management resources moving into agriculture is possible, although the number of agriculturalists with management training must be increasing. Agencies for management advice and the management section of the National Agricultural Advisory Service have grown quite rapidly, so it would be reasonable to believe that there is an inflow of management into the industry. Looking at labour and capital a very good impression of the volume of resources that have been used by agriculture can be gained. There has been a considerable net outflow of labour from agriculture since about 1950. The outflow of employees has been faster than that of farmers, their numbers being halved while those of farmers were reduced by less than 10 per cent. (Select Committee Report, 1968/9). Between 1953/4 and 1960/1 the labour force fell by 2·2 per cent. each year, while between 1960/1 to 1967/8 the rate of outflow quickened to 2·8 per cent. per annum. This means that agriculture has not increased her use of labour but has in fact reduced it by over 30 per cent. since 1953/4. The labour force is expected to fall still further in agriculture, but there are perhaps indications that the industry is suffering, or soon will be, from under-recruitment, particularly among younger people. This may become a regional problem rather than a national one (D. K. Britton, 1969). Little information is available on the quality of labour in agriculture. It appears that there is more specialization and many workers do have skills in machinery

handling that never existed before. A recent study on factors affecting productivity growth in agriculture could, however, find no evidence of a quality improvement in labour (G. J. Tyler, 1969).

A great deal therefore depends upon a continuing capital input into agriculture. The volume of both working capital and fixed capital going into the industry has increased very substantially since the end of the war. During the period 1954 to 1967 gross fixed capital formation in agriculture rose from £96 millions to £188 millions per annum in current prices, £109 millions to £163 millions at constant prices (*National Income and Expenditure*, 1969). In spite of this rise it did represent a rather smaller proportion of total national capital investment in 1967 than it did in 1954. Total investment in fixed capital in agriculture for the whole period amounted to £1,991 millions while the increase in book value of stock held was £470 millions. Farmers' costs, a measure of working capital needed to run the farm business from year to year, rose from £1,026 millions in 1954 to £1,439 millions in 1967, an increase of 40 per cent. (*Annual Abstract of Statistics*, 1968). A good deal of investment in fixed capital, particularly plant and machinery, has increased labour productivity in agriculture and allowed the labour force in agriculture to decline. In future it is likely that as more investment is made in buildings smaller gains will accrue as far as labour productivity is concerned.

Further intensification in agriculture will require substantial additional investment and although agricultural investment in fixed capital represents a small claim on the nation's capital stock (2·6 per cent.) the gross output of agriculture makes only a small contribution of about 3 per cent. to Gross National Product. Agriculture is currently investing almost 20 per cent. of its net value added and it appears that investment per worker is rather higher than that for manufacturing. No firm estimates of capital resources needed for the future exist, although it has been suggested that without any specific expansion scheme agriculture would require an additional investment of £200 millions per annum in fixed and current assets (C. I. C. Bosanquet, 1968). The N.E.D.C. proposals, which involved substantial additional output between 1967 and 1972, were estimated to require additional capital of the order of £230 millions in capital assets, and £110 millions each year for working capital (Economic Development Committee, 1968). In a memorandum to the government Select Committee on Agriculture (1968/9) the M.A.F.F. commented, "it is not possible to forecast with any precision the additional investment needed to finance further expansion because capital requirements depend not only on the rate of expansion of output but also on the rate of release of labour, or the practical application of advances in technology and an individual farmer's decisions about the most

economic methods of increasing efficiency". Nevertheless it is quite clear that the volume of capital needed by agriculture will increase substantially and it will probably be more crucial than the other resources of management and labour.

Efficiency in the use of resources

Productivity is basically a physical measurement of the utilization of resources. It can, however, be converted to economic terms. An improvement in productivity is said to have occurred if a given set of inputs produces a greater output than formerly, or a given output is produced with less resources than before. So, if there are gains in the productivity with which resources are utilized then an increase in output may be achieved without a corresponding increase in all inputs. Productivity gains are the result of technological change.

Productivity in technical or economic terms is a precise measurement which is sensitive to the number of stages in the production process which are considered, the range of inputs and outputs used, aggregation and index number problems and price changes (O.E.C.D., 1961). Productivity measurement should strictly refer to total measures where all inputs and outputs are included. In practice, however, partial measures are most frequently employed. These consider only one input and express its productivity in terms of output change. The advantage of such partial measures lies in the relative ease of data collection; it must not be forgotten, however, that an apparent change in the productivity of the factor in question is almost invariably the result of changing the input of resources which are specifically excluded from the estimation.

Productivity is relevant to this study in two senses. One is in its role in the expansion of output, the other is related to the efficiency with which resources are used in agriculture, as opposed to other sectors of the economy, which has a bearing on the inflow of resources for agricultural production. Thus technological change and the uptake of improved farming methods will be of fundamental importance in agriculture.

A number of productivity measurements are made for the agricultural industry, referring to the use of:

(i) all inputs,
(ii) inputs purchased from other industries and overseas agriculture,
(iii) labour,
(iv) capital.

The total productivity measurement (i) has been made by the Ministry of Agriculture, Fisheries and Food (M.A.F.F.), defining productivity

as "the ratio between the volume of output and a measure of the total volume of resources used in production". The estimates which appear in Table 28 indicate that productivity in the use of all resources grew by 1·8 per cent. per annum (compound) between 1949/50 and 1965/6. (A more recent series produced a very similar result.) The M.A.F.F. also have an estimate of the overall efficiency gain which combines the productivity estimate with economies gained by increasing the scale of operations in agriculture. This gain in efficiency has averaged rather more than 2·0 per cent. of the gross output of the industry each year since 1950. This would indicate that an annual increase of 2·0 per cent. in gross output could be expected due to extra efficiency in resource use and increasing the scale of operations in agriculture (M.A.F.F., 1961 and 1969).

TABLE 28

The Productivity of British Agriculture, 1949/50 to 1965/6

	Gain in productivity compared with previous year	Index of productivity 1949/50 = 100
1950/1	+2·4	102·4
1951/2	+2·4	104·9
1952/3	+2·4	107·4
1953/4	−1·1	106·2
1954/5	+2·1	108·4
1955/6	−0·1	108·3
1956/7	+4·6	113·3
1957/8	+0·7	114·1
1958/9	+1·1	115·3
1959/60	+2·5	118·2
1960/1	+2·5	121·2
1961/2	+2·5	124·2
1962/3	+2·0	126·7
1963/4	+1·6	128·7
1964/5	+1·3	130·4
1965/6	+2·4	133·5

Average rate of growth = 1·8 per cent. per annum compound.
Source: M.A.F.F. 1961, 1969.

A further measure made by the M.A.F.F. is that of agricultural Net Output, the current series running from 1953/4 (see Table 29). Net output is defined here as the efficiency with which inputs, from other industries and overseas agriculture, are used by the agricultural sector, this being farmers, farm-workers and landlords. This index is characterized by uneven progress but on average the annual rate of gain has been 2·8 per cent. compound growth (*Annual Abstract of Statistics*, 1960 and 1969; M.A.F.F., 1960).

Among individual resources the greatest emphasis has been given

TABLE 29

The Index of Agricultural Net Output, 1953/4 to 1967/8

Year	Index (1954/5–1956/7 = 100)
1953/4	103
1954/5	95
1955/6	98
1956/7	107
1957/8	105
1958/9	102
1959/60	112
1960/1	119
1961/2	115
1962/3	124
1963/4	127
1964/5	136
1965/6	135
1966/7	135
1967/8	143
1968/9	138

Source: *Annual Abstract of Statistics* 1960, 1969.

to the productivity of labour. Gross output of agriculture has been rising while the labour force has been declining in number. An estimate made using labour units rather than numbers of workers indicated that there was an increase in labour productivity of 5·8 per cent. per annum between 1954 and 1964. In the second half of the period, however, labour productivity was 6·8 per cent. per annum (D. K. Britton, 1969). In terms of output per head of the agricultural labour force an improvement of 5·1 per cent. per annum was observed for the same period. About half the gain in labour productivity can be attributed to rising output while the rest is due to the reduction in the labour force.

While the rate of labour productivity growth compares well with other sectors of the economy output per man is actually smaller. It may also be asserted that as wages are higher in industries other than agriculture, labour would make a greater contribution to the economy by moving from agriculture to other sectors. It certainly appears that in spite of improving efficiency the volume of labour in agriculture will decline still further.

A substantial part of labour productivity in agriculture has been the result of capital investment and consequently the productivity of these two factors is closely connected. If the supply of labour is going to be a limiting factor in the economic growth of the United Kingdom then the use of capital by agriculture, in replacing labour and freeing it for other uses, could be of considerable value to the

economy on the whole. If the efficiency of capital use is measured using the incremental capital output ratio (I.C.O.R.) then the performance of agriculture may be compared with that of industry. Three studies have shown that investment is higher, in relation to output, in agriculture than it is in manufacturing industries, particularly if current rather than constant price data are used (K. Dexter, 1967; G. H. Peters, 1967; M. C. Whitby, 1968). This, therefore, indicates that agriculture is a less efficient user of capital than industry. In two studies which used constant price data (Dexter, 1967; Peters, 1967), agriculture's performance was slightly better than other industry and the economy as a whole, if corrections were made for a changing labour force. The study which used current price data (Whitby, 1968) found that agriculture had a worse performance than manufacturing industry. Although in verbal evidence given to the Select Committee on Agriculture (1968–9) it was indicated, at several points, that the return from resources in agriculture was good, there are inevitably some reservations about the efficiency of resource use in agriculture, particularly in relation to capital. It is possible in this era of high interest rates and overall capital scarcity that a capital shortage in agriculture could occur (A. M. Middleton, 1969) though the implications of this have not been specifically taken into account when assessing the rate of agricultural expansion in the future.

Productivity in the use of land is the main interest of this study. No precise definition of productivity will be used but instead an attempt will be made to explore the prospects for the expansion of agricultural output in the face of a fixed or declining area of land. In this sense productivity in land use will have occurred if agricultural output can expand in spite of no further land being available. The remainder of this chapter will be concerned with possible sources of increased agricultural output.

Sources of agricultural expansion and the intensification of land use

Agricultural development will take place along four broad fronts. In essence each of these is concerned with technological change. Adjustments in the organization of agriculture facilitate the uptake of technology whether it be putting known techniques into wider practice or adopting new technology.

(i) Structural change within agriculture.
(ii) Land improvement.
(iii) Raising the general level of farming efficiency.
(iv) The discovery, development and application of new technology.

(i) *Structural change within agriculture*

The structure of agriculture is the term used to denote the features of the industry such as the number and size distribution of holdings, the type and size of the farm business and, to a certain extent, the concentration and specialization of enterprises. It is, fundamentally, concerned with the framework in which farming activities are carried out.

Existing agricultural structures are the result of social, economic and political forces usually acting over long time periods. Change is typically very slow, even when positive efforts are made to accelerate it. Due to this fact British agriculture has a structure which is not appropriate for modern technical and economic conditions. The contribution of structural change to output and productivity growth is therefore to create the right environment for modern farming techniques. The maximum gain may then be derived from mechanization, economies of scale, management techniques and so on. Much of the emphasis in structural change has been concentrated on the physical size of holdings but the degree of business activity is important too. It must be accepted that structural change will continue to be rather slow, although there is some indication that the last decade has shown a little improvement in the rate of change. Although almost 80 per cent. of holdings in England and Wales are still less than 40 hectares (100 acres) in size they account for only a quarter of the total agricultural area (M.A.F.F., 1968).

TABLE 30

Distribution of Holdings in the United Kingdom according to business size—June 1965

Size group* (smds.)	No. of Holdings	% of all Holdings	% of total smds.	% of crops & grass area	% of total Agri-cultural output	Average size of Holding (area of crops and grass)	
						hectares/acres	
over 1,200	41,900	10	47	40	47	121·4	300
600–1,199	66,600	16	26	30	25	52·6	130
275– 599	96,400	24	19	20	20	25·0	62
under 275	201,400	50	8	10	8	6·5	16
Total	406,300	100	100	100	100	—	—

* Definition: One standard man day (smd.) represents 8 hours' manual work for an adult male worker under average conditions. Two hundred and seventy-five (275) smds. is the equivalent of a year's work for one man.

Source: *The Structure of Agriculture.* M.A.F.F., 1966.

There is no continuous series of information relating to the business size of agricultural holdings but an analysis was carried out in 1965 to show the intensity with which farm businesses were run. The analysis appears in Table 30. It shows that although the greatest number of holdings provided employment for only two men or less, holdings which gave employment to two or more men accounted for over 70 per cent. of all labour requirements and produced 70 per cent. of all agricultural output (M.A.F.F., 1966). Although no trends can be recognized it is fairly certain that the intensity with which holdings are being run is increasing, if those holdings considered as only part-time enterprises are excluded.

Progress is also being made in the concentration and specialization of enterprises, more cows are being kept in herds of fifty or more, more wheat is grown in units of over 40 hectares (100 acres), and so on. This type of change facilitates efficiency, makes specialist knowledge and equipment worthwhile and gives economies of scale.

Structural change is, therefore, a considerable source of productivity in agriculture and will be an important ingredient in future expansion.

(ii) *Land improvement*

Although almost all the available land in the United Kingdom is used for agriculture a portion of this land is under-used to some degree. The development and improvement of such land would add quite substantially to agricultural potential. This topic is discussed in some detail in *Agriculture and Urban Growth*, by G. P. Wibberley, so little will be said here.

The greatest reserve of such land exists in the uplands and rough grazing areas of this country. While there are a number of features which make change difficult it has been estimated that on a little more than 2·0 million hectares (5·0 million acres) output could be increased by at least 50 per cent. if the right husbandry techniques were employed (E.D.C., 1968). A number of hectares of rough grazing land are improved every year and enter the permanent pasture category. This land, however, usually remains very marginal and it can easily revert to its former status and can never be equivalent to fertile lowland permanent pasture or be suitable for arable crops. The improvement in rough grazing which is envisaged is in terms of its traditional role and would take the form of higher stocking density initially and, later, produce improvement. There is widespread feeling that investment in the improvement of uplands would be better spent on lowland intensification. This approach neglects the complementary role which the uplands must play in future. Part of this is associated with relieving stocking pressures on lowland grass-

land, particularly with regard to sheep enterprises, when the cereal area expands. Perhaps more important is the role of the upland in providing land for recreation, for water gathering and storage and for forestry. A strong agricultural base will facilitate such developments.

While uplands and rough grazings provide the largest single section of improvable land there are other situations where such land exists. There are still areas where drainage could increase agricultural output. Many holdings possess areas of derelict orchard and woodland which could be reclaimed for agricultural use. Even though substantial investment would be involved the marginal value of extra hectares to a holding is often great and because agricultural land prices at present are very high, projects of land improvement could be worth while.

It is not likely that the rate of land improvement will offset agricultural land losses to urban growth but it can help to make good some of the output lost.

(iii) *Raising the general level of farming efficiency*

Technical progress in British agriculture since the end of the 1939–45 war has been remarkable. There has been the widespread adoption of fertilizers, chemical sprays, veterinary medicines, and new crop varieties. There has been a rapid growth in farm mechanization and the introduction of management science to farming.

The impact of these has been very great. Often traditional methods have been improved and streamlined but new processes have been introduced too. New inputs such as herbicides have been produced, existing inputs, for instance crop varieties, have been improved in quality. Mechanization has replaced horsepower and some labour, and it has increased the scope and timeliness of cultivations and harvesting. The results of technology can be spectacular; cereal yields in 1966 were 60 per cent. greater than in 1945; the combination of better varieties, fertilizer application, the use of sprays against pests, diseases and weeds, and the timeliness of harvesting and handling have been responsible. In the same period—1945–66—the average yield of milk from dairy cows in England and Wales rose by 200 gallons, quite an achievement in relation to the national average in 1966 of 800 gallons (M.M.B., 1969). The national average levels of crop and stock yields, however, are well below the best yields achieved by the leaders of the industry. Many farms are run inefficiently in a technical and an economic sense. Therefore one of the chief sources of future productivity and output potential is raising the overall level of farming efficiency, in which the uptake of existing technology is the major ingredient. If present-day techniques stayed unaltered there

would still be substantial improvement in United Kingdom agricultural output merely as a result of bringing farmers up to date in their production methods.

The spread of innovation through time is exemplified by the use of inorganic fertilizers since the war. In 1945 634 thousand tons of plant nutrient were used, in 1966 the total used was 1,664,000 tons. In a study, made by Metcalf and Cowling (1967) on demand functions for fertilizers, a time trend was included in their estimations in order to allow for the upward movement in farmers' knowledge and acceptance of fertilizers through time. Their results confirmed that time was a very important factor in fertilizer use, "a strong upward trend exists associated with the post-war diffusion of new technology through United Kingdom agriculture". Metcalf and Cowling (1967) also suggested that the trend through time had itself undergone change, starting in the cash crop arable sector and only later being taken up by the grassland sector. Fertilizer application in the United Kingdom is still far from the optimal level particularly with regard to the use of nitrogen on grassland.

This pattern of technical uptake is not confined to fertilizer use. Many farmers are unwilling or unable to make the best use of the resources which are available to them. Some explanation lies in the province of structural change already discussed. Certain types of technical change do depend on structural change and thus their application has been retarded by the slowness of structural adjustment. Thus the improvement of crop and animal husbandry and farm management, coupled with structural change, will be a major source of output growth for the future.

It is also apparent that institutional reorganizations within agriculture, particularly in the marketing and credit sectors, would help in improving efficiency. Movements towards co-operation, partnership and corporation are indications of what is needed, for it will become increasingly difficult for the individual farmer to run his farm in the traditional manner.

(iv) *Investment in new technology*

Further technical advance in all sectors of agriculture will be a major source of productivity and greater output in the future. New technology will take a variety of forms. It may involve completely new farming systems, or the improvement in the quality of an input for a traditional system.

It is difficult to measure the rate of technological advance precisely since many of its components are hard to define. One may find indicators in, for instance, the expenditure by farmers on the inputs which embody technology such as machinery, plant and equipment,

chemicals and so on. One can also look at quality of inputs because quality is an attribute of technology. A study made on tractors in the United Kingdom suggested that their quality improved, on average, by 5 per cent. a year between 1948 and 1965 (A. J. Rayner, 1968). Another inquiry into production relationships indicated that technology, embodied in capital inputs, increased by about 4 per cent. a year between 1948 and 1965, and technology not associated directly with capital or labour at about 5 per cent. a year (G. J. Tyler, 1969). In the United States, the rate of technological advance defined as "a change in total farm outputs that results from a given set of inputs" was measured for the period 1950/2 to 1964/6 and the resulting index rose from 100 to 187, giving an annual rate of technological advance of 4·6 per cent. (R. O. Nevel, 1969).

The main determinants for the future will be both the rate of technological discovery and the rate at which it actually has an impact in terms of farm output. The precise rate of development is hard to foresee. It seems that there is no "drying up" of ideas for innovations. Tremendous potential is already foreseen particularly in the grassland and livestock sectors. A great deal of future change is expected to be rather more sweeping than much of the change seen in the past, but this is not to suggest that continual improvements to existing systems will not be important. It is clear that substantial new investment will be required and this could be rather more of a deterrent to the uptake of technology than any other factor.

The expansion of agricultural production depends fundamentally on increasing the use of resources in agriculture and improving the efficiency with which they are used; both of these are closely linked with technological progress. The opportunities for output expansion appear to exist in British agriculture. Some of the more practical factors which must be taken into account when assessing the rate at which agricultural output could increase in the future are dealt with in the next chapter.

References

Annual Abstract of Statistics (1960, 1968, 1969). H.M.S.O.

Bosanquet, C. I. C. (1968) "Investment in Agriculture". *Journal of Agricultural Economics*. Vol. XIX, No. 1.

Britton, D. K. (1969) "Agricultural Manpower: The Current Situation", in *Agricultural Manpower*. N.E.D.O.

Dexter, K. (1967) "Productivity in Agriculture", in *Economic Change in Agriculture*, Ed. Ashton and Rogers. Agricultural Adjustment Unit, Newcastle.

Economic Development Committee for Agriculture (E.D.C.) (1968) *Agriculture's Import Saving Role*. N.E.D.O.

Metcalf, D. and K. Cowling (1967) "Demand Functions for Fertilizers in the United Kingdom, 1948–65". *Journal of Agricultural Economics*. Vol. XVIII, No. 3.

Middleton, A. M. (1969) "Land Planning and Capital Investment in Agriculture". *Town Planning Review*, Vol. 40, No. 1.

MILK MARKETING BOARD (1969) *United Kingdom Dairy Facts and Figures*. M.M.B.
MINISTRY OF AGRICULTURE, FISHERIES AND FOOD (1960) "The New Index of Agricultural Net Output in the United Kingdom". *Economic Trends*. March.
MINISTRY OF AGRICULTURE, FISHERIES AND FOOD (1961) "Productivity Measurement in Agriculture". *Economic Trends*. May.
MINISTRY OF AGRICULTURE, FISHERIES AND FOOD (1969) "Productivity Measurement in Agriculture". *Economic Trends*. July.
MINISTRY OF AGRICULTURE, FISHERIES AND FOOD (1966) *The Structure of Agriculture*. H.M.S.O.
MINISTRY OF AGRICULTURE, FISHERIES AND FOOD (1968) *A Century of Agricultural Statistics*. H.M.S.O.
National Income and Expenditure (1969). H.M.S.O.
NEVEL, R. O. (1969) "Technological Change in Agriculture". *Agricultural Economics Research*. Vol. 21, No. 1.
O.E.C.D. (1961) *Concepts of Productivity Measurement in Agriculture*. No. 57. Paris.
PETERS, G. H. (1967) "Capital and Labour in British Agriculture". *The Farm Economist*. Vol. XII, No. 6.
RAYNER, A. J. (1968) "Price-quality relationships in a durable asset. Estimation of a constant quality price index for new farm tractors, 1948–65". *Journal of Agricultural Economics*. Vol. XIX, No. 2.
SELECT COMMITTEE ON AGRICULTURE REPORT (1968/9) *The Availability of Labour in Agriculture*, pp. 155–164.
TYLER, G. J. (1969) "Factors affecting the growth of productivity in United Kingdom agriculture, 1948–65". In *Agricultural Manpower*. N.E.D.O.
WHITBY, M. C. (1968) "I.C.O.R.s: What do they mean?" *The Farm Economist*. Vol. XI, No. 8.
WIBBERLEY, G. P. (1959) *Agriculture and Urban Growth*. Michael Joseph.

Chapter 6

THE GROWTH OF AGRICULTURAL OUTPUT— ITS ACHIEVEMENT IN PRACTICE

The principal elements in the expansion of agricultural output can only be greater resource use and productivity gains which must be derived from technological change. In practice, however, the issue is not so clear cut. A number of interrelating processes as, for example, area adjustments and yield improvements, are involved in increasing output and some of these are linked with natural or biological factors which impose some limits on their rate of change. To assess the prospects for output expansion a number of these elements need to be explored. The final stage in the discussion, however, is the choice of a rate of output growth which will represent the combined contribution of all the individual processes and can be compared with the increases in demand already postulated in earlier chapters.

Change in the composition of agricultural output

A gradual change in the composition of British agricultural output has occurred within its general growth since the 1939–45 war. This change has been determined largely by the characteristics of demand for individual products but in some instances technical factors on the supply side have also played an important part.

The analysis of the demand for agricultural products in Chapter 3 and the investigation of import replacement possibilities in Chapter 4 implied that the demand for some products would be strong while the demand for others would be relatively weak. Some growth in demand is expected for most products but the greatest emphasis in output increase must be placed on the cereals sector and in beef, pig meat, and poultry meat production. If import replacement becomes a real possibility then an expansion in output of lamb and dairy products would also be needed.

The pattern of change in the composition of output has already been established (Table 31). Over a number of years the importance of cereal crops, particularly barley, in total output has risen and this has increased the overall share of crop products in total output. Dairy products and eggs have a reduced share in output, while poultry meat, although it still represents only 5 per cent. of gross output, has doubled its pre-war share. Fatstock sales are growing slowly and horticulture is currently maintaining its contribution of

TABLE 31

The Composition of Agricultural Gross Output
Per Cent. of Total Output

Product	1937/8	1950/1	1960/1	1967/8
Crops	14·27	20·79	18·40	19·94
Cereals	6·29	9·18	10·62	12·43
Wheat	3·13	5·16	4·99	4·71
Barley	2·03	3·22	4·95	7·25
Oats	1·13	0·80	0·68	0·47
Potatoes	4·87	7·31	4·30	4·46
Sugar beet ..	1·57	2·96	2·62	2·22
Other	1·37	1·44	0·86	0·81
Livestock Products	71·43	69·93	69·40	68·93
Fatstock	29·70	24·31	28·66	31·26
Cattle and calves ..	14·37	10·91	13·39	16·03
Sheep and lambs ..	5·70	4·02	5·25	4·44
Pigs	9·63	9·37	10·01	10·79
Milk	26·63	30·00	23·28	22·76
Eggs	10·50	11·47	11·32	8·96
Poultry	2·47	2·92	4·88	5·00
Other	2·13	1·22	1·33	0·94
Horticulture				
Fruit, vegetables, flowers, etc. ..	11·16	10·00	11·50	10·10

Source: *Annual Abstract of Statistics* 1950, 1969.

10 per cent. each year to total output. Although the changes which have occurred in output composition do not seem very great they do represent a real change in emphasis in agricultural production.

Changes in crop area

As in the case of output composition, area adjustments are already establishing a pattern in the United Kingdom and this pattern seems to be appropriate for future food needs (Table 32). The important constituents in the total agricultural area are arable area,* tillage area† and permanent grass. During the 1939–45 war the tillage area reached 5·67 million hectares (14 million acres) but it subsequently fell until 1961 when it began to expand again. This expansion has been almost entirely as a result of the rise in the area under cereals. The fall in tillage area after the war was largely compensated by a rise in the area of temporary grass, but permanent grassland did regain a little of its share of the total agricultural area. The area of temporary grass reached a peak in 1961 but has since declined as a result of the

* Arable area is equal to tillage area plus temporary grass area.
† Tillage area represents the area under non-grass crops.

expanding area of tillage crops. The result of this has been a reduction in the total grassland area from 8·094 million hectares (20 million acres) in the late 1950s and early 1960s to 7·285 million hectares (18 million acres) in 1967/8. This adjustment in crop areas, particularly the expansion of cereal crops, has moved in line with changes in the demand conditions facing the industry and with technical changes.

TABLE 32

*Area of Crops and Grassland in the United Kingdom**

(10^3 hectares)

Crop	Pre-war Average	1945	1955	1967	% change 1955–67
Wheat	751	920	788	933	+ 18·4
Barley	376	896	929	2,439	+162·5
Oats and other grains	1,018	1,730	1,242	450	− 63·8
All grain	2,145	3,546	2,959	3,822	+ 29·2
Potatoes	293	565	354	286	− 19·2
Sugar beet	136	169	172	185	+ 7·6
Fodder crops	579	763	573	313	− 45·4
Other	452	561	516	393	− 23·8
Total tillage	3,605	5,605	4,514	5,000	+ 9·3
Temporary grass ..	1,692	2,159	2,526	2,416	− 4·4
Arable..	5,297	7,764	7,100	7,416	+ 4·5
Permanent grass ..	7,588	4,791	5,476	4,989	− 8·9
Crops and grass ..	12,885	12,555	12,588†	12,405	− 1·5
Rough grazing ..	6,667	6,973	6,829	7,139‡	—
Total agricultural acreage	19,552	19,528	19,417	19,544	—

* This table in terms of acres can be found in Appendix 7.

† Including 11·7 thousand hectares flooded in 1955 and not returned as arable or permanent grass.

‡ There was a change in the definition of rough grazings in 1959.

Source: *Annual Abstract of Statistics* 1935–46, 1969.

The strong demand for cereal crops is expected to be met from both improved yields and further increases in the area of cereal crops in the United Kingdom, provided, of course, that agricultural policy does not favour imports filling the need. At the same time, however, more products from grazing livestock will be demanded and if the area of cereals does expand the grassland sector will be under some pressure, since extra tillage area will come from land at present down to grass. Putting aside the question of grassland output, the main

question which arises is—how far can the tillage area expand and what proportion of this can be cereals?

In 1944 tillage reached its highest point since the nineteenth century at 5·67 million hectares (14 million acres). This does not, however, represent a ceiling, since some counties have actually expanded their tillage area since 1944 while in others, land ploughed in 1944 has reverted to permanent pasture (*Agricultural Statistics, England and Wales*, 1949, 1968). It should be possible with the better cultural techniques and higher level of mechanization now available to agriculture to attain a tillage area greater than the war-time peak. How far this might go is debatable; in the authors' judgement 6·0 to 6·5 million hectares (15 to 16 million acres) may be the limit. Since sugar beet and potato production will require about 0·40 million hectares (1 million acres) (unless the sugar beet industry is greatly expanded), and other uses, for example, fodder roots, will take up a smaller area than at present, most of the increase in tillage area will be cereals. Some limit will be imposed on the share of cereals in tillage, and in arable area, by rotational measures for disease and weed control. Currently 50 per cent. of the arable area and 75 per cent. of the tillage area is in cereals. It is suggested that cereals can make up to 55–60 per cent. of areable land, their share being as high as 70 per cent. in the most suitable regions and less than 30 per cent. in the wetter mixed and livestock farming areas (Organization for Economic Co-operation and Development, O.E.C.D., 1968). In this case at least 80 per cent. of tillage would be in cereal crops but providing there are continually improving cultural techniques this should be possible. One may conclude, therefore, that providing there are no unforeseen setbacks in cereal technology, present trends will continue with cereals being grown increasingly in the more western counties of the United Kingdom. Correspondingly, the total area of grassland will fall, but this is likely to be accompanied by an improvement in the overall quality of grassland.

Improvements in yields

One of the most frequently used indicators of productivity in the use of land is yield per hectare. Yields can be a good indication of the intensity with which land is being used, although they must be treated with some caution when related to overall output increases where changes in the composition of output plus area adjustments are involved.

Yield improvements have been an important source of increases in output in British agriculture, and they have played a large part in using the available agricultural area efficiently. A good illustration of the contribution of yield to land saving is found in cereal production.

In 1966 3·4 million tons of wheat were produced from 0·890 million hectares (2·2 million acres) in Great Britain. At 1956 average yields this output would have required 1,092 million hectares (2·7 million acres) and at 1946 yields 1,457 million hectares (3·6 million acres) (M.A.F.F., 1968). The 1950s are often regarded as the era of rapid crop yield increases but improvements have continued up to date and further yield increases will continue to make a contribution to productivity in the use of land. Thus an estimate of the rate of yield improvement for the principal crop and animal products will be a useful guide to agricultural progress.

A series of annual average yields per hectare exists for most agricultural crops and data also exist on milk yields per cow and eggs per hen (*Annual Abstract of Statistics*, 1950, 1968; *Annual Review and Determination of Guarantees*, 1969; Milk Marketing Board, 1969). Other livestock products are not similarly treated and no figures exist for yields from grassland, although this represents a large proportion of the total agricultural area. Some measure of grassland output, however, may be gained from the estimation of livestock output per hectare of grassland.

In using past trends for the purposes of projection one must not overlook the fact that the products which have shown substantial yield improvements already are not always those where the greatest improvement is expected in the future. In the past the greatest emphasis has been placed on cereal crops while relatively little has been put on grassland and grazing livestock and it is thought likely that much of the potential of grassland is still to be realized. In addition, the expansion of output involving an increase in the area of a crop is not always consistent with a maximum increase in yield. An increase in the area under any one crop may mean that less suitable land has been brought into production, although this is not always the case. It can also mean that a crop features more frequently in a rotation with the associated risks of disease build-up. Products where output is increased substantially may not, therefore, show impressive yield increases. Where crop area is static or declining the reverse may be true. It may mean that only the most suitable land will be used and production will be rationalized; this sort of development is likely with main crop potatoes. Taking an example of increasing output from the livestock sector; an increase in the pig breeding herd involves keeping a number of poorer sows, which otherwise would be culled, for breeding. This will, for a time, depress the improvement in litter size per sow. The total output of pig meat will, however, increase.

There is also an element of addition associated with productivity gains in the livestock-feed sector. If there is a productivity gain in

the growing of feed and another productivity gain in livestock production the overall gain will be a combination of the two individual gains. An example of this is provided by the dairy industry (Table 36), where a combination of more cows per hectare of grass and more milk per cow gives a substantial increase in the output of milk per hectare (Milk Marketing Board, 1967). Since a large proportion of agricultural land, some 88 per cent. in fact, is involved in livestock production of some kind the question of addition is important in the assessment of the increase in productivity for the industry.

TABLE 33

(a) *Rate of Yield Increase per Hectare of Crops in the United Kingdom*

(% per annum)

	1946–66
Wheat	2·40
Barley	2·39
Oats	1·52
Mixed corn	1·91
Rye	1·58
Beans (livestock)	1·34
Peas (livestock)	0·88
Potatoes	1·41
Turnips and swedes	1·33
Mangolds	1·03
Sugar beet	1·75
Average (1965 acreage weights)	2·21

Source: *Annual Abstract of Statistics* 1950 and 1967.

(b) *Rate of Yield Increase for Milk and Eggs*

Milk per dairy cow	England and Wales	1949/50–1966/7	1·33 % per annum
Eggs per bird	United Kingdom	1945/6–1963/4	2·56 % per annum

Sources: Milk Marketing Board 1969.
Annual Review and Determination of Guarantees 1969.

In terms of yield increase, four crops are of fundamental interest—wheat, barley, potatoes and sugar beet. Wheat and barley yields have risen by more than 2 per cent. per year since 1946 (Table 33) and have a marked upward trend which shows no signs of levelling off in spite of the large expansion in the area of cereals, particularly barley. Yields are forecast to continue rising partly because the best yields achieved are well above the average and partly because improvements in crop varieties and cultural techniques continue to be made. A

number of studies have forecast cereal yield increases and their forecasts are given in Table 34. The rates of growth do vary considerably, the Economic Development Committee (E.D.C., 1969) rate being rather low. It is thought that the estimate was a cautious one since the cereal area was to expand by 0·607 million hectares (1·5 million acres). The forecast made by O.E.C.D. (1968) suggested that the cereal area would expand by over 0·400 million hectares (1 million acres) and yields would improve by an average of 2 per cent. a year. Taking into consideration the time period available and the continued improvement in cultural techniques it is expected that cereal yields will improve at a rate of 1·5 to 2·0 per cent. each year.

TABLE 34

Cereal Yield Forecasts

Forecast	Time Period	Rate of Yield Increase % per annum		
		Wheat	Barley	Oats
O.E.C.D.	1965–75	2·70	2·51	1·75
	1975–85	1·20	1·20	2·00
	1965–85	2·00	2·00	2·00
U.S.D.A.	1961–80	1·50	1·50	1·00
E.D.C.	1967/8–1972/3	0·72	0·84	1·90
Britton Report ..	1965–75	1·28	1·62	2·75

Sources: Organization for Economic Co-operation and Development (O.E.C.D.) 1968.
Economic Development Committee for Agriculture (E.D.C.) 1968.
United States Department of Agriculture (U.S.D.A.) 1969.
D. K. Britton, 1969.

Yield improvements for potatoes and sugar beet have been rather smaller than those for cereals, potato yields improving by 1·4 per cent. per annum and sugar beet yields by rather less than 2·0 per cent. per annum (Table 33). Yield forecasts made by O.E.C.D., E.D.C. and U.S.D.A. are shown in Table 35. There is some degree of agreement among them that yields will, in general, increase by 1·5 per cent. per annum. As the area is not expected to expand this may appear low but both crops are undergoing changes in mechanization and these may initially reduce yield improvement.

Grassland productivity provides in many ways the key to cereal output expansion and also the production of greater supplies of beef, milk and lamb. The reduction in the area of grassland which is implied by the projected increase in cereal area, together with a greater number of grazing livestock on British farms, demands a

TABLE 35

Root Crop Yield Forecasts

Forecast	Time Period	Rate of Yield Increase % per annum	
		Potatoes	Sugar beet (Sugar/hectare)
O.E.C.D.	1965–75	1·13	1·23
	1975–85	1·14	1·11
	1965–85	1·20	1·20
U.S.D.A.	1961–80	1·5	1·5
E.D.C.	1967/8–1972/3	2·0	1·0

Sources: Organization for Economic Co-operation and Development (O.E.C.D.) 1968.
Economic Development Committee for Agriculture (E.D.C.) 1968.
United States Department of Agriculture (U.S.D.A.) 1969.

substantial increase in the output of grass per hectare. It is fortunate that the grassland sector appears to have great potential; fertilizer application to grassland is far from optimal and grassland/stock management systems could be substantially improved. Because a great deal of the extra tillage area will come from mixed arable and livestock farming areas this will put pressure on the remaining grassland and this may be the catalyst necessary to release the potential of grassland.

Improving the yield of grassland involves not only growing more grass but also utilizing it more efficiently. There are, therefore, a number of elements in grassland yield improvement:

(i) Yield, quality and seasonality of grass production.
(ii) The density of stocking.
(iii) Harvesting efficiency by either mechanical means or the grazing animal.
(iv) Food conversion efficiency by the animal.

A study made by the Milk Marketing Board (1967) estimated the output of grassland between 1955 and 1965. They found that there was a 15 per cent. improvement in grassland stocking levels in England and Wales and 16·5 per cent. in the United Kingdom. The utilized starch equivalent from grassland per livestock unit showed a 4 per cent. increase over the decade 1955–65. Expressed as cwt./hectare of grass this was a 22 per cent. improvement, which indicated that there was a 2 per cent. per year increase in the yield of grass per hectare. Between 1955 and 1966 milk yield per cow rose by 16 per cent. while forage hectares per cow declined from 0·890 in 1955 to 0·732 in 1966 (2·2 acres to 1·8 acres), an improvement of 18 per cent. (Table

36). This gave an increase in gallons of milk per grassland hectare of 41 per cent., or 3·74 per cent. each year, which illustrates how the simultaneous improvement of stock and grassland can make a very large contribution to agricultural productivity. The E.D.C. study optimistically forecast a 3·0 per cent. annual increase in grassland productivity while the U.S.D.A. forecast a more conservative one of 1·5 per cent. per annum. O.E.C.D. suggested that in terms of livestock units per hectare grassland output would increase by 24 per cent. between 1965 and 1985—this being the result of a 5 per cent. fall in the grazing supply and a rise of 18 per cent. in grazing livestock units.

TABLE 36

Grassland Productivity, 1955–66

	1955	1960	1965	1966	% change
Milk: Gallons per cow	685	765	800	795	+16·1
Grassland hectares per cow	0·890	0·805	0·757	0·732	−17·8
Gallons per grassland hectare	768	949	1,057	1,085	+41·2

Source: Milk Marketing Board 1967.

Improvement in crop yields is therefore expected to make a significant contribution to the growth of agricultural output.

Livestock yields

While there are quite firm estimates made of future crop yields, future livestock yields do not present such a clear picture. The improvement of livestock yields involves interacting and complex genetic and environmental mechanisms and the process is inevitably slow. This is especially true in fatstock production where the position is further complicated by different rearing and feeding systems, different ages at slaughter and factors concerned with the quality of the end product. In milk and in egg production progress has been good resulting in an improvement of 1·5 per cent., or 10 gallons, per cow per year, and 2·5 per cent., or 3 eggs, per hen per year. Future progress in milk production may be rather slower as the swing to the higher yielding breeds is past its peak. An improvement of 1 per cent. per year in milk sales per cow should be, however, achieved easily. Egg yields will probably continue to improve at a rate of 1·0 to 1·5 per cent. per year and it is likely that the food conversion efficiency per bird will also improve so that the extra eggs can be produced with no additional feed.

In meat production much more will depend on increasing livestock numbers than on increasing yields although both will play a part. The expansion of stock numbers can retard yield improvements initially since selection cannot be so rigorous. In terms of productivity per unit of land, however, stock numbers are as important, if not more so, than individual yields. Improvements which are made in the environmental control of stock and in feeding efficiency also add, indirectly, to efficient land use. Space per animal can be kept to a minimum and stock do not damage or waste pasture. In addition, by converting feed more efficiently the output of the land on which the feed crop is grown is increased. The poultry industry has made a great deal of progress in this way and the pig industry is moving along the same lines. Other stock enterprises should follow. The combination of better breeding, feeding and environment can improve output by increasing throughput per unit, lowering age at slaughter or improving the quality of the end product, rather than merely raising the quantity of output per beast. These changes, nevertheless, show real efficiency and productivity in resource use.

To summarize, therefore, yield increases will make a valuable contribution towards increasing agricultural output and the efficiency with which agricultural land can be used. It is predicted that tillage crop yields will increase on average by 2·0 per cent. per year and grassland output by 2·0–2·5 per cent. per year. Output per dairy cow will grow by at least 1·0 per cent. per year and output from each hen by 1·5 to 2·0 per cent. per year. Much smaller individual yield gains will be made in the case of fatstock, probably of the order of less than 1·0 per cent. per year. It must not be forgotten, however, that where crops are used for animal feed overall productivity will combine productivity in both the crop and the livestock sectors.

Livestock numbers

If the demand for livestock products in the year 2000 is to be met, without relying heavily on overseas supplies, the number of livestock kept on United Kingdom farms must increase substantially. In the discussion on yields it was pointed out that livestock yields would play a relatively small part in increasing livestock output except in the case of milk and eggs. Stock numbers would be the most important means of increasing supply. Thus the rate at which numbers can grow is going to limit livestock output to a large extent.

If a forecast is made for a short forward period of, say, less than five years, some account must be taken of the problems of increasing livestock numbers. Little difficulty is experienced in expanding poultry numbers and pig numbers may be increased fairly quickly, although there is a characteristic cycle in pig numbers over time

which in the past has influenced output. In the case of cattle and sheep the long gestation periods, natural wastage and again, livestock cycles, particularly important for beef cattle, make sustained growth slow. In this study, however, the period under consideration is long enough for the necessary adjustments to be made and if economic conditions prove right there should be little difficulty in expanding livestock numbers. There may be a lag at the beginning of the period, particularly in relation to beef cattle but this should be corrected with time. An illustration of the way in which livestock numbers can grow is given in Table 37, which shows livestock numbers in Great Britain over the period 1946–66. Cattle numbers expanded by over 25 per cent. in the period, while pig numbers, kept rather low during the war years, almost quadrupled. Sheep and poultry numbers also increased substantially.

TABLE 37

Total Livestock Numbers in Great Britain, 1946–66

(000s)

Livestock	1946	1956	1966	% Increase 1946–66
Cattle and calves ..	8,716	9,989	1,017	+ 26·4
Sheep	19,718	22,721	28,903	+ 46·6
Pigs	1,644	4,821	6,277	+281·8
Fowls	43,397	77,348	102,894	+137·1

Source: M.A.F.F. 1968.

Forecasts made by O.E.C.D. emphasize the initially slow expansion of cattle numbers but after 20 years (1965–85) the number of beef cattle in the age group 1–2 years is forecast to have risen by 30 per cent. Pig numbers are forecast to increase by 30 per cent. and the number of ewes by 15–20 per cent. U.S.D.A. forecasts of animal numbers for the period 1961–80 give a steady annual trend in numbers of 0·75 per cent. per annum for breeding cattle and ewes and 3·0 per cent. per annum for sows.

In general, therefore, the evidence suggests that stock numbers will be able to expand sufficiently to make the necessary contribution to growth of output.

A forecast of the future growth in agricultural output

The factors which contribute to the growth of agricultural output have been outlined but the final spoke in the argument is the choice of an appropriate rate of output growth which will represent the combined contribution of these factors.

Briefly the mechanics of the increase in output will be:

(a) The use of additional inputs, other than land and possibly labour. In the absence of a supply of new technology this might suggest that eventually diminishing returns would be experienced.

(b) Further extension and adoption of present-day technology to give a general improvement in efficiency. This would eventually reach saturation point.

(c) New technology, both innovation and extension. This will make it possible to increase output without necessarily experiencing diminishing marginal returns. It will also make possible general and continuing efficiency improvements in the industry.

In making the forecast three main points must be dealt with. First, what are the appropriate aggregate measures to use for agricultural output growth? Second, what growth characteristics should the projection have, i.e. what growth function should be used? Finally, what annual rate of growth should be used in conjunction with the appropriate function?

Two measures are felt to be appropriate as indicators of overall output growth in agriculture. One is agricultural gross output,* the other agricultural gross output, less the inputs of all feed, seed and livestock, whether produced in the United Kingdom or abroad.† Agricultural gross output, at constant prices, is a useful measure of the total volume of production coming from the agricultural industry, but since 1953/4 it has contained an element of double counting, mainly in relation to animal feedingstuffs produced on United Kingdom farms

* Agricultural Gross Output is defined as that portion of total agricultural production which is sold off the national farm, together with the quantity consumed in farm households. In its valuation individual commodities are priced in the form in which they leave the national farm and the effects of processing such as milling, malting, etc., are thus expressly excluded. For the years before 1953–4 all products which left the national farm and were wholly returned, whether in the same or a modified form, for further agricultural production were also expressly excluded. From 1953–4 onwards, however, cereals sold off the national farm and subsequently re-purchased as animal feedingstuffs are included in the value of output. Since about 1960 there has been a tendency for the value of bought back feedingstuffs to increase. The change in definition means that there are two series of figures for gross output—one from 1936/7–38/9 until 1953/4 and one from 1953/4 onwards.

† The measure of Net Output estimated by the Ministry of Agriculture, Fisheries and Food since 1953/4 represents gross output reduced by the cost to United Kingdom farmers of fertilizers, feedingstuffs, store livestock, seeds, machinery costs, etc. It is a measure of the value added by the farming community to all goods and services purchased from outside the agricultural sector, whether from abroad or from other industries within the United Kingdom. The measure used in this study, i.e. gross output net of inputs of feeds, seeds, and livestock, corresponds to the original Net Output Index estimated by the Ministry, which continued until 1960.

and subsequently bought back by United Kingdom farmers for livestock feed. By using the second measure, i.e. gross output net of all agricultural inputs (feeds, seeds, and livestock) this double counting element is eliminated but, in addition, agricultural products from abroad which are used on British farms are excluded. The justification for doing this is that if we are attempting to assess the real output of agricultural land then inputs which are themselves products of agricultural land elsewhere should be excluded. Data for agricultural gross output and for agricultural gross output net of agricultural inputs, for the period 1936/7–38/9 until 1968/9 were derived from Ministry of Agriculture, Fisheries and Food statistics. From 1936/7–38/9 until 1953/4 the gross output series excluded bought back feedingstuffs though subsequently they have been included in the value of gross output (see footnote, page 76). Up to 1960 the index of net output estimated by the M.A.F.F. was used, another definition was adopted by the M.A.F.F. after 1960. It has been possible, however, to derive data to continue the original series to date. The series are shown in Figure 4.

There are some problems associated with using the whole period covered by the series. The war-time distortions to production which followed a period of economic depression in agriculture do cast some doubt as to the applicability of war-time observations. There are also difficulties involved in using linked series. Bearing these factors in mind, observations were taken for a number of time periods within the whole series.

There is no clear principle on which to decide which growth function is the most appropriate to use in forecasting the growth of aggregate agricultural output. Since the period over which the projection is to be made is so long, however, it will be important to use the correct function. Both a linear function and an exponential function were investigated to see whether output growth in the past had corresponded closely to either one or the other.* Evidence from the sources of growth already cited suggests that the most important source of output growth in the long term will be innovation and its adoption. Although the use of more capital and management inputs and improving efficiency levels generally will be significant it will be the application of, and investment in, new technology which will make sustained output growth in agriculture possible. With changing

* The functions have the following characteristics:
(i) Linear: The absolute size of the annual output increment remains constant over time while the increment as a proportion of the previous year's output declines.
(ii) Exponential: The absolute size of the annual output increment increases over time while the annual increment as a proportion of the previous year's output remains constant.

technology there is no reason why there should be diminishing returns operating in agriculture in the long run. Thus it would appear pessimistic to anticipate that each successive year's increase in output will get proportionately smaller and eventually tend to zero. On the other hand to expect that it will be possible consistently to increase absolute increments to output in order to keep the proportionate increase constant may be too optimistic. An analysis of growth rates for the two output series provided no compelling evidence but it did appear that proportional rates of growth were being maintained and absolute increases in output were increasing marginally.

It was therefore decided for the purposes of this study to use an exponential trend but to do so with great caution and to indicate the divergence arising between this and a linear trend over the projection period of thirty-five years. It must be emphasized that the exponential trend does represent the maximum growth possibilities which can be expected but in view of the predominant role of new technology in output increase it is a more appropriate growth function than the linear one. In reality the pattern of output increase will not conform precisely to either function but its form is expected to correspond more closely to an exponential function than a linear one.

Past growth rates were used as a basis for selecting an annual rate of growth to apply to the growth function. Rates of growth which have ruled in the past do, to a great extent, delineate possibilities and give a range of rates within which to work. Also, the factors contributing to output growth which have been important in the past are largely appropriate for the future. There is no reason therefore to expect annual growth rates to be significantly higher or lower than those of the period from pre-war up to the present time, providing that the economic conditions which face the industry do not alter radically. Attention was paid to war-time distortions to production and also to the very recent slowing up of output increase.

The annual rates of output growth for agricultural gross output and gross output net of agricultural inputs are set out in Table 38. The growth rates were measured for a number of different time periods and expressed in both compound and simple interest terms. It will be observed that over the whole period, i.e. immediately pre-war up to the present, both measures of agricultural output have broadly similar rates of growth. The war years and the immediate post-war period show significant differences but these can largely be explained by the war-time shortage of imported feeds on which the industry had previously relied, together with the provision of more home produced feed which was excluded from the gross output series until 1953/4. In the years since the early 1950s growth rates for the two measures have again been broadly similar. In compound

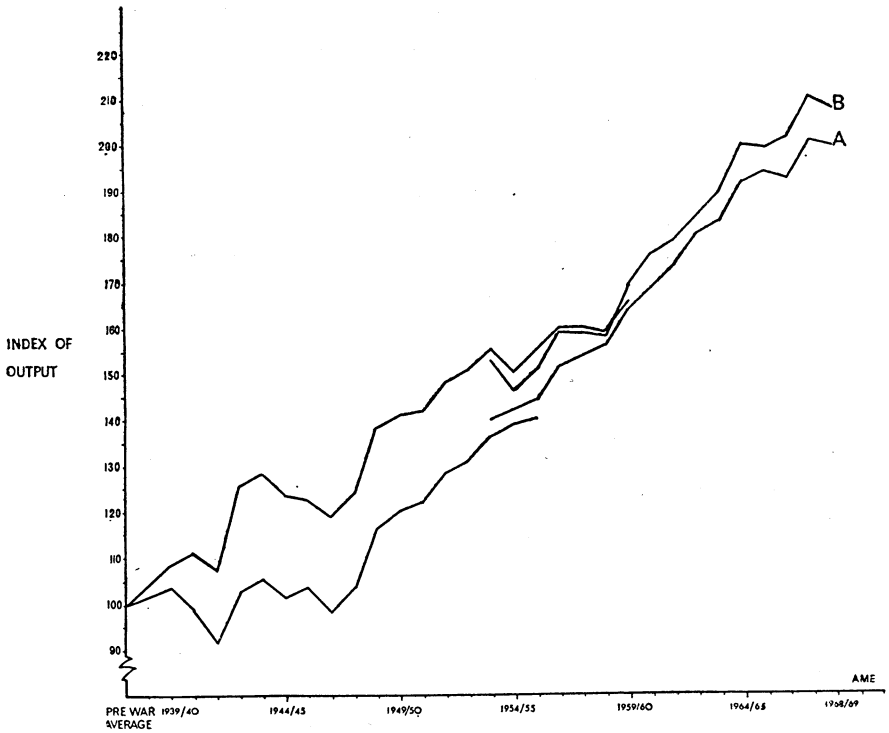

FIG. 4

The Growth of Agricultural Output—Pre-war to 1968/9.

A. Agricultural Gross Output (pre-war to 1955/6 the definition excludes home-grown feeds, from 1953/4 to 1968/9 the definition includes home-grown feeds).

B. Agricultural Gross Output net of Inputs of Feeds, Seeds and Livestock (pre-war to 1959/60 M.A.F.F. series, 1953/4 to 1968/9 derived series).

terms growth rates have generally been of the order of 2·5 per cent. per annum. Using a linear trend 3·0 per cent. per annum seems to be the appropriate rate.

These increases in output have been achieved from a diminishing area of agricultural land, thus in terms of output per hectare growth rates have been marginally above those of Table 38.

The conclusions which can be drawn from this discussion and from Chapter 6 suggest that there is potential for a considerable growth of agricultural output in the United Kingdom. A great deal will depend on the economic conditions surrounding the agricultural industry and the rate of technological progress. Substantial capital investment will also be essential. The experience of the last three

TABLE 38

The Growth of Agricultural Output
1937/8–1968/9

	Gross Output		Gross Output Net of Agricultural Inputs	
	Compound rate	Simple rate	Compound rate	Simple rate
	% per annum		% per annum	
1936/9 –1966/9 ..	2·3	3·2	2·4	3·5
1936/9 –1949/52 ..	1·6	1·8	2·8	3·3
1949/52–1966/9 ..	2·8	3·6	2·1	2·6
1949/52–1958/61 ..	3·2	3·6	1·7	1·8
1958/61–1966/9 ..	2·4	2·6	2·7	2·9
1936/9 –1953/6 ..	2·0	2·3	2·7	3·3
1953/6 –1966/9 ..	2·6	3·0	2·5	2·9

decades when the rate of technological uptake in British agriculture was good and economic conditions in agriculture not altogether unfavourable, particularly in the earlier years, suggests that an output growth per hectare of the order of 2·5 per cent. compounded annually has been fairly representative.

TABLE 39

Forecasts of the Future Growth of Agricultural Output per hectare over the years 1965 to 2000

	Rate of output growth, compounded annually			
Exponential trend ..	2·0	2·25	2·50	2·75
	Output in 2000 (1965 = 100)			
	200·0	218·0	237·5	258·7
	Rate of output growth, linear trend			
Linear trend	2·5	2·75	3·0	3·25
	Output in 2000 (1965 = 100)			
	187·5	196·4	205·0	213·8

In order to forecast agricultural output per hectare, in the year 2000, a range of growth rates has been chosen. These appear in Table 39. Annually compounded rates of 2·0 to 2·75 per cent. were judged to be appropriate in the light of past performance in agriculture and

future sources of output growth. These indicate that agricultural output per hectare would at least double between 1965 and 2000 and could possibly increase by as much as 160 per cent. If a linear growth function is used, with annual growth rates in the range 2·5 to 3·25 per cent., based on past trends, output per hectare would increase by between 81 and 113 per cent. In our judgement, although the growth of output in agriculture will correspond more closely to an exponential trend than a linear one the figures should be used with caution. This means that an increase in agricultural output per hectare of 110 to 120 per cent. would be most probable.

References

Annual Abstract of Statistics (1935–46, 1950, 1969). H.M.S.O.

Annual Review and Determination of Guarantees (1969). H.M.S.O.

Britton, D. K. (1969) *Cereals in the United Kingdom.* Pergamon Press.

Economic Development Committee for Agriculture (1968) *Agriculture's Import Saving Role.* N.E.D.O.

Milk Marketing Board (1967) *The Balance of Arable and Livestock Farming in British Agriculture.* M.M.B.

Milk Marketing Board (1969) *United Kingdom Dairy Facts and Figures.* M.M.B.

Ministry of Agriculture, Fisheries and Food (1949, 1958) *Output and Utilization of Farm Produce in the United Kingdom.* H.M.S.O.

Ministry of Agriculture, Fisheries and Food (1949, 1968) *Agricultural Statistics.* H.M.S.O.

Ministry of Agriculture, Fisheries and Food (1968) *A Century of Agricultural Statistics.* H.M.S.O.

O.E.C.D. (1968) *Supply and Demand Projections for United Kingdom Agriculture.* Paris.

United States Department of Agriculture (1969) Economic Research Service. R. E. Shepherd. Summary of "United Kingdom: Projected levels of demand supply and imports of agricultural product, 1970, 1975 and 1985". Washington,

Chapter 7

COMPETING CLAIMS FOR AGRICULTURAL LAND

The agricultural area of the United Kingdom expanded, though rather spasmodically, from about Saxon times until the end of the nineteenth century. By then it had reached not only an economic maximum but a physical one too, with 87 per cent. of the total area of England and Wales and a rather larger proportion of the United Kingdom being used for agricultural production of some kind (R. H. Best, 1968). The twentieth century has seen quite striking land use changes occur in the United Kingdom, the main one being the noticeable growth of land uses which compete with agriculture for land. There has, therefore, been a persistent fall in agricultural area during this century.

The initial drop in farmed area was largely due to the onset of less prosperous conditions in agriculture and these lasted from the end of the nineteenth century until 1939, with only a slight improvement during World War I. By the 1920s, however, this cause of a reduced agricultural area was joined by another influence, the extension of the area of land under urban uses. The expansion of forestry activity also had an impact on land use but this came somewhat later. The fortunes of the agricultural industry improved after 1939 and some land was actually returned to cultivation during the war. At the end of the war, largely as a result of government measures, agriculture did not return to its former depressed condition. Due, however, to the renewed growth of urban land and forestry, both of which had been checked in the war years, the agricultural area has continued to contract.

These relative changes in land use can be observed in Table 40 which refers only to England and Wales. Unfortunately, no accurate figures are available for the United Kingdom but the broad movements in land use will have been similar. The striking growth in the urban area, which doubled between 1900 and 1960, is readily apparent, and urban land now occupies over 11 per cent. of the land area of England and Wales. The extension of the area under forest and woodland has been less marked than that of urban growth but nevertheless there is a strong upward trend in area, particularly noticeable since the end of World War II. It appears from the data that the agricultural area was little influenced by the strong growth of these competing uses. This apparently slow fall in area is, however, largely due to

better enumeration over time and this has transferred parcels of land, previously in the "unaccounted for" section, into the agricultural category. The land use situation in the United Kingdom in 1965 can be seen in Table 41. Although the drop in area has been substantial, agriculture clearly remains the largest land user, using 79 per cent. of England and Wales and 81 per cent. of the United Kingdom. The proportion of land in urban use and forestry seems, by contrast, rather insignificant. What then has been the real impact of these competing claims for land on the agricultural industry?

TABLE 40

Changes in the Major uses of Land in England and Wales between 1900 and 1965

	Percentage of total area					
	1900	1925	1939	1950	1960	1965
Agriculture	83·6	82·9	81·3	80·6	79·3	78·6
Forest and Woodland ..	5·1	5·1	6·2	6·4	6·8	7·5
Urban land	5·4	6·2	8·6	9·7	10·8	11·5
Land unaccounted for ..	5·9	5·8	3·9	3·3	3·1	2·4

Source: R. H. Best, 1965. Table 41.

When other demands for rural land began to make themselves felt in the interwar years agriculture was in a state of economic depression and there was little pressure of demand for home-produced agricultural products. The position has now altered radically because there is currently a strong demand for domestic agricultural output arising from population and income growth and the drive for greater self-sufficiency in food supplies. If the effective area under agriculture in the United Kingdom is gradually diminishing, then, in order to merely maintain the level of agricultural output, production from each hectare remaining in agriculture must continually increase to make good the loss of land alone. In the face of pressure to expand output the loss of cultivable land assumes more serious proportions. It is therefore essential to anticipate the area of farm land which will be required for non-agricultural purposes in the future. The significance of this land loss to the agricultural industry may then be assessed.

Up to date the principal sources of land loss to agriculture have been urban extension and afforestation. But now there is another demand for rural land which arises from the growing demand for outdoor recreation in the countryside. In the following sections these three competing claims for rural land will be discussed in order to

evaluate their future development and likely impact on rural land resources and agricultural production.

Urban growth

Although urban growth has been the major factor in British land use changes during this century, until comparatively recently very little was known about the actual area of urban land which existed or what agricultural land losses had been incurred in its growth. Furthermore, the distribution of post-war urban growth between regions and counties was largely unexplored. Fortunately such information is now available and throws considerable light on the impact of urbanization on agricultural land use in Britain. This in turn provides a base for assessing the extent of future developments (Best, 1968 *a* and *b*; Best and Champion, 1970).

In the United Kingdom about 2·125 million hectares (5·25 million acres) of land are in some form of urban land use, about 1·740 million hectares (4·3 million acres) being located in England and Wales. The definition of "urban land" used in this context includes land which is closely built over and the open spaces associated with it such as gardens, sports grounds and roads; it also includes roads and railways in the countryside, villages, isolated dwellings, farmsteads, airports and open-cast mineral workings.* (R. H. Best and J. T. Coppock, 1962.) The background to urbanization is interesting because although the changeover from rural to urban living has taken place over the last 200 years the major physical impact of urbanization has only been felt in the twentieth century. Once under way, however, urban growth advanced very rapidly and the urban area was doubled in the period 1900–60. In addition to housing a growing population, this growth has also been influenced by the introduction of improved living and working conditions and by technological developments which have involved new forms of urban land use. In spite of the rate of urban extension in the interwar years no real conflict with agriculture arose due to the agricultural depression. Competition between agriculture and urban growth did not arise severely until the years following the end of World War II when urban growth was renewed and at the same time agriculture was placed on a sounder economic footing. Since then the transfer of land from agriculture to urban use has given rise to increasing comment and concern.

A fairly precise picture of the impact of urban growth on agriculture in terms of area, from the interwar years until the present time, has

* Airports and mineral workings are now included in the urban land area. The original definition (Best and Coppock, 1962) excluded them.

been built up by R. H. Best (1968*a* and *b*). His findings put the situation into perspective. Most of the urban growth of the United Kingdom occurs in England and Wales and here transfers of land from agriculture for this purpose have averaged about 15,600 hectares (40,000 acres) a year since the end of World War II. In Scotland, for which comparable data exist only for the 1960s, losses have averaged 2,500 hectares (6,000 acres) a year, making a total for Great Britain of 17,900 hectares (44,000 acres) each year between 1960/1 and 1964/5. In Northern Ireland between 1946 and 1961 an estimated 5,700 hectares (14,000 acres) of agricultural land were taken for urban development. More recently, the rate of loss has been 810 hectares (2,000 acres) a year (Select Committee Report, 1969). These figures immediately refute the suggestion that it is only a few years before the entire countryside will be built over. Because the conflict between different land uses has only been recognized fairly recently there is a widespread impression that urban extension is greater now than it has ever been and that it is accelerating. This is clearly not the case, for the greatest losses of agricultural land were sustained in the period 1927/8–38/9 when in England and Wales alone 24,500 hectares (60,000 acres) a year were urbanized. This level of loss has never since

TABLE 41

*The Land Use Pattern of the United Kingdom, 1965**

Area—10^3 hectares

	England and Wales	Scotland	Great Britain	Northern Ireland	United Kingdom
Total land surface area	15,026·7	7,718·0	22,744·1	1,335·5	24,079·6
Crops and grass ..	9,857·3	1,742·2	11,599·5	808·6	12,408·1
Rough grazing ..	1,953·9	4,985·9	6,939·8	276·0	7,215·8
All agricultural land ..	11,811·2	6,728·1	18,539·3	1,084·6	19,623·9
Forest and woodland..	1,119·1†	655·6	1,774·7	42·1	1,816·8
Urban land	1,736·6	239·2	1,975·7	67·6	2,043·3
Land unaccounted for	359·8	95·1	454·3	141·2	595·5
	Percentage of total land surface area				
Crops and grass ..	65·60	22·57	51·00	60·54	51·53
Rough grazing ..	13·00	64·60	30·51	20·67	29·97
All agricultural land ..	78·60	87·17	81·51	81·21	81·50
Forest and woodland..	7·5	8·49	7·80	3·15	7·54
Urban land	11·5	3·10	8·69	5·06	8·49
Land unaccounted for	2·40	1·23	2·00	10·57	2·47

* This table in terms of acres can be found in Appendix 8.

† Including 32·5 thousand hectares of land awaiting planting.

Sources: R. H. Best and M. Mandale. (Unpublished data. See note in references.)
Forestry Commission 1970. Select Committee Report, 1969.

been achieved. Since the end of World War II, year-to-year land transfers from agriculture have fluctuated quite widely due in large measure to economic conditions but no long-term upward movement can be discerned (Best, 1968*a*). Currently more land is being transferred to forest development than to urban growth in the United Kingdom, although the expansion of forest area has less agricultural significance than urban growth.

A relevant feature of urbanization which should give rise to at least as much concern as the loss of agricultural area is the location and pattern of urban development. Far from occurring uniformly across the United Kingdom as a whole, urban growth has tended to be very pronounced in certain areas and negligible in others. Furthermore, there is evidence that there have been relative changes in the degree of agricultural land losses between regions where urbanization has traditionally been strong (Best and Champion, 1970). The effect of this unevenness of urban growth has been to create some regions where up to one-quarter of the total land area is urbanized, while in other regions it is as little as 5·0 per cent. Agriculture can therefore be operating in a region where about one hectare out of every four is in urban use. How important this is depends on the urban pattern of the area. If urban land is fairly concentrated, leaving broad areas of agricultural land with little urban intrusion, production potential should suffer little damage. On the other hand there are urban forms which consist of inter-linking urban nests with relatively small rural areas in between. This sort of configuration can pose a number of problems for agriculture since it maximizes the rural-urban interface and agriculture feels the urban presence close. The practical effect of such development patterns can be seen on the outskirts of some large cities where farmable land becomes practically enveloped by new urban uses. There seems to be some psychological barrier against wholly productive agriculture in such regions, as well as the physical constraints of trespass, which means that the full potential of the land is not realized (G. P. Wibberley, 1967).

While urban concentration in certain areas poses problems for agriculture within that region it does have the advantage of leaving areas where little urbanization occurs and agriculture is not faced with either substantial land losses or urban intrusion effects. Much of East Anglia and Lincolnshire comes into this category and these are highly productive agricultural areas. On the other hand the least productive areas such as upland rough grazings and moorlands are very little urbanized or ever likely to be. This leads on to another extremely relevant question: that of the agricultural quality of the land which is transferred into urban use. If urban growth takes poor agricultural land then obviously the loss in terms of production

potential is much less than it is when good agricultural land is taken. It is a serious omission in our knowledge that so little is known about the real agricultural potential of land which has been built on or is scheduled for development. In the absence of precise evidence it appears that on the whole better than average quality agricultural land is used for urban extension. In evidence given to the Select Committee on Agriculture (1969) it was stated "it has been estimated that the agricultural productivity of land taken for urban development in recent years has been some 70 per cent. higher than the average productivity of all enclosed land: and from what is known of the likely location of major development over the next few years the trend seems likely to be maintained".* This sort of comment, though highly subjective, is deemed reasonable on a number of counts. Many settlements actively extending today were originally sited in fertile areas since this made the area initially attractive for settlement. Most towns and the greatest proportion of urban growth occurs in lowland England where most of the good agricultural land exists. On practical grounds it is desirable that a building site should be level and well drained; two attributes of good agricultural land.

The urban growth versus agriculture syndrome has therefore three components: absolute area loss, land quality, and urban intrusion effects. In assessing the significance of urban growth in terms of agricultural output ideally all three should be measured. In practice it is only possible to allow for the actual area lost to agriculture and the average quality of this land. Nothing quantitative may be said about the other effects of urban growth.

The extension of urban land in the future will be the result of a number of interacting factors. Two have already been discussed in some detail—population increase and economic growth. Population is one of the major factors governing urban growth. Obviously more people need more housing, work, shops, schools, and hospitals, but the mere statement of numbers oversimplifies the issue. Urban growth is closely connected with demographic changes as a whole which include the number of households, the age structure of the population, regional changes in population size, migration and so on. There are also determinants of urban extension which are independent of population size to a marked degree. Economic growth linked with technological change largely determines the growth of industrial activity and the demand for road, rail and air transport facilities. The growth of individual incomes provides potential purchasing power which may be used to buy more space for housing and other

* This statement arises from surveys made in the early 1950s by a research team in the Ministry of Agriculture directed by G. P. Wibberley. But this work is now very much out of date.

activities. Another factor linked with both increasing public and private affluence and social progress is the improvement of urban space standards. The effect of this is quite striking in some regions where urban development proceeds at a fast rate, although population size is increasing only slowly (Best and Champion, 1970).

On the basis of generally improving space standards and of population growth and economic growth proceeding at the rates already suggested in this study, R. H. Best (1968*a*) has estimated the average annual rate of urban extension in Great Britain between 1965 and the end of the century to be 18,200 to 19,200 hectares (45,000 to 47,500 acres) each year. Taking an estimate of 810 hectares (2,000 acres) a year for Northern Ireland, land transfers from agriculture to urban development in the United Kingdom will average 19 to 20 thousand hectares (47,000 to 49,500 acres) each year. Between 1965 and 2000 this amounts to between 665 and 701 thousand hectares (1,645 to 1,733 thousand acres) leaving agriculture, a loss of 1·0 per cent. of the agricultural land area each decade.

The next step is to assess what this loss means in terms of agricultural production. Using as a basis the system of agricultural land classification devised by Stamp (1960) the approximate production potential of the agricultural land of the United Kingdom in 1965 was derived. Assuming that virtually no urban growth would occur on moorland or upland rough grazing the average production value of enclosed agricultural land was estimated, and because better than average enclosed land is used for urban growth, a weighting factor of 1·5 was applied to this average potential to give a measure of the potential of land going into urban uses. This figure was then multiplied by the agricultural area to be transferred to urban development between 1965 and 2000 to give the agricultural value of the land lost to agriculture. When compared with the total production potential of the agricultural land of the United Kingdom it was found that 7·5 to 8·0 per cent. of this potential would be lost over the thirty-five years. This would mean that each remaining hectare in the year 2000 would have to produce 8·1 to 8·6 per cent. more agricultural output to make up for loss of land area. It is interesting to note that in terms of area alone agriculture will sustain a loss of 1·0 per cent. per decade, while in terms of production potential this loss will amount to about 2·2 per cent. per decade. Urban development will not swamp agriculture by the end of the century but it will have a significant impact in terms of production which will add another pressure to those which urge greater productivity from the agricultural industry.

The development of forestry

The United Kingdom has less than 8·0 per cent. of its land area

under forest and woodland (Table 41). This is a small proportion when compared with other European countries (F.A.O., 1963), yet much of the land at present afforested is the result of plantings undertaken only in the last twenty years. There was little government interest in forestry until the establishment of the Forestry Commission in 1919, and unlike many other nations the United Kingdom had only small areas of state forest, the bulk of woodland being in private ownership (H. L. Edlin, 1967).

After the establishment of the Forestry Commission in the inter-war years a little planting was done, but World War II emphasized the need for home-grown supplies of timber. During the war a report, *Post War Forest Policy* (Forestry Commission, 1943) set out a programme for forest development in the post-war years. The target was for 2·023 million hectares (5 million acres) of productive forest in Britain within fifty years. This would involve both the improvement of existing woodland and the afforestation of bare ground.

State afforestation

Immediately following World War II the Forestry Commission greatly increased its activities both in afforestation and woodland improvement. Between 1947 and 1967 almost 405,000 hectares (1 million acres) were added to the area of state forest. In this period the area of state forest trebled, the Forestry Commission having 685·6 thousand hectares (1,694 thousand acres) of forest and woodland under its control in 1965, 96 per cent. of this considered to be productive (Table 43). In this year it was estimated that there were 1,376 thousand hectares (3·4 million acres) of productive forest, including both state and private forest and this left 647 thousand hectares (1·6 million acres) to be afforested or improved in order to reach the target set up in 1943 (Forestry Commission, 1943).

State forests are found in all four countries of the United Kingdom, and their distribution in 1965 can be seen in Table 42. The greatest part of the Commission's land is in Scotland, and there is more forestry activity in Wales than in England. The distribution of planting is connected with the type of land the Forestry Commission acquires and most of this is upland rough grazing, moorland and heathland. The two main reasons for this are that competition with agriculture is minimized and the Forestry Commission cannot afford to purchase good lowland. The type of land used can be seen in Table 44 (P. A. Wardle, 1966), and it is clear that very little good agricultural land is taken for tree planting. A further factor in the location of Forestry Commission activities is that the rate of return expected by the Treasury on forestry investments in Scotland, the North of England

and Wales is substantially less than for purchase and planting in lowland England.

The Forestry Commission programme of work is currently expansionist. The target for 1964–73, amounting to 20,235 hectares (50,000 acres) of planting a year, has been substantially increased because plantings proposed in Scotland have been increased from 12 thousand hectares (30,000 acres) a year to 14·6 thousand hectares (36,000 acres) a year from 1969 onwards and subsequently, to 20·2 thousand hectares (50,000 acres) a year from 1965 onwards (J. D. Mathews, M. S. Philip and D. G. Cumming, 1969). The total Forestry Commission plantings for the United Kingdom are therefore programmed as 20,235 hectares (50,000 acres) annually between 1965

TABLE 42

Total Area of Forest and Woodland in the United Kingdom in 1965*

(10^3 hectares)

		England	Wales	Scotland	Northern Ireland	United Kingdom
Forestry Commission	Area	233·7	117·2	304·0	30·8	685·7
	Per cent.	26·4	58·4	46·4	73·2	38·4
Private	Area	652·3	83·4	351·6	11·3	1,098·6
	Per cent.	73·6	41·6	53·6	26·8	61·6
Total	Area	886·0	200·6	655·6	42·1	1,784·3
	Per cent.	100·0	100·0	100·0	100·0	100·0

* This table in terms of acres can be found in Appendix 9.
Sources: *Annual Abstract of Statistics* 1969. Forestry Commission, 1970.

TABLE 43

Productivity of Forest and Woodland in Great Britain, 1964*

(10^3 hectares)

	Productive		Unproductive		Total	
	Area	Per cent.	Area	Per cent.	Area	Per cent.
Forestry Commission	617·2	95·9	26·3	4·1	643·5	100
Private	712·3	65·2	380·4	34·8	1,092·7	100
Total	1,329·5	76·6	406·7	23·4	1,736·2	100

* This table in terms of acres can be found in Appendix 10.
Source: P. A. Wardle, 1966.

and 1969, 22,663 hectares (56,000 acres) annually between 1969 and 1976 and 28,239 hectares (70,000 acres) for each year from 1976 onwards. No further proposals are set out in specific terms but a reversal of this expansionist policy is not expected. One possible limitation to increased state afforestation is the difficulty which is and could continue to be experienced in obtaining plantable land at reasonable cost.

TABLE 44

Forestry Commission Planting by the Type of Site Used
(1963)

	Proportion covered (per cent.)	Agricultural value
Upland heaths, moors and bogs ..	70	Poor
Lowland heaths	13	Poor
Chalk downlands	4	Poor
Heavy clay	6	Average
Sites with high growth potential ..	7	Good
	100	

Source: P. A. Wardle, 1966.

It appears, therefore, that there is likely to be an estimated increase in the area of state forest of 919,480 hectares (2·272 million acres) between 1965 and 2000. By the year 2000 the forest area controlled by the Forestry Commission will be about 1,605 thousand hectares (3,966 thousand acres).

Private woodland

Although the area of state forest has been trebled since 1947 the bulk of the nation's woodland remains in private ownership (Table 42). In 1965 1,098 thousand hectares (2,715 thousand acres) of forest and woodland in the United Kingdom were privately owned. This woodland is very varied. The size of holding may range from 2 to 40,000 hectares (5 to 10,000 acres), and the woodland may be well run and productive or completely derelict. About one-third of all privately owned woodland is now classed as unproductive. Future developments in the private sector are difficult to foresee with any degree of confidence. It has been estimated that owners of private forestry plant about 15,000 hectares (37,000 acres) annually, of which 8,100 hectares (20,000 acres) are for restocking cleared woodland (Edlin, 1969). The total woodland area in private hands is, however, falling and this indicates that there must be, on balance, more felling and clearing than new planting. There appears to be two distinct groups of wood-

land owners. One group is pursuing an active policy of planting, felling and restocking while the other has no interest in forestry as such and is trying to reduce the area of woodland under its control, mainly to increase the area under agricultural use. It has in fact been estimated that 64 per cent. of disafforestation is for agricultural purposes (Forestry Commission, 1970).

Estimates made by the Forestry Commission suggest that by the end of this century there will be 809 thousand hectares (2 million acres) of productive woodland in private hands. No figure is given for the remaining unproductive area. To bring the total area of privately owned productive woodland to 809 thousand hectares (2 million acres) another 95 thousand hectares (235 thousand acres) must be added to the 1965 productive area of 714 thousand hectares (1,764 thousand acres). It is difficult to tell how much of the remaining unproductive area will remain by the end of this century. A reasoned guess for the year 2000 puts privately owned forestry at 1,012 thousand hectares (2·5 million acres) and this represents a fall of 87 thousand hectares (215 thousand acres) over 35 years.

The agricultural implications of probable changes in forest and woodland

In essence Forestry Commission plantings are estimated to cover 1,605 thousand hectares (3,966 thousand acres) in the United Kingdom by the end of the century, a rise of 919 thousand hectares (2·272 million acres) over 1965. Privately owned woodland area is expected to be about 1,012 thousand hectares (2·5 million acres). This will give a total forest and woodland area of approximately 2,617 thousand hectares (6·467 million acres), a net increase of about 832 thousand hectares (2,056 thousand acres).

Forestry, fortunately, does not have the same impact on agriculture as urban growth. Planting is principally carried out in the uplands and poorer lowlands which have a limited agricultural value and thus competition with productive agriculture is minimized. The viability of private forestry concerns will probably improve but this is unlikely to take much good land out of agriculture for, like the Forestry Commission, private concerns cannot really afford to take over good agricultural land for afforestation and, in addition, they have considerable scope for the improvement of existing woodland. Any land which is reclaimed for agriculture from existing woodland will probably be about average in quality so it will prove a small, but nevertheless positive, net addition to cultivated farm land.

By using a weighting procedure based on data derived from Table 44, the agricultural significance of the net increase in forest area of 832 thousand hectares has been estimated to be of the order of 1·95 per cent. of overall production potential of farm land in the United

Kingdom. Thus agricultural losses to forestry will be only moderate in terms of productivity and output—amounting to 0·555 per cent. per decade, although the loss in terms of area will be 1·2 per cent. per decade.

Outdoor recreation and rural land use

Outdoor recreation now ranks as one of the potentially important users of rural land, and research into recreational demands and the provision of appropriate facilities is now a growing section of land planning. Studies made by Burton and Wibberley (1965) have emphasized the role of the countryside in providing for outdoor recreation both in relation to existing levels of use and future demands and their work is largely used as a base for this section.

The determinants of demand for outdoor recreation were first pointed out by American research work, but the findings are equally applicable to the United Kingdom. Demand is largely determined by the size of the population and by its age structure together with the degree of urbanization or sub-urbanization of the population which strongly influences the desire for leisure hours in the countryside. The ability of the individual to take part in recreational activities is conditioned by the length of the working week and the length of the annual holiday and by the size of personal income. In addition the level of education attained and the degree of personal mobility are important. In the United Kingdom all these factors are moving in a positive direction to increase the demand for outdoor recreation. This has important implications for rural land use for the basic resource required for many forms of recreation is land. Urban sports centres and inland water will be important but areas of land in the countryside will also be wanted.

It is difficult to foresee how seriously the claims of recreation will affect the agricultural industry. There has always been quite substantial use of the countryside for leisure activities of both an active and a passive nature but until recent years this has not had too serious an impact on farming practice. The rapidly growing demand for recreation, and greater mobility, coupled with modern farming methods and the greater intensity of agricultural activity, does indicate some conflict of interest. The agricultural industry is bound to feel the impact of recreation and equally those seeking pleasure in the countryside will be concerned about modern trends in agriculture.

An estimate made by Burton and Wibberley (1965) suggested that 1·2 million hectares (3 million acres) of England and Wales were in effective recreational use in 1962/3, and on a considerable area of "open country" in Scotland there was *de facto* access by the public. They included in their estimates common lands available for recrea-

tion, Forestry Commission parks, some private woodland and portions of National Trust and nature reserve property where appropriate. There was also a very small proportion (less than 1 per cent. of the total area) of National Parks where access agreements with landowners had been made. This last category emphasizes one of the main problems of outdoor recreation, that of *de facto* access to the countryside. Only in a few cases—for instance in the "open forests" run by the Forestry Commission, and at reservoirs managed by water authorities is there statutory public management of recreational areas. In the ten National Parks of England and Wales, accounting for 9 per cent. of the total land area of the two countries, there is very little recreational management as such.

In some cases recreational provisions are made by private concerns and in most of these cases there is some degree of control and resource management with the interests both of the landowner and the public taken into consideration. Most of the privately made provisions are, however, for the more intensive and gregarious recreational activities, and for facilities such as caravan and camp sites.

Future developments in rural recreation will obviously affect farming and rural land use to some degree. The Countryside Commission and local authorities, aware of the growing demand and the associated pressures, have been given the task of providing opportunities for enjoyment in the countryside. What is not clear is the form that these developments will take and their impact on agricultural output and productivity.

Outdoor recreational developments in relation to agriculture are likely to take two main forms. The first is where certain areas of land, large or small, will be devoted almost entirely to recreation, and agricultural activity will be limited or non-existent. The second form is where land will be mainly in agricultural use and any recreational use of the land will be light. In addition to the areas where recreation will be permitted to some degree there are bound to be large areas of farm land where no recreation will be sanctioned.

There are already in existence examples of the first type of recreational land use. The Duke of Bedford and the Marquis of Bath both use a part of their country estates purely for the pleasure of visitors. On a more modest scale farmers with holdings near to the coast or in popular recreational areas set aside fields for caravans, camping and holiday chalets. The best example of the second type of recreational land use is provided by National Parks, although few access agreements have been made with landowners. Where footpaths and bridleways across farm land are used properly agricultural activity can go on unaffected by this light recreational use. Bird watching and fishing would also come into this category.

Both kinds of recreational land use will be developed further in the future. In the case of a complete transfer of land from agriculture to recreation, whether it be for a road layby, a caravan site or a park full of wild animals, the situation is clear cut and an area loss to agriculture or perhaps forestry will be involved. The greater problems will arise from the multi-use of land for both agriculture and recreation. This will involve a great deal of practical organization and careful management which is as yet relatively untried in this country. One of the principal proposals for recreational provision in the countryside is the "country park" to be created by local authorities under the guidance of the Countryside Commission, and specifically for "recreational and quiet enjoyment". At present the land which will be used for these parks is mostly in agricultural or forestry use. The size distribution of these country parks is not known or how the parks will be managed in relation to present land uses. The typical country park might well cease to have any agricultural importance and become merely a playground in rural surroundings. On the other hand it might be so managed as to preserve a productive agricultural interest in the land but at the same time provide authorized access to the sort of countryside the public wish to enjoy. This interaction will, of course, be the most difficult to attain but it would appear to be the kind of development most likely to satisfy both those who demand recreation and those on whose land it is to take place.

Any casual recreational use of good farm land is liable to affect agricultural productivity and, ideally, an integral part of recreational planning should be the zoning and management of rural areas into two types—those which can absorb heavy recreational use, such as moorlands and rough grazings, and those which cannot and should not, such as commercial farming areas of the Fens. Recreation should, where possible, be organized to minimize interference with commercial agriculture, as well-farmed land is an asset to the rural scene and no small part of the enjoyment of the countryside is the observation of farming activities.

While no quantitative estimate can be made at this time as to the area of land that is likely to be transferred wholly or partially into recreational use in the future or the likely effect of this on agricultural production, it is clear that some loss in agricultural output will be sustained. A great deal will be expected from the agricultural industry of the future in terms of productivity and import saving, but it must be remembered that the countryside has other roles to play. One of these will be the provision of outdoor recreation facilities and this will modify the productive potential of the agricultural industry to some extent.

The general picture

Over this century a number of claims for rural land have arisen which compete strongly with agriculture, which is the major land user of the United Kingdom. In order to satisfy these demands land will be transferred from agriculture to other uses, and so the effective agricultural area will contract and with it the overall productive potential of the industry.

By the year 2000 the distribution of land between the major uses will be roughly as shown in Table 45, with the reservation that the category "unaccounted for" may be reduced as knowledge of land uses improves. (There might in future be a new category introduced of land being used for recreation.) Agricultural use will still account for 75 per cent. of the total land area of the United Kingdom and forestry and urban land will each extend over about 11 per cent. of the land area.

The impact of urban development and afforestation on agriculture can be assessed in so far as it concerns area and land quality. There are, however, aspects of urbanization such as the effects of urban intrusion into the countryside where no quantitative measures can be made. Equally, the quantitative effect of recreation in the countryside cannot be determined. It is probable, however, that the effects of both urban intrusion and recreation will have a depressing effect on agricultural production and efficiency.

Urban development and forestry together will extend over another 1·5 million hectares (3·7 million acres) between 1965 and 2000. This represents 6·2 per cent. of the total land area of the United Kingdom and, more important, 7·64 per cent. of all agricultural land. In terms of production this is equivalent to about 9·65 per cent. of the total productive potential of United Kingdom agricultural land. In order to make up for this loss each remaining agricultural hectare in 2000 must therefore produce an extra 10·7 per cent. of output. This

TABLE 45

Land Use in the United Kingdom in A.D. *2000**

	Area (10^3 hectares)	Percentage of total land area
Total land area	24,080	100·0
Agricultural land	18,122	75·25
Forestry	2,617	10·86
Urban land	2,745	11·43
Unaccounted for	596	2·47

* This table in terms of acres can be found in Appendix 11.

increase must be added to the other demands for extra output from British agriculture stemming from population and income growth and improved self-sufficiency. The overall implications of this are set out in Chapter 8 where the various predictions made in this study are brought together.

References

Annual Abstract of Statistics (1969). H.M.S.O.

Best, R. H. (1965) "Recent changes and future prospects of land use in England and Wales". *Geographical Journal.* 13, Part 1. March 1965.

Best, R. H. (1968*a*) "The extent of urban growth and agricultural displacement in post-war Britain". *Urban Studies.* Vol. 5, No. 1.

Best, R. H. (1968*b*) "Competition for land between rural and urban uses". *Transactions and papers of the Institute of British Geographers.* Publication No. 44.

Best, R. H. and A. G. Champion (1970) "Regional conversions of agricultural land to urban use in England and Wales, 1945–67". *Transactions of the Institute of British Geographers.* Publication No. 49.

Best, R. H. and J. T. Coppock (1962) *The changing use of land in Britain.* Faber and Faber. Chapter 6.

Best, R. H. and M. Mandale. Table 41 is partly constructed from unpublished data compiled and estimated by these two workers at Wye College in connection with a research project supported by the S.S.R.C. Please note that, until official publication, the land-use figures for urban land may not be quoted without permission from the individuals concerned.

Burton, T. L. and G. P. Wibberley (1965) *Outdoor Recreation in the British Countryside.* Wye College.

Edlin, H. L. (1967) *Forestry in Great Britain.* Forestry Commission Booklet.

Edlin, H. L. (1969) *Timber. Your growing investment.* Forestry Commission Booklet No. 23. H.M.S.O.

Food and Agricultural Organization of the United Nations (1963) *World Forest Inventory.* F.A.O., Rome.

Forestry Commission (1943) *Post-War Forest Policy.* Command 6447. London, H.M.S.O.

Forestry Commission (1970) *Census of Woodlands 1965–7.* H.M.S.O.

Grayson, A. J. (1967) *Forestry in Britain in Economic Change and Agriculture.* Edited by J. Ashton and S. J. Rogers. Oliver and Boyd.

Mathews, J. D., Philip, M. S. and D. G. Cumming (1969) *Forestry and the Forest Industries.* Agricultural Adjustment Unit Conference, "The Remoter Rural Areas of Britain".

Ministry of Agriculture, Fisheries and Food (1970) *Agricultural Census Data.* Statistics Branch, Guildford.

Select Committee on Agriculture (1969) H.M.S.O.

Stamp, L. D. (1960) *Applied Geography.* Pelican.

Wardle, P. A. (1966) "Land Use Policy". *Timber Grower.* No. 19.

Wibberley, G. P. (1967) "Land scarcity in Britain". *Journal of the Town Planning Institute.* April 1967.

Chapter 8

LAND REQUIREMENTS FOR UNITED KINGDOM AGRICULTURE BY THE YEAR 2000

This chapter brings together the suggestions, forecasts and predictions made in earlier sections of this study to express their cumulative impact on the United Kingdom land situation in the year 2000. Most of the chapter consists of tables with explanations where necessary. Tables 46, 47 and 48 are familiar and Table 49 is an expanded version of Table 27 in Chapter 4. Together they represent the demand for food produced on farms in the United Kingdom and the implications for resource use in agriculture. Tables 50 and 51 are new, as they combine the demand data with the predictions on productivity made in Chapters 6 and 7 and show how a balance could be achieved

Table 46

Population

1965 Population of United Kingdom = 54,436 million

	Rates of Population Growth		
Predicted growth rate range ..	0·60	0·65	0·70
Population in the year 2000 ..	67·3 m.	68·5 m.	69·7 m.
Percentage increase over 1965 ..	23·3	25·5	27·7
Percentage increase over 1965 in terms of consumer units ..	22·1	24·2	26·4

Table 47

Income Growth

Index of real personal disposal income per head in 1965 = 100

	Rates of Income Growth		
Predicted growth rate range ..	2·0	2·5	3·0
Level of income per head in the year 2000	200·0	237·5	281·4
Resulting level of demand for food per head in the year 2000 in terms of farm gate value	108·6	110·0	111·6

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between demand and agricultural output by the year 2000. When an allowance is made for the loss of agricultural production potential, due to competing land uses, the balance of Tables 50 and 51 is changed. Tables 52 and 53 show the conditions which are necessary for equilibrium to exist between the demands for land to be retained in agricultural use and the demands for land to be transferred to other uses.

TABLE 48

The Demand for Food

Index of total demand for food in 1965 = 100

	Income Growth Rates		
Population Growth Rates	2·0	2·5	3·0
0·60	132·6	134·3	136·3
0·65	134·9	136·6	138·6
0·70	137·3	139·0	141·0

The demand for food at the farm level in the United Kingdom is predicted to increase by between 32·6 and 41·0 per cent. in the period 1965 to 2000.

The demand for food

The demand for food in the United Kingdom is a function of the population size, the composition of population in terms of consumer units and the real wealth of consumers. Tables 46 and 47 show the forecast rates of growth of these elements in the period 1965 until 2000 and Table 48 shows the resulting demand for food. One point deserves emphasis: although income growth itself is substantial, its impact on the consumption of food is small, particularly in terms of demand at the farm gate level. Population growth alone accounts for about three-quarters of the total increase in demand for food.

The demand for food and feed produced on farms within the United Kingdom

The total demand for food in the United Kingdom is not met solely from home agriculture. In 1965 the United Kingdom produced 60 per cent. of all the temperate, or potentially replaceable, food and feed products she consumed. The level of self-sufficiency is expected to improve, partly because this is in line with the general trend in food imports, partly because there is both encouragement from the government and technical opportunity for import replacement. A range of conceivable levels of self-sufficiency might reach 80 per cent. self-sufficiency (if the United Kingdom had replaced the £800 millions of potentially replaceable imported foods in 1965 she would

TABLE 49

The Demand for United Kingdom Agricultural Output in the Year 2000 (1965 = 100)

Demand for food and feed in the year 2000 1965 = 100	Self-sufficiency level in the year 2000				
	60%	65%	70%	75%	80%
	Implied extra demand for agricultural output				
	0%	8·3%	16·6%	25·0%	33·3%
133	133·0	144·1	155·2	166·3	177·3
134	134·0	145·2	156·3	167·5	178·7
135	135·0	146·2	157·5	168·8	180·0
136	136·0	147·3	158·7	170·0	181·3
137	137·0	148·4	159·8	171·3	182·7
138	138·0	149·5	161·0	172·5	184·0
139	139·0	150·6	162·6	173·6	185·3
140	140·0	151·7	163·3	175·0	186·7
141	141·0	152·7	164·5	176·3	188·0

The range of demand for domestically produced food and feed, shown by Table 49 is very wide. Within the self-sufficiency limits judged to be most likely this is narrowed to an increase in demand of between 44 and 76 per cent., which calls for a substantial increase in agricultural output.

have been almost 80 per cent. self-sufficient). But this is very unlikely in practice, especially as it would cut back into base year (1965) import levels. At roughly 70 per cent. self-sufficiency an additional demand for food of 40 per cent. could be met entirely from home resources but no inroads made into base year imports. The most probable self-sufficiency levels in the year 2000 would lie in the range 65 to 75 per cent. In Table 49, however, the wider range is included to illustrate the pressures created by greater self-sufficiency improvements.

Productivity improvements in the use of agricultural land

The agricultural industry is able to increase the output and hence the productivity of a given area of land. This makes a very valuable contribution to solving Britain's land use problems. The rate of output growth, or productivity in the use of agricultural land, forecast for the period of the study was 2·0 to 2·75 per cent. compounded annually, although a more conservative trend in agricultural output growth has also been included for comparison. Table 50 shows the range of output growth rates and the corresponding levels of output per hectare in the year 2000. If these output levels are compared with the levels of demand for farm output derived earlier it is possible to determine whether the agricultural industry is able to meet the extra demand for its products or not.

Explanation of tables 50 and 51

For example:

An increase in output per hectare of 2·25 per cent. compounded annually for thirty-five years gives a production level per hectare in the year 2000 118 per cent. greater than in 1965. If there is no decline in the agriculture area in that period the aggregate output of the agricultural industry will therefore increase by 118 per cent. If demand grows by 50 per cent. between 1965 and 2000 then it can be met by

$$\frac{150}{218} \times 100 = 68{\cdot}8 \text{ per cent. of production capacity in 2000.}$$

An output growth rate per hectare of 3·0 per cent. given a linear trend increases agricultural output by 105 per cent. between 1965 and 2000 providing no area losses are incurred by agriculture. If demand grows by 70 per cent. it can be met by $\frac{170}{205} \times 100 = 82{\cdot}9$ of production capacity by the year 2000.

Any conclusions drawn from Table 50 (or Table 51 if it is preferred) omit the final element in the argument, that of competition for farm land from non-agricultural sectors. A 2·5 per cent. annual increase in output per hectare will only produce a 2·5 per cent. increase in

TABLE 50

The Balance Between the Demand and Supply of Agricultural Output in 2000

(using an exponential output growth trend)

Annual Increase in Output per Hectare

% compounded annually

Demand for output produced on farms in the United Kingdom in the year 2000 (1965 = 100)	2·0	2·25	2·5	2·75
	Output per hectare in 2000 (1965 = 100)			
	200·0	218·0	237·5	258·7
130	65·0	59·6	54·7	50·3
135	67·5	61·9	56·8	52·2
140	70·0	64·2	58·9	54·1
145	72·5	66·5	61·05	56·0
150	75·0	68·8	63·2	58·0
155	77·5	71·1	65·3	59·9
160	80·0	73·4	67·4	61·8
165	82·5	75·7	69·5	63·8
170	85·0	78·0	71·6	65·7
175	81·5	80·3	73·7	67·6
180	90·0	82·6	75·8	69·6
185	92·5	84·9	78·0	71·5
190	95·0	87·2	80·0	73·4

total agricultural output if the agricultural area does not change. The estimates made in Chapter 8 suggested that there would be a drop in the agricultural area of 7·64 per cent. between 1965 and 2000. Furthermore, this would represent a loss of 9·65 per cent. in production potential. If this factor is taken into account production levels in the year 2000 are correspondingly reduced. For example, instead of a productivity increase of 2·5 per cent. per annum giving an output of 237·5 in 2000 (1965 = 100), it will give an output of 237·5 × 90·35 = 214·5.

TABLE 51

The Balance Between the Demand and Supply of Agricultural Output in 2000
(using a linear output growth trend)

Annual Increase in Output per Hectare
% linear trend

Demand for output produced on farms in the United Kingdom in 2000 (1965 = 100)	2·5	2·75	3·0	3·25
	Output per hectare in 2000 1965 = 100			
	187·5	196·4	205·00	213·8
130	69·3	66·2	63·4	60·8
135	72·0	68·7	65·9	63·1
140	74·7	71·3	68·3	65·5
145	77·3	73·8	70·7	67·8
150	80·0	76·4	73·2	70·2
155	82·7	78·9	75·6	72·5
160	85·3	81·5	78·0	74·8
165	88·0	84·0	80·5	77·2
170	90·7	86·6	82·9	79·5
175	93·3	89·1	85·4	81·8
180	96·0	91·7	87·8	84·2
185	98·7	94·2	90·2	86·5
190	100·7	96·7	92·7	88·9

In order to show how the loss of production potential, due to land transfers from agriculture, affect the balance between supply and demand for farm products in the year 2000 four possible levels of loss are assumed. These are 10 per cent., which is approximately the level of loss predicted in Chapter 8, 15 per cent., 20 per cent., and 8 per cent. Tables 52 and 53 are derived by marking contours, corresponding to levels of land loss on the arrays of Tables 50 and 51. Tables 52 and 53 then show which combination of demand for agricultural output and productivity levels are possible given each level of production potential loss. Any combination *above* the appropriate contour represents a situation where conflict in land use does *not* occur.

The implications of Tables 52 and 53 can best be illustrated using three examples of population, income growth and self-sufficiency levels.

TABLE 52

The Balance Between the Demand and Supply of Agricultural Output in 2000 when Non-agricultural Demands for Land have been met

(using an exponential output growth trend)

Annual Increase in Output per Hectare
(% compounded annually)

Demand for output produced on farms in the United Kingdom in the year 2000 (1965 = 100)	1·0	2·25	2·5	2·75
	Output per hectare in 2000 (1965 = 100)			
	200·0	218·0	237·5	258·7
130	65·0	59·6	54·7	50·3
135	67·5	61·9	56·8	52·2
140	70·0	64·2	58·9	54·1
145	72·5	66·5	61·1	56·0
150	75·0	68·8	63·2	58·0
155	77·5	71·1	65·3	59·9
160	80·0	73·4	67·4	61·8
165	82·5	75·7	69·5	63·8
170	85·0	78·0	71·6	65·7
175	87·5	80·3	73·7	67·6
180	90·0	82·6	75·8	69·6
185	92·5	84·9	78·0	71·5
190	95·0	87·2	80·0	73·4
	8% Loss	10% Loss	15% Loss	20% Loss

(a) *Low demand assumption*

If population and real income per head grow relatively slowly at 0·6 per cent. and 2·0 per cent. per annum respectively, the demand for food grows by 33 per cent. between 1965 and the year 2000. Coupled with a slow improvement in self-sufficiency from 60 per cent. in 1965 to 65 per cent. in 2000 this creates a demand for home-produced farm products of 144 in 2000 (1965 = 100). If 10 per cent. of agricultural production potential is lost through urban extension, afforestation and so on in the same period total demand can be met easily by any exponential or linear growth rate shown in Tables 52 and 53. Even if 20 per cent. of agricultural production potential is lost this relatively small increase in demand can be met.

TABLE 53

The Balance Between the Demand and Supply of Agricultural Output in 2000 When Non-agricultural Demands for Land have been met

(using a linear output growth trend)

Annual Increase in Output per Hectare (% linear trend)

Demand for output produced on farms in the United Kingdom in 2000 (1965 = 100)	2·5	2·75	3·0	3·25	
	Output per hectare in 2000 (1965 = 100)				
	187·5	196·4	205·00	213·8	
130	69·3	66·2	63·4	60·8	
135	72·0	68·7	65·9	63·1	
140	74·7	71·3	68·3	65·5	
145	77·3	73·8	70·7	67·8	
150	80·0	76·4	73·2	70·2	
155	82·7	78·9	75·6	72·5	
160	85·3	81·5	78·0	74·8	
165	88·0	84·0	80·5	77·2	
170	90·7	86·6	82·9	79·5	20% loss
175	93·3	89·1	85·4	81·8	
180	96·0	91·7	87·8	84·2	15% loss
185	98·7	94·2	90·2	86·5	
190	100·7	96·7	92·7	88·9	
			8% Loss	10% Loss	

20% loss 15% loss

(b) *Medium demand assumption*

If population grows at 0·65 per cent. each year and real income per head by 2·5 per cent. each year the demand for food would grow by 37 per cent. between 1965 and 2000. If self-sufficiency increases from 60 per cent. to 70 per cent. this gives a demand for home produced farm products of 160 in the year 2000 (1965 = 100). In this case a loss in production potential of up to 20 per cent could be accommodated if an exponential growth rates of at least 2·0 per cent. was achieved. If a linear trend in output is expected then an increase in demand of 60 per cent. would require an annual increase in output of 2·5 per cent. if land losses were to account for 10 per cent. of production potential. If losses were 15 per cent. a 2·5 per cent. annual increase would be barely sufficient, and with a loss of 20 per cent. a 3·0 per cent. annual increase in output would be needed.

(c) *High demand assumption*

The highest level of demand for food envisaged was of an increase of 41 per cent. by the year 2000; the result of a population growth rate of 0·70 per cent. each year and a real income growth rate of 3·0 per cent. each year. With a substantial increase in overall self-sufficiency, from 60 per cent. in 1965 to 75 per cent. in the year 2000, this gave an increase in demand for home-produced farm products, between 1965 and the year 2000, of 76 per cent. At this level of demand a 10 per cent. loss in production potential requires an annual productivity improvement of at least 2·0 per cent. compounded annually. A 15 per cent. loss would require a 2·25 per cent. annual increase in output per hectare and a 20 per cent. loss a 2·5 per cent. annual increase. If the linear growth trend assumption is used then for a 10 per cent. loss an annual output increase of 2·75 per cent. is barely sufficient to compensate. For 15 per cent. and 20 per cent. losses in production potential the annual output increases necessary are 3·0 per cent. and 3·25 per cent respectively.

Conclusion

While the implications of this analysis will be discussed more fully in Chapter 9 some comments can be made at this stage.

It is possible, using the tables provided in this chapter, to trace the land use implications of a number of different developments regarding population growth, agricultural self-sufficiency, economic growth, urban and recreational provisions and afforestation and to see how these can be matched by different levels of productivity in the agricultural industry.

In this way the findings of this study show how a land use "balance" may be achieved up to the end of this century. The term "balance" implies that the different demands which are likely to be made on the land area of the United Kingdom can be satisfied without any sector having to sustain a real and irreversible loss due to the development of other sectors. This means, for instance, that meeting the non-agricultural demands for land foreseen up to the end of the century does not necessarily involve the reduction of agricultural output to a degree where, in order to meet demands for food and feed, Britain would have to accept self-sufficiency levels lower than those deemed economically desirable. Alternatively a "balance" in land use means that it is possible for home agriculture to feed a growing population and maintain or possibly increase self-sufficiency levels and at the same time release land for urban growth, forestry and recreation at a rate which allows adequately for their likely future development.

What would constitute a serious imbalance, for example, would be the failure of the agricultural industry to meet the demand for its

output that food needs and Britain's external trading balance might dictate, unless there was a drastic long-term reduction in the area of land going into non-agricultural uses which, of course, would give rise to the many problems associated with restrictive land use controls.

If this analysis is made then the tables presented in this chapter do indicate that in fact a balance can be created, up to the end of this century at least, between competing land uses. This basically optimistic outcome is discussed in more detail in the following chapter.

Chapter 9

THE IMPLICATIONS OF THIS LAND BUDGET

It has been necessary to present the findings of this research in an involved way because the subject is a very complicated one. Any undue simplicity of presentation would be dangerous as well as wrong, particularly as the subjects of present and future land use are very emotive.

An attempt to forecast a future land use budget for the United Kingdom is complicated first by the relatively large number of variables involved. Each of these variables is difficult to measure, a good example of this being the analysis made in Chapters 5 and 6 of growth in agricultural productivity. We have also taken all the risks involved in a long time period—the thirty-five years between 1965 and 2000—and in decisions as to the way some of these variables will alter through this time.

But despite all the difficulties and errors of the analysis it seems clear that the overall land use position of this country should not be difficult in terms of the availability of land for all major uses. There is nothing in the analysis to support any prophet of doom—nothing to help those who insist that Britain is bound to be heavily overcrowded by the end of this century and without the natural resources to support the people it will contain. Unless we have been wrong on *all* of our estimates and assumptions there should be enough land area for us to use—but, of course, we shall have the constant problem of using it wisely or unwisely.

This, therefore, is the principal finding of this study. A major conflict could occur between competing land uses by the year 2000 but it is by no means inevitable. If one accepts that agricultural output can and will show exponential growth, or something closely approaching it, then the levels of demand for food and movements of land out of agriculture must be relatively high to create a severe overall conflict in land use by 2000. Even accepting the authors' more cautious judgement that output of food is likely to increase by 110 to 120 per cent. between 1965 and 2000, no serious conflict arises unless the demand for food grows by more than 70 per cent. and land lost to agriculture exceeds the forecast loss of 10 per cent. of food production potential. If a linear growth trend is preferred for agricultural output then conflict arises at more modest increases in the demand for food and for land area for non-food uses.

Another feature of this study has been the insight it has given into the various factors contributing to balance or imbalance of land uses in the United Kingdom. Population growth is the important factor in determining the demand for food whereas personal income growth has little significant impact. The size of British agriculture, that is, the proportion of the nation's food needs produced at home, is quantitatively important in the demand for land, whereas both population growth and economic growth influence the non-agricultural demand for land to a great extent. Agricultural productivity also influences the land use balance to a very significant degree. It is therefore possible to achieve a balance in land use in a number different ways as no one factor is all-important. A potential imbalance may be tackled by lowering the demand for home-grown food either by limiting population growth or by accepting a lower level of self-sufficiency in agricultural products. It can also be tackled in terms of agricultural productivity or, alternatively, by alterations in the extent of agricultural land losses. Equally a combination of two or more of these would be effective.

On the purely agricultural side, the analysis has provided evidence that we can, as a nation, expect with some confidence that changes can take place in the agricultural sector which will make it possible for us to meet the level of demand for home-produced agricultural products expected and at the same time reduce the area of land in agricultural use so that it can be available for other uses. This optimism is based on the following conditions: (a) that there will be no significant increase in the size of British agriculture over and above that allowed for in the forecasts; (b) that it is possible to attain the rates of increase in agricultural output forecast; (c) that land losses to agriculture will not be severe in terms of either area or quality; (d) that there is an effective rural and urban planning policy with regard to such matters as urban density, urban form, recreation.

While we can see in a simple and direct way what conditions are necessary to prevent serious conflict arising in land use, to state them categorically is to present a naïve view of what is essentially a complex situation. None of the conditions can be treated in isolation from the others since they are interrelated. Neither can the agricultural factors be isolated from those which are non-agricultural. There will always be a number of alternatives open to the nation. Once the costs and benefits involved are appreciated then we can be aware of the possible trade-offs between different land use situations in the United Kingdom. Simply balancing a land budget in terms of acres or hectares is insufficient. There are critical implications of a social, economic and environmental nature to take into account. Any balance in land use is not purely fortuitous. It is something to be consciously worked for

and it involves a number of very real choices, and hence opportunity costs, for the community and for the individual. An obvious, yet important, point to appreciate also is that land planning problems will not come to an end in the year 2000.

We have reached an era in land planning when a number of alternative acceptable courses are open to the nation, particularly in the light of this study which indicates the real contribution which the agricultural sector can make in balancing competing land needs. Whether it is in the long run desirable to see agriculture fulfilling its wholly traditional role or not is a matter for community decision.

Before the future of the agricultural industry can be appreciated it is necessary to look at the two major forces in economic and social planning which condition any land use policy from the outset and continue to influence developments over time—population growth and economic growth. Many of the pressures which are faced by the United Kingdom are the result of population growth. Are we as a nation prepared to adopt a positive policy towards population size? Have we any concept of an ideal population size, and if we do, do we have any method of achieving the desired goal? Should the decision between personal freedom and policy determination be made here rather than at later stages in the planning process? A fast rate of economic growth can bring with it numerous benefits to the individual and the state but at the same time create problems of dealing with wealth and the side effects of a high level of economic activity. For instance, a satisfactory economic growth rate may permit the nation to give more freedom to individuals in relation to their spatial demands since the balance of payments situation might not require such a large home agriculture. Economic growth can increase some of the hazards to the urban and rural environment but should equally bring the economic and technological resources to contain them. As far as the implications of this study are concerned a relatively wealthy nation with a secure external trading balance is permitted far more freedom in land use matters and is not tied to the acceptance of traditional values regarding agriculture or the role of rural land in general. Thus any conclusions we may suggest on the land use of the future, particularly with regard to agriculture, are not independent of the choices open to the United Kingdom in formulating a population policy or in allocating resources in a situation of greater or lesser economic growth.

What will be expected of British agriculture by the end of the century will therefore be largely influenced by external forces and the resulting choices with regard to resource use. These will determine the size of British agriculture and the intensity with which land is used by agriculture. The proportion of food needs which should be

met from home resources is central to agricultural policy making. Adjustments in the size of the future home agricultural industry will be a function of a number of factors; considerations of safeguarding the nation's food supply, social conditions and needs in agriculture, the relative cost of home-produced as opposed to imported food, the productivity of resources in agriculture as compared with other sectors of the economy, the external trading position of the United Kingdom and the long-term view of the role of rural land in Britain in the light of changing agricultural technology, other needs for land and the rural environment. This study has suggested that the size of British agriculture can increase gradually should economic conditions warrant it, but any pressures for a large-scale additional contribution to replacement of food imports will inevitably lead to pressures in land use. It is therefore necessary to weigh the net contribution which agriculture can make to the balance of payments situation against the pressures in land use this would create for other sectors of the economy. It is possible that the costs to the community of tightening the land budget might far outweigh any gains to the trading position of the country—particularly where there are alternative ways of redressing an adverse payments situation which may be less costly in land use terms.

The rate of agricultural output growth in relation to the level of demand for agricultural products will be fundamental to balancing different land needs in the future. What must not be neglected is that the rate of output growth in this industry is not an unchangeable phenomenon but depends on consciously undertaken investment and technological decisions. The willingness of farmers to undertake intensification of agricultural land use is determined by the real price of agricultural products in relation to their cost of production. Thus growth in output depends upon the amount consumers are prepared to pay for the extra output and upon the agricultural policy which is followed to this end. The predictions of rates of output growth made in this study are reasonable long-term assumptions given adequate incentives. Lower rates could certainly be experienced if the flow of resources into agriculture was to be smaller. It is unlikely in practice, however, that the British nation would be prepared to allocate a disproportionate amount of resources to agriculture in order to produce an output in excess of that required to meet food needs and to release enough land required for other purposes.

It is certainly unlikely that British agricultural profitability would be such that the output of food outstripped British demand for it in the long run. Policy adjustments would obviously match agricultural supply with the various demands to be made on the agricultural industry. What we therefore envisage happening is that

agricultural policy, reflecting general land planning goals, will be such as to promote the intensification of agriculture in order that food demands can be met and land released for other purposes as it is needed. We see neither serious over-production of food nor land being abandoned by agriculture in advance of a need for it by other sectors. It would not be correct to conclude from Tables 50–53 that a high output growth rate would mean that agriculture would actually only use, say, 80 per cent. of the land available for it in the year 2000 and the rest of the land would be unused. High output growth rates reflect prosperity in agriculture and a buoyant demand and land would not leave agriculture to become derelict in such circumstances. On the other hand there are difficult areas in agricultural use in this country which might well have a change in emphasis in agricultural production over time particularly if they cannot compete in cost terms with the better agricultural land. In formulating land planning goals, however, we must also recognize that, given a range of choices for the community, it may be that the intensification of agricultural practices will be deemed undesirable from an amenity standpoint and this factor would then have to be weighed against the benefits which may accrue if land is able to leave agriculture without reducing food output. Another issue is, of course, the acceptability of the products produced by intensive agricultural systems. In addition there is likely to be an increasing emphasis on synthetic foods which to a greater or lesser extent by-pass the agricultural process in their production. Certainly they could contribute to easing land pressures but how acceptable will synthetics be as foodstuffs if there are feasible alternatives?

Another area of community choice influencing agriculture is the quality of land which is taken from agriculture for urban growth and forestry, and also the location and form of urban land uses. It is often stated that urban growth should avoid the best agricultural land and, indeed, if we do require maximum productivity from agriculture there is no question that it should. But what costs are involved in consciously planning settlements and other urban uses on poorer than average agricultural land? Are urban forms which minimize interference with agriculture unacceptable as places in which to live and work? Will the general expansion of urban settlements, lower housing densities, greater personal mobility and more recreational provision be worth the monetary and non-monetary costs of taking greater quantities of land out of agriculture?

One cannot be sure as to what will constitute a satisfactory land use balance in the year 2000. From a traditional standpoint we forecast agriculture using all the land not wanted for other purposes and, according to our predictions, being able to meet the demands

being made upon it. But there may be a future in which agriculture will still be using most of Britain's rural land but doing so in a protective rather than an active role with the community choosing to forfeit maximum agricultural output in order to create a rural environment which provides for environmental rather than economic needs.

Appendix 1

FORECASTS OF MIGRATION

Annual Abstract	
1956	"Net outward migration of 32,000 each year."
1963	"Net inward migration of 60,000 in the year mid-1962 to mid-1963; in the longer term a notional *inward* balance of 20,000 a year has been incorporated."
1968	"A net outward migration of 47,000 in the year mid-1967 to mid-1968 and of 55,000 in the year mid-1968 to mid-1969, declining thereafter to 20,000 a year from mid-1977 onwards."
1969	"A net outward migration has been assumed of 20,000 a year for all future years."

Source: *Annual Abstract of Statistics* 1956, 1963, 1968, 1969.

APPENDIX 2

DEATH RATES IN UNITED KINGDOM,* 1870–1968

(per thousand population)

	Males	Females
1870–2	23·3	20·8
1880–2	20·8	18·6
1890–2	20·7	18·6
1900–2	18·4	16·3
1910–12	14·9	13·3
1920–2	13·5	11·9
1930–2	12·9	11·5
1932	12·9	11·7
1933	13·1	11·9
1934	12·7	11·3
1935	12·7	11·3
1936	13·1	11·6
1937	13·4	11·9
1938	12·6	11·0
1939	13·0	11·5
1940	16·2	13·0
1941	15·8	12·0
1942	14·5	10·8
1943	15·3	11·4
1944	15·2	11·0
1945	14·9	11·0
1946	13·4	11·1
1947	13·6	11·4
1948	11·9	10·3
1949	12·6	11·2
1950	12·4	11·1
1951	13·4	11·8
1952	12·3	10·6
1953	12·2	10·6
1954	12·3	10·6
1955	12·5	11·0
1956	12·5	11·0
1957	12·3	10·7
1958	12·5	11·0
1959	12·3	11·0
1960	12·1	10·9
1961	12·6	11·4
1962	12·6	11·3
1963	12·8	11·6
1964	12·0	10·7
1965	12·2	10·9
1966	12·4	11·2
1967	11·8	10·6
1968	12·4	11·3

* During war years rates based on civilian deaths only.

Source: *Annual Abstract of Statistics* 1969.

Appendix 3

WEIGHTS USED IN THE DETERMINATION OF CONSUMER UNITS

Age Groups (years)	Weights	
	Males	Females
0– 4	0·3	0·3×0·875
5– 9	0·5	0·5×0·875
10–14	0·7	0·7×0·875
15–64	1·0	0·875
65 and over	0·7	0·7×0·875

Source: Lipton, 1968.

Appendix 4

ESTIMATES OF INCOME ELASTICITIES OF DEMAND FOR INDIVIDUAL FOODS

	Income Elasticities of Expenditure					Income Elasticities of Quantity Purchased				
	1955	1958	1960	1962	1965	1955	1958	1960	1962	1965
Dairy products										
Liquid milk full price ..	0·31	0·33	0·26	0·31	0·28	0·28	0·31	0·24	0·29	0·26
Total other milk and cream	0·30	0·30	0·45	0·40	0·31	−0·04	0·27	−0·12	−0·15	−0·34
*Cream										
Cheese	0·19	0·24	0·23	0·29	0·26	0·11	0·21	0·20	0·25	0·22
Eggs	0·39	0·37	0·26	0·26	0·22	0·34	0·33	0·23	0·21	0·18
Butter	0·37	0·30	0·24	0·28	0·17	0·37	0·30	0·24	0·27	0·17
Carcass meat										
Beef and veal	0·18	0·06	0·16	0·16	0·21	0·08	−0·02	0·07	0·09	0·10
Mutton and lamb ..	0·48	0·47	0·38	0·41	0·27	0·35	0·34	0·29	0·32	0·21
Pork	0·38	0·62	0·46	0·41	0·35	0·30	0·53	0·43	0·34	0·31
Total carcase meat ..	0·31	0·25	0·27	0·28	0·25	0·21	0·17	0·19	0·21	0·18
Total other meat and meat products ..	0·36	0·33	0·29	0·26	0·15	0·20	0·19	0·18	0·15	0·08
†Broiler chicken, uncooked †Other poultry, uncooked	1·70	1·51	1·37	0·90	0·42 0·88	1·61	1·40	1·34	0·88	0·42 0·82
Sugar	0·06	0·07	0·00	−0·03	−0·04	0·05	0·06	−0·01	−0·04	−0·07
Total potatoes	0·013	0·10	0·07	0·06	−0·05	0·03	0·07	−0·08	0·02	−0·11
Total fresh green vegetables	0·71	0·72	0·66	0·71	0·56	0·53	0·45	0·39	0·45	0·35
Total other vegetables ..	0·26	0·24	0·26	0·26	0·13	0·14	0·08	0·10	0·12	−0·04
Apples Pears	0·72	0·77	0·60 0·70	0·84 0·95	0·61 0·96	0·57	0·64	0·48 0·78	0·77 0·88	0·59 0·85
Tomatoes	0·55	0·46	0·44	0·45	0·42	0·53	0·45	0·43	0·47	0·44
Total bread	−0·05	−0·05	−0·09	−0·04	−0·20	−0·09	−0·09	−0·15	−0·09	−0·25
Total flour	−0·20	−0·18	−0·21	−0·08	−0·16	−0·20	−0·19	−0·21	−0·12	−0·18
Total cakes and biscuits ..	0·35	0·21	0·18	0·23	0·13	0·26	0·12	0·09	0·15	0·03
Total other cereals ..	0·27	0·19	0·28	0·27	0·18	0·16	0·10	0·16	0·18	0·04

* Included in total other milk and cream. † Included in total other meat and meat products.

Source: *Annual Report of National Food Survey Committee*, 1965.

Appendix 5

THE IMPACT OF GREATER SELF-SUFFICIENCY ON THE LIKELY DEMAND FOR HOME FARM OUTPUT IN THE YEAR 2000

(1965 = 100)

Demand for Food and Feed in the year 2000 1965 = 100	Self-sufficiency level in the year 2000										
	60%	62%	64%	66%	68%	70%	72%	74%	76%	78%	80%
	Implied Extra Demand for Farm Output										
	0%	3·3%	6·6%	10·0%	13·3%	16·6%	20·0%	23·3%	26·6%	30·0%	33·3%
132	132·0	136·4	140·8	145·2	149·6	154·0	158·4	162·8	167·2	171·6	176·0
133	133·0	137·4	141·9	146·3	150·7	155·2	159·6	164·0	168·5	172·9	177·3
134	134·0	138·5	142·9	147·4	151·9	156·3	160·8	165·3	169·7	174·2	178·7
135	135·0	139·5	144·0	148·5	153·0	157·5	162·0	166·5	171·0	175·5	180·0
136	136·0	140·5	145·1	149·6	154·1	158·7	163·2	167·7	172·3	176·8	181·3
137	137·0	141·6	146·1	150·7	155·3	159·8	164·4	169·0	173·5	178·1	182·7
138	138·0	142·6	147·2	151·8	156·4	161·0	165·6	170·2	174·8	179·4	184·0
139	139·0	143·6	148·3	152·9	157·5	162·2	166·8	171·4	176·1	180·7	185·3
140	140·0	144·7	149·3	154·0	158·7	163·3	168·0	172·7	177·3	182·0	186·7
141	141·0	145·7	150·4	155·1	159·8	164·5	169·2	173·9	178·6	183·3	188·0

Appendix 6

CONVERSION TABLE

ACRES : HECTARES

1 Acre = 0·4047 Hectares		1 Hectare = 2·471 Acres	
Acres	Hectares	Hectares	Acres
1	0·405	1	2·47
2	0·809	2	4·94
3	1·214	3	7·43
4	1·619	4	9·88
5	2·024	5	12·36
6	2·428	6	14·83
7	2·833	7	17·30
8	3·238	8	19·77
9	3·642	9	22·24
10	4·047	10	24·71
11	4·452	11	27·18
12	4·856	12	29·65
13	5·261	13	32·12
14	5·666	14	34·59
15	6·071	15	37·07
16	6·475	16	39·84
17	6·880	17	42·01
18	7·285	18	44·48
19	7·689	19	46·95
20	8·094	20	49·42
25	10·118	25	61·78
35	14·165	35	86·49
45	18·212	45	111·20
50	20·235	50	123·55
55	22·259	55	135·91
65	26·306	65	160·62
75	30·353	75	185·33
85	34·400	85	210·04
95	38·447	95	234·75
100	40·470	100	247·10

APPENDIX 7

TABLE 32 IN TERMS OF ACRES

Area of Crops and Grassland in the United Kingdom

(10^3 acres)

Crop	Pre-war Average	1945	1955	1967	% change 1955–67
Wheat	1,856	2,274	1,948	2,305	+ 18·4
Barley	929	2,215	2,296	6,027	+162·5
Oats and other grains	2,516	4,276	3,036	1,111	− 63·8
All grain	5,301	8,765	7,307	9,443	+29·2
Potatoes	723	1,397	874	708	− 19·2
Sugar Beet	335	417	424	457	+ 7·6
Fodder crops	1,431	1,885	1,415	774	− 45·4
Other	2,175	3,209	1,262	971	− 23·8
Total tillage	8,907	13,849	11,301	12,354	+ 9·3
Temporary grass ..	4,181	5,334	6,138	5,971	− 4·4
Arable..	13,088	19,183	17,542	18,325	+ 4·5
Permanent grass ..	18,750	11,840	13,532	12,328	− 8·9
Crops and grass ..	31,838	31,023	31,103*	30,653	− 1·5
Rough grazing ..	16,470	17,229	16,875	17,639†	—
Total agricultural acreage	47,308	48,252	47,978	48,292	—

* Including 29,000 acres flooded and not returned as arable or permanent pasture.

† Change in definition of Rough Grazing in 1959.

Source: *Annual Abstract of Statistics* 1935–46, 1950, 1969.

APPENDIX 8

TABLE 41 IN TERMS OF ACRES

The Land Use Pattern of the United Kingdom—1965

(10^3 acres)

	England and Wales	Scotland	Great Britain	Northern Ireland	United Kingdom
Total land surface area	37,129	19,071	56,200	3,300	59,500
Crops and grass ..	24,357	4,305	28,662	1,998	30,660
Rough grazing ..	4,828	12,320	17,148	682	17,830
All agricultural land ..	29,185	16,625	45,810	2,680	48,490
Forest and woodland..	2,765*	1,620	4,385	104	4,489
Urban land	4,291	591	4,882	167	5,049
Land unaccounted for	889	235	1,124	349	1,472

* Including 80,000 acres of land awaiting planting.

Sources: R. H. Best and M. Mandale. (Unpublished data. See note in references.) Forestry Commission, 1970. Select Committee Report, 1969.

APPENDIX 9

TABLE 42 IN TERMS OF ACRES

Total area of Forest and Woodland in the United Kingdom in 1965

(10^3 acres)

		England	Wales	Scotland	Northern Ireland	United Kingdom
Forestry Commission	Area	577	290	751	76	1,694
	Per cent.	26·4	58·4	46·4	73·2	38·4
Private	Area	1,611	206	869	28	2,715
	Per cent.	73·6	41·6	53·6	26·8	61·6
Total	Area	2,190	498	1,620	104	4,409
	Per cent.	100·0	100·0	100·0	100·0	100·0

Sources: *Annual Abstract of Statistics* (1969).
Forestry Commission, 1970.

APPENDIX 10

TABLE 43 IN TERMS OF ACRES

Productivity of Forest and Woodland in Great Britain in 1964

(10^3 acres)

	Productive		Unproductive		Total	
	Area	Per cent.	Area	Per cent.	Area	Per cent.
Forestry Commission ..	1,525	95·9	65	4·1	1,590	100
Private	1,760	65·2	940	34·8	2,700	100
Total	3,285	76·6	1,005	23·4	4,290	100

Source: P. A. Wardle, 1966.

APPENDIX 11

TABLE 45 IN TERMS OF ACRES

Land Use in the United Kingdom in A.D. *2000*

	Area 10^3 acres	Percentage of total land area
Total land area	59,500	100·0
Agricultural land	44,779	75·25
Forestry	6,467	10·86
Urban land	6,783	11·43
Unaccounted for	1,473	2·47

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