Potatoes

WYE COLLEGE
(University of London)

The Potato Crop: Policy and Practices

by
J. D. SYKES and J. B. HARDAKER

DEPARTMENT OF AGRICULTURAL ECONOMICS
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The Potato Crop: Policy and Practices

A study of the need for adjustment in the production and marketing of a major British farm crop

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FOREWORD

In the past twenty years Great Britain has moved from a position of absolute scarcity in the supplies of some foods to a situation of surplus. No commodity shows this contrast more vividly than potatoes. Many of us remember the early 1940's when large quantities of potatoes were grown and stored in order to provide bulk in our diet and to enable us to avoid bread rationing. Yet today there are acreage quotas and intermittent support of prices to potato growers.

The growing and selling of potatoes throws into bold relief the difficulties of balancing the supply of a food and the demand for it when production varies greatly from year to year, (even from an identical acreage). Demand, on the other hand, is steady, being dominated by habit. Thus the market for potatoes is one of widely fluctuating supplies and prices, both from year to year and within each year.

If we add to this situation the additional facts, that the demand for potatoes drops appreciably as personal incomes rise, that potato growing has become progressively easier with new developments in varieties, fertilizers, mechanization and disease control and that supplies from other countries with lower costs of production are likely to be more easily available in the future—it is clear that potato growing in Great Britain must look forward to a period of considerable change.

The report tries to interpret this dynamic situation in the potato industry. The first part deals with the approaching need for overall adjustment of acreage and supplies, the second looks more particularly at the individual grower's powers of adjustment.

Advice and help in the preparation of material for this report has been willingly given by many people, including advisory officers of the N.A.A.S. and members of the Potato Marketing Board's staff. Thanks are also due to those potato producers in Kent who co-operated in a survey of potato growing undertaken by this Department between 1958 and 1960.

G. P. WIBBERLEY

Reader and Head of Department.

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SYNOPSIS

Agricultural adjustment concerns the evolution of agriculture to meet changing economic needs. This study of the potato industry illustrates the urgency of the problems of adjustment facing most parts of British agriculture. Productivity in farming is increasing, and neither the growth in population nor a rising standard of living seems likely to absorb all the extra production. It is inevitable that fewer farmers, fewer workers and fewer resources in general can be gainfully employed in agriculture in the future. There is an urgent need to study the nature and significance of these important and swift-moving developments.

The potato industry is a good example of a branch of agriculture where such changes will be of growing importance in future years. The shape and extent of the adjustments that may be expected can be appreciated from a study of the present pattern of production and marketing.

The potato industry has features typical of most agricultural industries. Small-scale growers are still numerically the most important, with one half of the producers having less than five acres of potatoes, (Table I). But the situation is gradually changing with production becoming concentrated on the larger farms. In 1948, about two-thirds of the potato acreage was grown on farms of more than 100 acres. This contrasts with rather more than three-quarters in 1960. Thus production is tending to move on to the farms of the larger, probably more efficient growers, mainly situated in the eastern counties, (Figure 2).

Three other factors have an important bearing on the fortunes of the potato industry and its adjustment problems. Firstly, consumer demand is remarkably stable, and in the short-run period there is little response to changes in price. Secondly, approximately 90 per cent. of this demand is met by supplies from British farms, and only in years of low production are substantial imports of maincrop potatoes allowed, (Table II). The consumption of new potatoes, however, has grown rapidly over the last seven or eight years, with imported new potatoes arriving earlier and in greater quantities, (Figure 3). Finally, the yield of the home potato crop is highly unstable. Over the last ten years there have been large fluctuations in production, with the total crop varying between five and eight million tons, (Table E, Appendix). The combined effects of the steady demand, the high degree of self-sufficiency and the instability of yield, coupled with the perishability of the crop, result in very marked price fluctuations.

This is well illustrated by events since 1955. During this period, yields have been unusually unstable and have presented the Potato Marketing Board with formidable problems of surplus and

shortage. The farm-gate value of the crop has ranged from less than £60 million in a year of surplus, to more than £90 million in a year of scarcity. Similarly, returns to growers have ranged from an average of £18 per ton, with production totalling 5 million tons, to less than £10 per ton, with 6½ million ton crop, (Figure 4).

The size of the crop has also had a marked effect on the seasonal pattern of prices, (Figure 5). The critical level of production appears to be about 5½ million tons. With production below this amount, prices have generally risen throughout the season. On the other hand, larger supplies have saturated the market, and price collapse has only been averted by Marketing Board intervention.

The main factor determining the price structure for potatoes is the regulation of imports, but in years of high national production support buying has been necessary to maintain market prices. This has sometimes proved very costly. For example, £5.3 million was spent in 1959-60 and some £6.6 million in 1960-61, on the purchase of surplus potatoes.

The above illustrations indicate the size and nature of the problems now confronting producers. But in the longer-term, account must also be taken of the downward trend in consumption. The annual rate of consumption is currently rather less than 200lb per head per year. The level, however, varies widely throughout the country owing to differences in earnings, occupation, family size and food buying habits, (Table IV).

Consumption may be expected to fall appreciably in the future as a consequence of rising incomes, changes in occupation and competition from other foods. It is estimated that twenty years hence annual potato consumption will have fallen to about 145lb per head, (Figure 7). Allowing for rising yields, one acre of potatoes in 1980 will probably be adequate for 145 consumers, as compared with 90 today, and only 45 in 1880.

In the face of shrinking demand, production must be adjusted to avoid chronic problems of surplus disposal and a consequent general weakness of prices. Despite a rising trend in population, the potato acreage will need to fall over the next twenty years by almost one third. At least 20,000 growers, about two in seven of the present number, will have ceased the commercial production of potatoes by 1980, (Table G, Appendix).

Further considerable changes would result from Britain joining the Common Market. Prices received by European potato growers recently have been about three-quarters of the British level, (Table VI). Although no specific proposals have yet been made regarding the treatment of the crop, perhaps one fifth of the present number of British producers would be unable to face the increased competition from this source.

In this situation the three major problems of the potato industry must be considered. These are the need to :—

1. stabilize prices, largely through the control of supplies,
2. adjust production to meet the downward trend in consumption,
3. improve the efficiency of production and the quality of supplies.

Solutions to these problems, compatible with both the short and long-term interests of the industry, can be found within the marketing board type of organization. For example, the buying of surplus potatoes with market support funds could be further developed. Plans are already in hand to build up the necessary fund which is mainly to be financed by Government contributions. However, the present market support fund could be turned into a 'price insurance fund,' mainly financed by levies on farm sales in years of high potato prices. This would obviate the need for Government intervention and subsidization.

Alternatively, potato supplies could be regulated by replacing the present system of acreage allotments with 'quantity' contracts. The surplus problem would be tackled at its source, and encouragement would be given to the more efficient specialist producers.

Consideration should also be given to the case for creating a small number of competitive regional marketing authorities. Alternatively, a strong case exists for the marketing of potatoes on a co-operative basis. Potatoes would be stored, graded and packed at a central point, and would be sold on contract to distributors.

Profitable potato growing depends primarily on the way the enterprise fits into the economy of the farm as a whole. Although this question is best analyzed with reference to a particular farm, a wide range of other important management decisions within the potato growing enterprise demand consideration.

For example, the high level of fixed costs in potato growing means that a high output is essential for profitable production. An analysis of survey data by level of output shows results ranging from a loss of £33 per acre to a profit of £155 per acre, with only a small rise in costs, (Table VIII).

This relationship focuses attention on the importance of high standards of management in potato growing. There are many tested production techniques leading to improved returns, which await widespread adoption. For example, early planting, the chitting of seed and the control of blight and drought may all result in higher yields and more profitable production. Planting in good time avoids the loss of yield of 6 or 7 cwt per acre for every week's delay after mid-April. Similarly, chitting can raise yields

by between 10 and 20 per cent. Both of these practices are generally very profitable, and irrigation and blight spraying often prove quite remunerative.

But the adoption of these few important techniques does not ensure the highest level of profitability. Expenditure at all stages of production must be kept under constant review. For example, economies may often be effected by careful buying of seed, while the amount planted per acre should be varied according to seed prices. Traditional sowing rates are generally extravagant when seed is expensive, (Table XI).

The response of the crop should be a prime consideration when determining levels of application of mineral fertilizers. Recent research shows that at present prices, 10-11 cwt per acre of a 10:10:18 compound is often satisfactory.

Labour and machinery expenses constitute nearly half of the direct cost of production, and an average of some 150 man hours per acre are required. Furthermore, the very irregular seasonal pattern of labour requirements creates special problems on farms where casual labour is not readily available, (Figure 9). The rising trend in wages and the steady decline in the number of workers employed, (Figure 8), emphasize the growing need for economies in labour use.

One solution to this problem lies in further mechanization. For example, mechanized potato planting cuts labour requirements by up to four-fifths, and on twenty acres, reduces planting costs by half, (Table XII). Similarly, with wages at current levels, investment in a complete potato harvester, costing about £600, would be fully repaid in 5 years on a farm growing 40 acres of potatoes, (Table XIII).

Methods of potato growing will change considerably over the next few years. The costs of many inputs, particularly labour, will tend to rise relative to potato prices. Hence it is essential for growers to seek more efficient methods of production. Some guidance can be given on the improvements that will be needed, and it is forecasted that by 1970 efficient growers will be producing potatoes with approximately half the present average labour needs, (Table XV).

As consumption tends to shrink in future, the least efficient growers are bound to be squeezed out of production. Nevertheless, potatoes will continue to make a useful contribution to profits on the more efficient farms remaining in production. In short, better management, improved methods and a more effective marketing system are the means whereby potato growers can prosper in the more competitive days ahead.

PART I

THE POTATO INDUSTRY— A STUDY IN AGRICULTURAL ADJUSTMENT

AGRICULTURAL ADJUSTMENT—THE GENERAL PROBLEM

Little real attention has been given in Britain to the problem of agricultural adjustment—the question of developing an agricultural economy appropriate in size and kind to the needs of the 1960's and beyond. There has been much discussion of agriculture's role as an import-saver, of the need for farming subsidies, or the 'drift from the land' and the rate at which land is being taken up for non-farm use. Yet these matters, and many others, are in fact part and parcel of the larger issue of agricultural adjustment—a topic of increasing importance with respect to Britain's interests in the Common Market and general economic position.

Over recent decades there has been remarkable growth of productivity in agriculture which in many countries has resulted in the emergence of surplus farm products. The greater supplies of food and raw material have outstripped, or are in danger of outstripping the needs and purchasing power of consumers. In almost all Western countries Government intervention has been necessary to support prices, in order to preserve the incomes of producers.

Essentially, the growth of productivity means that fewer people, fewer acres, and possibly less capital can be gainfully employed in agriculture—unless a great expansion in consumer demand occurs. Over much of North America, during the last decade, roughly one farmer in every four has gone out of production. Much land has also gone out of cultivation but the total supply of farm products has continued to grow. In Europe a trend toward fewer farmers is also developing. In the Common Market countries alone some five million farmers and their families are expected to leave the land over the next twenty years to find employment and higher earnings in industry. No fall in food production should be anticipated as a result of this considerable migration. In Britain, too, the farming pattern of the future will involve not only fewer workers but also fewer farmers and less land. The smallholder seems likely to be succeeded by the part-time producer, while a trend towards farm amalgamation, which shows signs of development, will act to reduce the number of full-time farmers and workers.

It would be foolish to try to stop these evolutionary changes, though it would be wise to guide them. It is in the latter context

that the problems of agricultural adjustment arise. Clearly, unless the processes are under control the welfare of both the individual and the nation could be adversely affected. For example, the country's economy has been under heavy pressure since the end of the war as the rising trend in land values, interest rates and wages and the balance of payments position shows. No sector of the economy, whether agricultural or industrial, can justify the extravagant use of land, labour and capital under these conditions. Thus, if 'surplus' resources and manpower are to be found in any part of agriculture or industry there are urgent grounds for encouraging their transference.

Although there are complex political, social and economic issues affecting agricultural policy, there is a major need to anticipate and assist the process of agricultural adjustment. In particular, this calls for longer term policies and for the avoidance of conflict between long-term and short-term development. More especially, care is required to avoid stimulating investment in fixed capital equipment on farms except on the basis of the long-term interests of the agricultural industry.

Agricultural adjustment as a whole requires the investigation of the production and marketing problems, trends, and potentials of the various farm enterprises. The present study concerns the problems and prospects of British potato growers. Much further research is needed into the economics of the industry in general, into the demand for its products, and into the techniques and economics of production on the farm.

THE CHANGING PATTERN OF POTATO PRODUCTION

The potato crop is notorious for its variability of yield, which, owing to the unresponsiveness of demand* to changes in price, results in wide variations in producers' returns. Under these conditions in a free market the acreage planted would naturally tend to fluctuate considerably since producers' expectations of future prices are largely based on recent market experience. Much of the work of the Potato Marketing Board has been directed at damping down acreage fluctuations and a considerable degree of success has been achieved in reducing this cause of price instability.

The wartime mobilization of agriculture was, of course, the cause of the most significant changes in the potato acreage in recent times, the effects of which can be traced in Figure 1.

* The demand for potatoes is said to be inelastic since quite wide changes in price have little effect on the quantity demanded. A rise in price will curb demand to only a limited extent and, likewise, a price fall will not lead to much expansion of consumption.

Between 1939 and 1944, a surprisingly long period in view of the critical food situation, the acreage of potatoes in Great Britain doubled, reaching a peak of about 1.2 million acres. About the same area was planted in each of the next five years, during the darkest days of the post-war food shortage and dollar crisis. During a further five-year period of 'controlled' production, ending with the 1954 crop, the acreage fell by one third. With the area thus reduced, yet still 25 per cent. greater than the pre-war level, the Potato Marketing Board* resumed operations in 1955, after a break of fifteen years. Although there have been fluctuations in the six succeeding crops there has been little sign of any trend towards a smaller acreage.

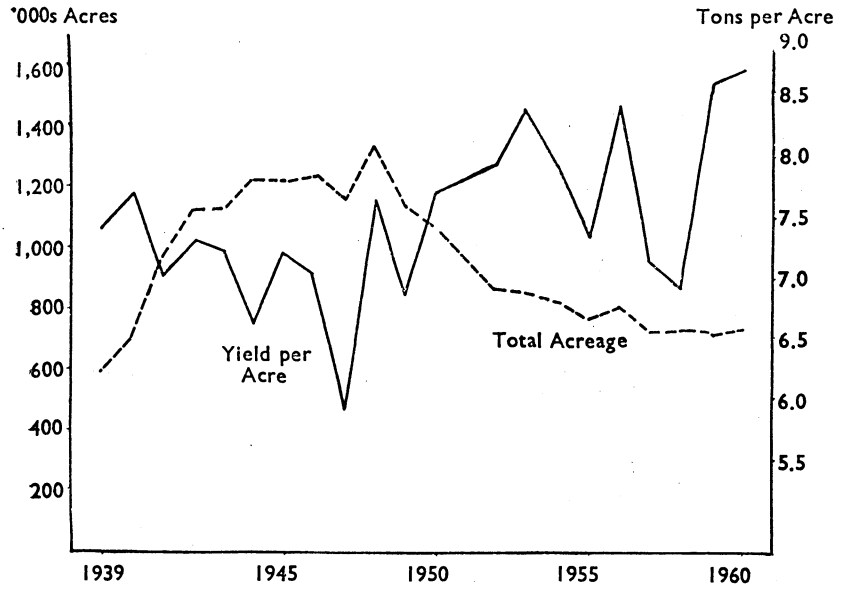
The pattern of yield variations is also shown on Figure I. It shows a tendency for yields to decline, up to about 1946-47, during the period of expanding acreage. In the following six year period, yields per acre tended to rise quite steeply concurrent with a considerable, though perhaps reluctant decline in the potato acreage. Under the more stable acreage of the last six harvests, no significant upward or downward trend in yield is evident. Present yields, however, tend to average almost one ton per acre (15 per cent.) more than a decade ago. Thus, while the total potato acreage has fallen by almost two-fifths since 1948, total supplies have been reduced by only one third.

Perhaps the most significant feature emerging from Figure 1 is the high variability of yields over the twenty-two years covered. This emphasizes the difficulties of regulating market supplies. Most remarkable of all is the extreme violence of the fluctuations during the last seven years, a singularly unfortunate occurrence to confront a marketing authority at the recommencement of its activities.

* A Marketing Board for potatoes was first set up in March, 1934 and continued until December, 1939, when the Government assumed control over the potato industry owing to the war emergency. The Board was granted powers to regulate supplies of home-grown potatoes by means of the registration of producers and distributors, the regulation of size of riddle and by levies on acreage planted in excess of basic allotments. It did not fix prices neither did it engage in direct trading. In the spring of 1939, however, authority was sought to purchase potatoes surplus to market requirements, thus anticipating recent practice, and to manufacture potato products. It is interesting to note that the Board received no assistance from Exchequer funds throughout the whole of its pre-war existence.

Detailed accounts of the operations of the Potato Marketing Board prior to the outbreak of World War II are to be found in the 'Agricultural Register' published annually from 1934 to 1939 by the Agricultural Economics Research Institute, Oxford. The same Institute published an account of Government control of the potato industry between 1939 and 1954 in a Supplement to the Farm Economist, 1954.

Figure 1. **Potatoes in Great Britain—Acreage and Yield**



Scale of Production

Although during recent years the potato acreage has remained fairly stable at around 700,000 acres, largely as a result of the Potato Marketing Board's activities, considerable changes in production have been taking place. For example, the number of producers registered with the Board has declined by 13 per cent. over the last six years. Although the statistics tend to overemphasize the decline in the number of actual growers, they do indicate a tendency for production to be concentrated in fewer hands. The development of large potato growing units has not yet gone far however, and the average acreage per registered producer has only risen from 7.9 acres in 1955 to 9.0 acres in 1960. Between 1948 and 1960 too, as Table H, (Appendix) shows, production was tending to be concentrated on the larger farms. For example, nearly one half of the potatoes were grown on farms of 250 acres and above in 1960, as compared with one third in 1948. On the other hand, farms of 100 acres and less grew only one quarter of the acreage in 1960, as compared with one third in 1948. Similarly, the acreage grown by producers who grow less than one acre of potatoes, and who do not require to be registered with the Potato Marketing Board, appears to have fallen by almost one third between 1955 and 1960.

The potato industry, like most other branches of farming, is still dominated by a large number of very small-scale producers, as Table I shows. Indeed, nine out of ten producers still grow less than 20 acres, and virtually half the growers have less than 5 acres. In respect of the total tonnage of potatoes produced, however, the larger growing units are clearly highly important. For example, about 2,500 farms grow more than 400 tons annually and between them produce almost one third of the industry's output. At the other extreme, only one quarter of the tonnage is grown in units of less than 75 tons. From the view-point of the efficiency of the industry this is, of course, of considerable significance. Thus, although many producers rely upon potato growing for some part of their livelihood, the consumers' interests are mainly affected by the efficiency of a comparatively small number of growers. Altogether the 15,000 largest producers probably supply the needs of 40 million consumers, and there are good reasons for believing that this total includes a very high proportion of the most efficient growers.

TABLE I—SCALE OF POTATO PRODUCTION IN GREAT BRITAIN

Acres of Potatoes	Distribution of Number of Producers	Distribution of Potato Acreage
	%	%
1—5	50	10
5—10	22	14
10—20	15	19
20—50	10	28
50—100	2	15
over 100	1	14
	100	100

Based on Potato Marketing Board statistics for 1959.

The pressure of market forces and uneven increases in productivity could considerably change the size structure of the industry over a relatively short period. Although it is difficult to be certain of the exact nature of the changes, it is most likely that the trend towards fewer producers will continue. Singularly little is known about changes in the numbers of producers in agriculture in general or of the extent to which the scale of farm production is changing. Apart from levels of yield about which a good deal is known, these are the chief factors determining the supply of agricultural products. In the absence of any broad information from the agricultural census on such changes, a small sample of 53 potato growing farms in South East England has been studied over a four year period. Details are given in Table F, (Appendix).

The picture which emerges illustrates the complexity of the changes taking place. Producers are variously expanding or contracting their potato acreage, while some are starting up as other growers cease production. It also reveals, however, a high and possibly excessive, degree of stability of acreage and of numbers of producers resulting from the Potato Marketing Board's control of acreage*.

Control of this type obviously stabilizes the area in cultivation and the number of producers. It also protects the investments of the latter in what is admittedly a highly risky form of production. Nevertheless, the cost is high. For instance, the scope for fresh entrants to the industry is sorely restricted and the adoption of more efficient methods is thereby retarded. Furthermore, newcomers are obliged to pay enhanced prices for farms with potato acreage allotments, whose outgoing owners thus receive unearned windfall gains. In addition, since the opportunities for expanding the acreage of potatoes are limited, existing producers are compelled to push up per acre yields in order to increase turnover, thereby defeating the object of the controls.

The extent to which production has been 'stabilized' is not generally recognized, and to throw light on the situation the sample of potato growing farms in South East England mentioned above is compared with a similar group in Manitoba, Canada. Free market conditions which exist in Canada have produced an extreme degree of instability and a high and very wasteful level of turnover in the number of potato growers.

	South East England 1956 to 1959	Manitoba, Canada† 1957 to 1959
Original number of potato growers in sample	49	307
Decline in numbers over period	10%	50%
Initial average acreage per grower	12	29.5
Final average acreage per grower	12.6	37.4

The British potato industry has fortunately been free from the 'transient' type of grower who, in Canada, moves freely into and out of production, to the detriment of established growers. This

* The control of acreage operates through the following :—
1. the allotment of basic potato acreages to farms growing potatoes in some previous period in proportion to the area of the crop then cultivated,
2. the imposition of acreage quotas in years of expected surplus supplies indicating what proportion of the basic acreage may be planted,
3. the imposition of a levy, at present £10 per acre and shortly expected to be £25 per acre, on all acreage planted in excess of basic allotments or quotas.

† From 'Primary Aspects of Potato Marketing in Manitoba' by Arthur G. Wilson, Research Report No. 8, (1961) University of Manitoba, Winnipeg, Canada.

group, " relatively poorly informed, inadequately equipped and appearing to hold the idea that conditions which occur in one year will be repeated in the next work to the disadvantage of specialists in the field." In Britain on the other hand, the Potato Marketing Board's present method of regulating production seriously hinders expansion by the more efficient producers and at the same time encourages high-cost growers to stay in production.

The Location of Production

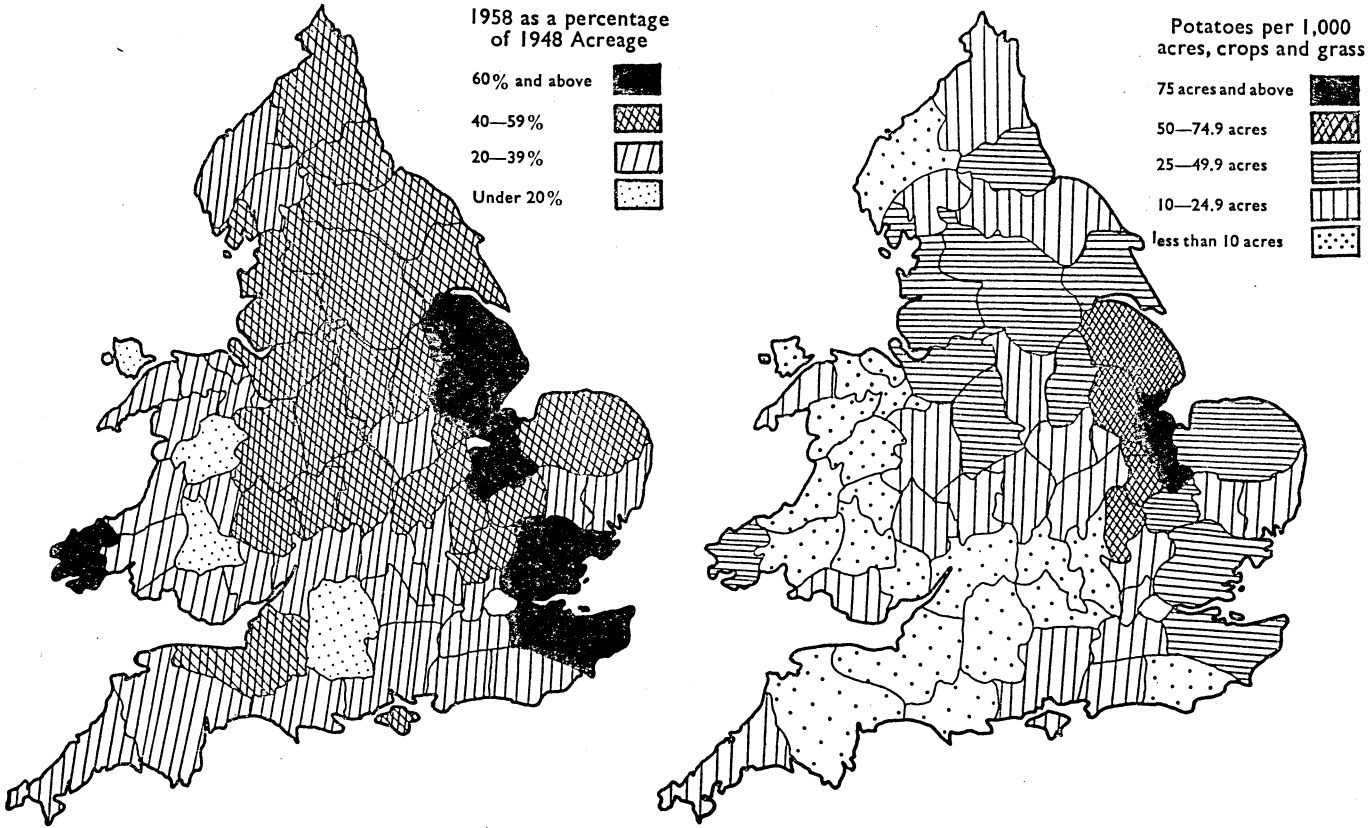
Certain areas enjoy comparative advantages in respect of production or markets. Under conditions of increasing competition these advantages assume greater significance.

During the period of declining potato acreage, production has been increasingly concentrated in half-a-dozen or so counties of Eastern England where favourable conditions result in above average yields of quality potatoes. As can be seen from the accompanying maps (Figure 2), these areas are strategically placed to serve the vast Midland and London markets. Proximity to markets and favourable soils also occur in respect of the potato growing areas of Lancashire, the West Riding of Yorkshire, Durham, etc., and this is reflected in the comparatively high proportion of potatoes per 1,000 acres of crops and grass in these counties.

In the west of the country, Pembroke has also retained a high proportion of its peak (1948) potato acreage and is the only county west of Huntingdon to do so. This reflects, of course, the exploitation of climatic factors, which has resulted in the emergence of Pembroke as a main source of early potato supplies. About four-fifths of the county's total potato acreage is in earlies, whereas Cornwall, with the second highest proportion, has less than half that amount, (Table A, Appendix). The competitiveness of the Pembroke supplies is also revealed by the relatively small decline in the acreage of earlies. Production in this county fell by only one fifth between 1948 and 1958, whereas supplies from Cornwall and the Isle of Wight declined by more than three-quarters.

The present concentration of the industry in certain main districts reflects the recent pattern of comparative advantage in production and marketing, but there are technical changes in the offing which could have a considerable effect on the location of production. Greater consumption of processed potatoes might lead to an expansion of production in areas more distant from the market centres. Transport costs would become relatively less significant and advantage could possibly be taken of cheaper land and lower production costs. Similarly, the improvement of harvesting machinery would enable production to be undertaken in those areas where the shortage or high cost of picking labour has previously restricted operations. Other changes may be important also, such as, for example, the development of a control for eelworm. This

Figure 2. **The Location of Potato Production**



might considerably affect the industry since it could appreciably raise the potato growing potential of formerly intensively cultivated land. Clearly, such factors could have a significant influence upon the distribution of the potato acreage and upon the overall economic efficiency of the industry.* If producers and consumers are to reap the full benefits of greater efficiency, it seems very desirable not to curtail unnecessarily the industry's flexibility. A rigid system of acreage control is likely to restrict the capacity of growers seeking to alter the scale of their production or to adopt new and cost reducing methods. The present system of acreage allotments and the high levies on excess acreage enforced by the Potato Marketing Board obviously introduces a dubious degree of protection for existing growers.†

THE STATE OF THE MARKET

The coming into cultivation of the potato gave society the advantage of cheap food but at the price of occasional shortage, and in some instances even disaster. To-day, the misfortunes of the industry are still bound up with the extreme annual variability of per acre yields, and the perishability of the crop. Until these difficulties have been overcome no solution of the potato growers' 'income problem' is possible. At this point, however, it would be somewhat premature to discuss solutions to problems which have neither been outlined nor discussed. In particular, it is necessary to consider the factors involved in 'balancing' potato supplies on the one hand, and the structure of demand on the other hand.

The market demand for potatoes is highly inelastic and over the last seven years the total quantity of potatoes annually entering into human consumption has varied by less than 3 per cent., (Table B, Appendix). The stability of this large market is a most noteworthy feature which might well be the envy of many industries. Unfortunately, the output of the potato industry is largely unpredictable, and to a considerable extent uncontrollable. The resultant fluctuations in supplies have very deleterious effects on both producers and consumers. The producer has always to cover himself against the considerable risk of income failure and, under these conditions, it is impossible to reduce production costs to the

* For a detailed analysis of the situation in one county see 'The Growth of Potato Production in Lincolnshire' by K. A. Ingersent. Farm Management Notes No. 24, 1960, Department of Agricultural Economics, University of Nottingham.

† Field survey experience indicates that there is a body of marginal growers, of unknown size, who consistently produce indifferent quality, poorly presented potatoes. It is obviously undesirable that such producers should be enabled to stay in production through price support programmes essentially designed to counter the vagaries of the weather.

Traditional methods were used to harvest this crop of Majestics on the Wye College Farm. The yield was 9.3 tons per acre but, as a result of surplus market supplies in 1960, more than a quarter was fed to livestock and the average value of the crop was only £9 per ton. This example illustrates the problem often confronting growers. The average income from potato sales to producers in Great Britain in this year was only £80 per acre, the lowest level since 1954.

A potato harvester working in dry, dusty soil. Although the problem of separating potatoes from stones and clods awaits a really satisfactory solution, modern machines are able to work under less favourable conditions than formerly. There are indications too that rates of work are tending to improve, although at present a complete harvester is still likely to be uneconomic on most farms growing less than thirty acres of potatoes.

fullest extent. Indeed, this will be possible only when supply fluctuations can be ironed out, through improving production techniques, by strengthening market controls, or by reducing the perishability of the potato or potato products. The importance of directing research along these lines, and of basing production and marketing policies upon these considerations, cannot be over-emphasized.

British farmers produce between 80 and 95 per cent. of the potatoes required for human consumption in this country. Home-grown earlies account for nearly one tenth of all supplies, (Table II).

TABLE II—SOURCE OF POTATO SUPPLIES FOR HUMAN CONSUMPTION (GREAT BRITAIN)

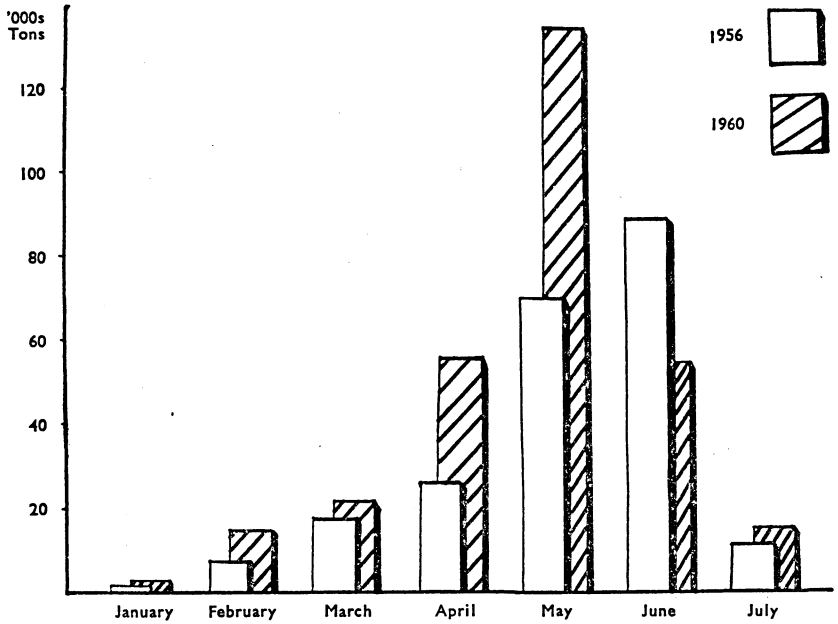
Crop Year	1954/5 %		1958/9 %		1959/60 %		1960/61 %	
Earlies								
Imported	3.7		6.1		6.9		6.6	
Homegrown	9.1		9.5		9.4		9.8	
	—	12.8	—	15.6	—	16.3	—	16.4
Ware								
Imported	5.0		10.7		2.7		2.3	
Homegrown	82.2		73.7		81.0		81.3	
	—	87.2	—	84.4	—	83.7	—	83.6
Total		100.0		100.0		100.0		100.0
Total percentage of imported potatoes :		8.7		16.8		9.6		8.9

Import statistics include Channel Isles and Northern Ireland supplies

There has been a tendency for early potato supplies to increase in importance ; seven years ago they accounted for one ton in eight, but they have now risen to one ton in six. While home production has shown relatively little change, the quantities imported have risen steadily, (Table B, Appendix). The expansion of early potato consumption, which is likely to continue, is of course, a reflection of changing consumer tastes and rising levels of disposable income. Unfortunately, the producer of home-grown earlies does not appear to be doing more than hold his own in this market, while the opportunities for the maincrop producer show a tendency to decline.

Earlies displace much more than their own weight of main-crops and, year by year, there has been a tendency for supplies to increase in volume and to arrive earlier in the season, (Figure 3). But a considerable degree of market protection has been operative since late 1960 through a revision of the Customs' definition of new potatoes which, in the words of the Potato Marketing Board, prevented " much of the disturbing importation of winter crop

Figure 3. **Monthly Distribution of New Potato Imports—Great Britain**



potatoes of mature appearance from the Eastern Mediterranean." Following Marketing Board representations, the Government is also at present considering a further reinforcement of the protective measures by raising the tariffs on imports of new potatoes arriving in May and July.

Ware potato imports are also strictly regulated. Supplies from Northern Ireland are allowed to enter without restriction, although there are consultations over prices, but imports from other countries are controlled by the Board of Trade. Ware imports, of course, play a vital part at times in filling the gap in supplies which cannot be met by new potatoes and home-grown maincrops. But the regulation of ware imports is chiefly significant as the principal means of maintaining a high general price level for home potato producers.

Despite the almost complete control of imports, potato producers are still confronted with violently fluctuating incomes. The extent of the difficulties confronting British potato producers can be clearly demonstrated from recent experience. Over the last few years, although producers overall have made only minor alterations to the acreage grown and to methods of production, the farm gate

value of the crop has varied from one year to another between approximately £60 and £95 million, (Figure 4). This enormous range has occurred despite all the powers of the Potato Marketing Board. Undoubtedly, the Board's recent experience of variability in per acre yields has been singularly unfortunate, but history has clearly demonstrated once again that we are by no means rid of the risks and uncertainties inherent in the production and disposal of the potato crop.

The highly variable supply of maincrop potatoes clearly produces great stresses and strains within the production and marketing system. Since the demand for potatoes for human consumption is inflexible, adjustments must be made to the quantities of potatoes entering into alternative uses, as Table III shows.

TABLE III—DISPOSAL OF HOME-GROWN MAINCROP POTATOES IN GREAT BRITAIN

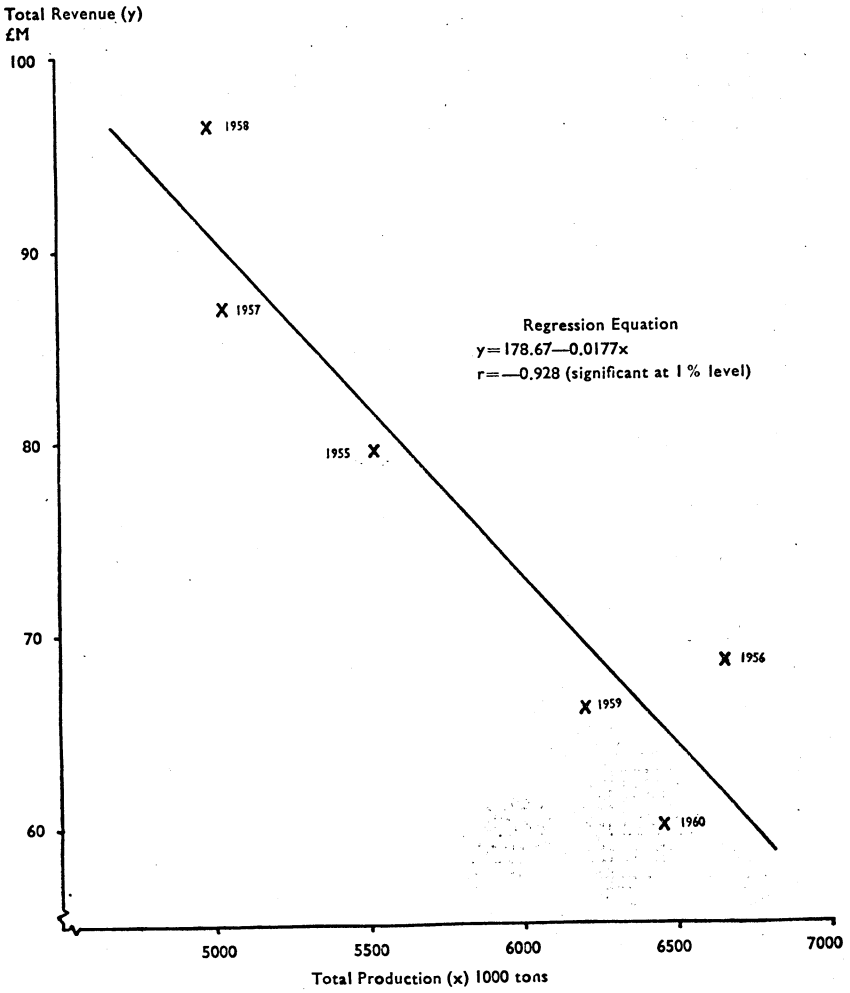
Harvest Year	1956		1957	
	'000 tons	%	'000 tons	%
Farm Sales				
Human Consumption	4,197	63.1	3,869	76.9
Other Use	356	5.3	65	1.3
Total	4,553	68.4	3,934	78.2
Farm Use				
Stockfeed	912	13.6	344	6.8
Seed	697	10.5	695	13.8
Waste & Surplus	497	7.5	57	1.2
	2,106	31.6	1,096	21.8
Total Production	6,659	100.0	5,030	100.0

Source : Estimates prepared by the Ministry of Agriculture, Fisheries and Food.

Thus in years of very heavy yield, such as 1956, total sales account for little more than two-thirds of production, with supplies for human consumption falling somewhat below this level. In years of very small production, however, such as 1957, almost four-fifths of the crop is sold off farms, of which only a minute amount is not used for human food. Thus, while the 1957 crop was fully a quarter less than that of 1956, the fall in supplies for food use was less than 8 per cent. In the latter year, market requirements were finally met by a large expansion of ware imports.

Even in years of light yield the quantity of potatoes remaining on farms does not appear to fall below one fifth of total production, while heavy crops may raise this proportion to nearly one third. Seed potato requirements remain fairly constant and the brunt of any fluctuation falls chiefly upon supplies used for livestock feed. Surplus and waste stocks too, can assume substantial proportions,

Figure 4. **Total Income from the Potato Crop Great Britain, 1955-60**



thereby involving large compensation payments. Thus in 1956, payments in respect of 370,000 tons of surplus potatoes cost the Potato Marketing Board and the Government £4.6 million. In addition, the cost of disposing of a further 722,000 tons of potatoes, sold for livestock feed, or as dried products, was £7.8 million.

The Pattern of Prices

The inelastic demand for potatoes for human consumption has a marked effect upon prices and eventually upon producers' profits. Indeed, the correlation between total production, sales and prices is so strong that it would appear to provide a useful guide to forecasting the revenue of potato growers and average returns per ton. The position, shown diagramatically in Figure 4, is based upon calculations set out in Table E, (Appendix). The diagram reveals the following main features :—

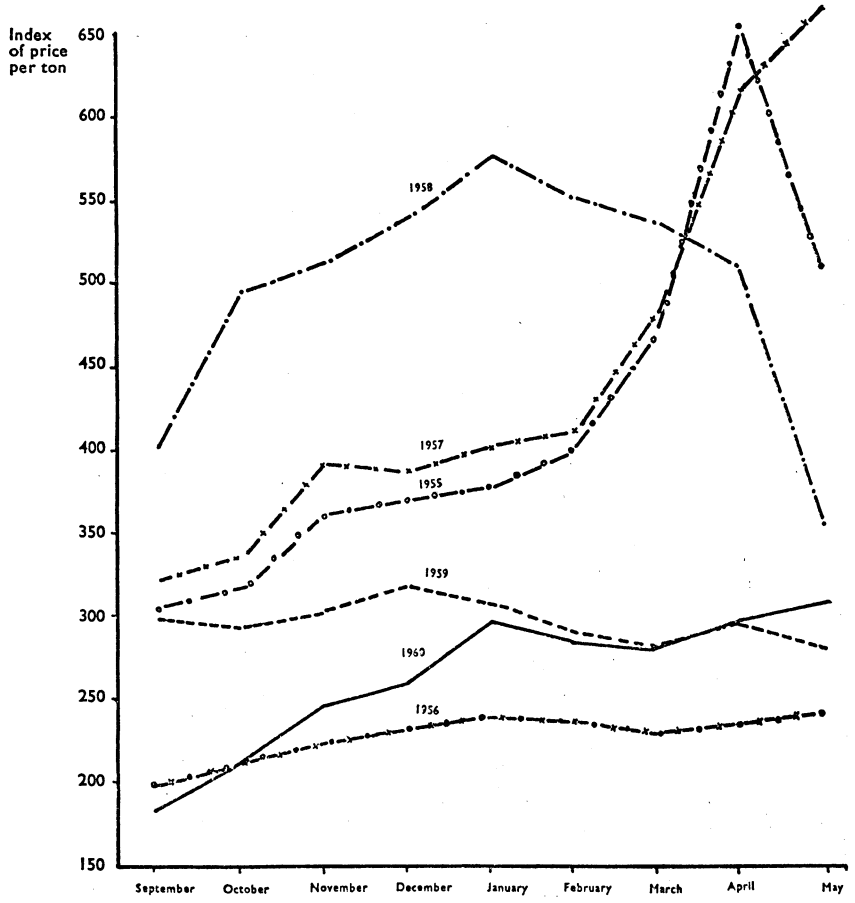
1. The high variability of total income from potato sales from season to season.
2. The sensitivity of the market to shortfalls in supplies and the equally noticeable unresponsiveness to low prices in times of surplus.
3. The marked annual fluctuations in total production which have occurred since 1955.

The regression equation associated with Figure 4 can be used to determine the effects of changes in yields, or in overall production, on the total receipts of potato producers. Alternatively, it can be used to determine the average price per ton resulting from a given level of production. Thus, a home-produced potato crop yielding 5 million tons is worth some £90 million, or £18 per ton of potatoes produced. A crop of 6½ million tons, however, is only worth some £63 million, or £9.8 per ton, despite Government and Marketing Board support operations.

The cost of surplus production arising from high yields or the planting of excess acreage can thus be determined by measuring the fall in producers' receipts. In 1960 for example, 204,000 tons of potatoes grown on the acreage planted in excess of basic quota is estimated to have reduced the receipts of potato producers by more than £3½ million. It is noteworthy that the growers of this acreage contributed levies amounting to only £213,000 to the Board's market support fund.

The monthly pattern of potato prices is also important to producers and the nature of past movements can be traced in Figure 5. It illustrates the dominant influence of the total size of crop on trends and levels of prices. For example, a crop of 6 million tons or above saturates the market, as in 1956, 1959 and 1960.

Figure 5. **Monthly Potato Prices**



Harvest Year	*Total Production (in order of yield)* '000 tons	*Index of Price* for Period August-May* (1927-29=100)
1958	4,982	480
1957	5,030	440
1955	5,521	413
1959	6,098	308
1960	6,455	257
1956	6,659	225

* Derived from M.A.F.F. statistics.

From October onward there is a limited range of price changes and the tendency is for any upward or downward trend to be fairly small. A short crop, such as occurred in 1955 and 1957, produces a rising trend. In both years prices rose steadily from September to February, after which very steep advances, reflecting the high inelasticity of demand, took place.

For purposes of forecasting seasonal price trends, early estimates of total production are essential. A crop of 5½ million tons appears to be critical. With production below this level prices can be expected to rise throughout the marketing period. Above this amount there appears to be little prospect of a seasonal price rise occurring. Indeed, considerable support measures may be needed to prevent prices collapsing.

The price pattern for 1958, a year of very small supplies, is interesting since it appears to ' break the rules.' However, the trend which emerges on the diagram reflects the consequences of two successive years of shortage. Market interests and consumers had become conditioned to high prices during the latter part of the 1957-8 season and the threat of inadequate supplies in 1958-9 resulted in prices rising to high levels unusually early. Speculative interests undoubtedly helped to drive up prices but inelasticity of consumer demand was the essential background to these operations. Fortunately for the consumer, large-scale imports began to arrive in November 1958, (Table D, Appendix), and from the following January prices declined appreciably.

The Potato Marketing Board can considerably influence seasonal and annual prices for potatoes by any one of a wide range of methods. There are, for example, long-term, basic methods of supporting and stabilizing prices, such as acreage quotas, the registration of producers and distributors, and the improvement of market intelligence and standards of potato grading and presentation. It is difficult, perhaps impossible, to assess the real economic significance of some of these factors. In the short-term the Board makes use of further powers, such as the control of riddle size, the purchase of surplus supplies and, in extreme cases, the prescription of minimum prices. The Board also makes representations to the Government regarding the inflow of imports particularly at times when competition with home-produced supplies is held to be excessive.

Over recent years the Board has had some success with the increasing use of its powers to purchase surplus potatoes. Originally the Board was provided with funds by the Government to the extent of 95 per cent. of the net cost of the buying operation. In 1959, however, a deficiency payment was introduced by which the funds made available by the Government represented the difference between the guaranteed standard price and the realized price for

ware potatoes. But this system had many short-comings, and at the Annual Price Review of 1961 it was decided to establish a Market Support Fund towards which the Government would contribute two-thirds of the necessary finance, totalling £15 million, and the Potato Marketing Board the remaining one-third. The decision to continue development along these lines has much to commend it, although it is open to question whether it is desirable to use Government funds to the extent proposed. Further consideration also needs to be given to alternative methods of regulating or preventing surpluses since market support buying can be very costly. For example, the purchase of some 650,000 tons of surplus potatoes from the 1960 crop cost about £6.6 million and a considerably larger bill would have had to be faced but for a reduction in imports of earlies and of Northern Ireland ware potatoes.

The pattern of market prices in 1959-60 shows the effect of intervention by the Board to support the market. Although at first it was expected that owing to the dry season supplies would be light and of poor quality, it became increasingly apparent that surplus stocks existed. In the event, production from the 1959 crop totalled 6.1 million tons, of which the Potato Marketing

Figure 6. Potato Marketing Board Intervention in the Support of Producers' Prices—1959 Maincrop

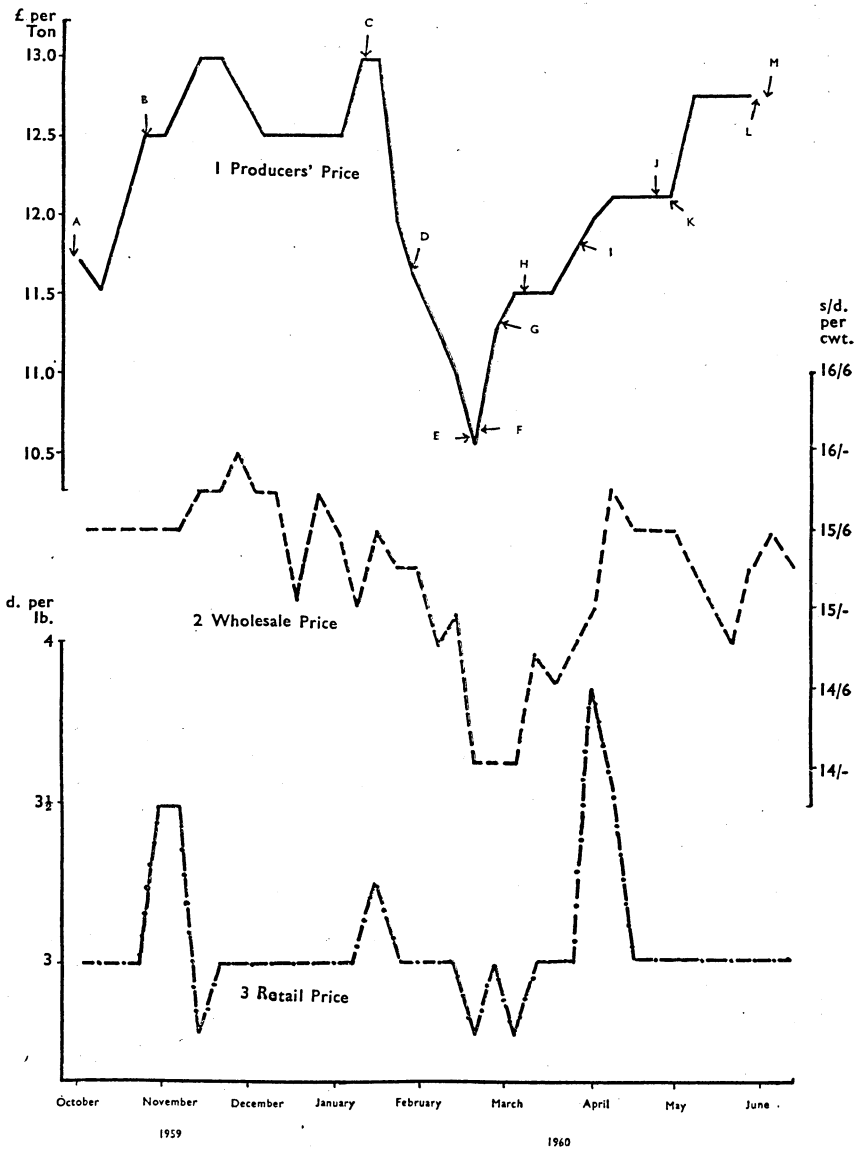
Key

1.	Producers' Price	Siltland Majestics—Spalding Market
2.	Wholesale Price	Siltland Majestics—London Markets
3.	Retail Price	Majestics—London

(*The above are derived from Potato Marketing Board statistics*).

A.	1 October, 1959	riddle size set at 1¾ inches for ' whites '
B.	27 October	Board commences purchase of surplus supplies
C.	12 January, 1960	Board ceases purchase having bought 78,000 tons
D.	27 January	riddle size raised to 2 inches for ' whites '
E.	17 February	Board recommences buying operations using Government funds
F.	22 February	Minimum price prescribed at £11 10s. 0d. per ton (Region I)
G.	29 February	Prescribed minimum price raised to £12 10s. 0d. per ton
H.	9 March	Board buys supplies at premium of £3 per ton
I.	1 April	Prescribed minimum price raised to £13 10s. 0d. per ton
J.	29 April	Board ceases purchase having bought 387,000 tons
K.	1 May	Minimum price raised to £14 10s. 0d. per ton
L.	1 June	Minimum price raised to £15 10s. 0d. per ton
M.	4—14 June	Board purchases final surplus supplies, amounting to 39,000 tons, making a grand total of 504,000 tons

Figure 6. **Weekly Prices of Majestic Potatoes—1959 Crop**



Board eventually purchased 504,000 tons, at a net cost of £5.3 million. There were no foreign imports of ware potatoes in the 1959-60 season. Imports from Northern Ireland, 123,000 tons, however, were the highest for four years, and substantial quantities of imported new potatoes began to reach the markets early in 1960, (see Figure 3, page 18).

The response of the Marketing Board to the developing situation can be traced in Figure 6. This chart shows the effect of the detailed operations on producers' prices for Majestics at Spalding. The Board's first act was to limit supplies by raising the minimum riddle size for ware potatoes at the beginning of October.* Later in the same month it commenced the first of three purchasing programmes. In the first period, lasting some eleven weeks, 78,000 tons of inferior quality potatoes were purchased, but the operation had to be ended due to the exhaustion of the Board's reserve funds. From this point prices fell disastrously, and even the imposition of a larger riddle could not prevent the fall continuing.

A second buying programme was initiated by the Board in mid-February, with funds largely originating from Government sources. Supplies were purchased through to the end of April, with the result that the market was relieved of some 387,000 tons of unwanted potatoes. The effect of this operation is difficult to assess since the Board also prescribed minimum prices in producers' markets a few days after recommencing its purchasing activities. Under these regulations, the price to farmers rose by £1 per ton per month through to the end of June.

The final stage of the Board's intervention took place during the first fortnight in June, when a further 39,000 tons of surplus potatoes were purchased. Thus the Board removed from the market some 504,000 tons of potatoes, of which slightly less than half were disposed of for stockfeed, export and drying. The purchase of these supplies cost the Board and the Government almost £6 million, less £700,000 received from the disposal of stockfeed and dried potatoes.

The first buying programme, aimed at removing potatoes of inferior quality, commenced before the real extent of the surplus was apparent. It cost £0.5 million and was financed from the Marketing Board's current income. (£200,000 originated from the £10 per acre levy on acreage grown in excess of basic allotments and £300,000 was the unused balance of the £1 per acre contribution paid to the Board by all registered growers).

* An upper size riddle was not prescribed, although it would probably have been of considerable value. A top riddle was used for the first time in 1960-61.

The second and third buying programmes cost a further £5¼ million, approximately. This was financed by the Board liquidating £1¼ million of its investments and by a Government subsidy of £4 million made as a contribution towards the total cost of the support programmes. The first buying operation exhausted the Board's liquid funds in eleven weeks. It was noticeably reluctant thereafter to encash its longer term investments on the grounds that it was 'the business of the Government Guarantee under the Agricultural Act' to deal with heavy surpluses. Up to this point, in fact, no Government aid had been forthcoming, since the average market price to producers had been held above the guaranteed standard price.

It is of some interest to speculate on what effect the Board's first buying programme would have had on prices if it had not been abruptly terminated through the unwillingness of the Board and the Government to provide the necessary funds, as explained above. It is not inconceivable that the cost to the taxpayer might have been considerably less than it was, and the development of Government plans for providing financial support in subsequent years adds weight to this view. In the event, however, prices tumbled rapidly when support buying ceased and both buyers and sellers lost confidence in the market as the size of the surplus became more and more apparent. It does not appear that the outlay of almost £5 million, in the second phase of the buying operations, really managed to produce a more buoyant situation ; prices hung too close to the prescribed minimum levels for this to be said to have happened.

The Board obviously profited from its experience with the 1959 crop and arrangements to deal with the 1960 crop appear to have been more thorough. A top riddle was introduced for the first time at the beginning of the season and steps were taken to curb the importation of 'new' potatoes of Eastern Mediterranean origin. Purchases of surplus potatoes began in early October but the main bulk of purchases was not made until the January through to March. The wet weather very seriously delayed harvesting and supplies were late in coming onto the market. But more important was the fact that the weather reduced the potential surplus by some half-a-million tons thereby reducing the cost of support buying by at least £5 million.

For most of the year at least, while the bulk of the home-grown crop is being sold, prices in the wholesale markets closely reflect the situation in the producer markets. This is shown in Figure 6, page 25. However, wholesale prices for any single kind or variety of potato are also sensitive to alternative supplies, such as imports. Thus, although wholesale prices kept in step with producer prices during the period while most of the 1959 crop was

being marketed, imports of earlies began to affect prices considerably from the middle of April.

At the retail level, as Figure 6 shows, price movements may differ appreciably from those to be found in the wholesale and producer markets.* Two salient features emerge from the chart : in the first place, retailers and consumers strongly prefer stable prices and, in the second place, price falls in the wholesale and producer markets, occasioned by heavy supplies, are not fully reflected by retail prices. On the other hand, it is clear that even a hint of shortage is sufficient to drive up retail prices appreciably. Thus the chart indicates the highly inelastic nature of consumer demand for potatoes. The weekly needs of a family for potatoes vary little for many weeks of the year and both housewives and retailers obviously prefer stable prices to facilitate trading.

Patterns of Consumption

Patterns of consumption are not only diverse, they are also dynamic, and the accuracy of forecasts of the future demand for potatoes calls for detailed, and far ranging analyses.

Table IV—The Relationship Between Income and Level of Potato Consumption

Annual Income of Head of Household	Index of Consumption per Head
£1,650 or above	100
£1,000 to £1,650	112
£600 to £1,000	127
£400 to £600	131
under £400	121

Based on ' Domestic Food Consumption and Expenditure : 1958.' H.M.S.O.

The main determinants of demand are earnings, type of occupation, size and composition of family, regional and local food preferences, and the relative attractiveness of potato prices. Over the last twenty years considerable light has been thrown on these matters through the investigations conducted by the National Food Survey Committee. Table IV, based on its findings, gives some indication of the variation in levels of potato consumption associated with various levels of income.

* This point is discussed by Allen, G. R. in ' The Short-term Behaviour of Distributors' Margins on Fruit and Vegetables.' Farm Economist, Vol. VIII, 1956.

Regional differences in potato consumption are also highly significant, as can be seen from Table V. Even more important are the variations in expenditure resulting from differences in quantities and types of potatoes consumed, and the sources of supplies. Thus, the National Food Survey reports show a range in spending from under 4½d. per person per week in rural areas to more than 17d. in the Midlands. In other words, a countryman may spend no more than £1 per year on farm produced potatoes in contrast to the townsman whose outlay might be more than £3 10s. 0d.

TABLE V—REGIONAL DIFFERENCES IN POTATO CONSUMPTION

	Annual Consumption per Head		
	Yorkshire	S.W. England	Great Britain
	lb	lb	lb
Old Potatoes	141	131	132
New Potatoes	44	37	44
Chips and Crisps	8	3	4
Total	193	171	180

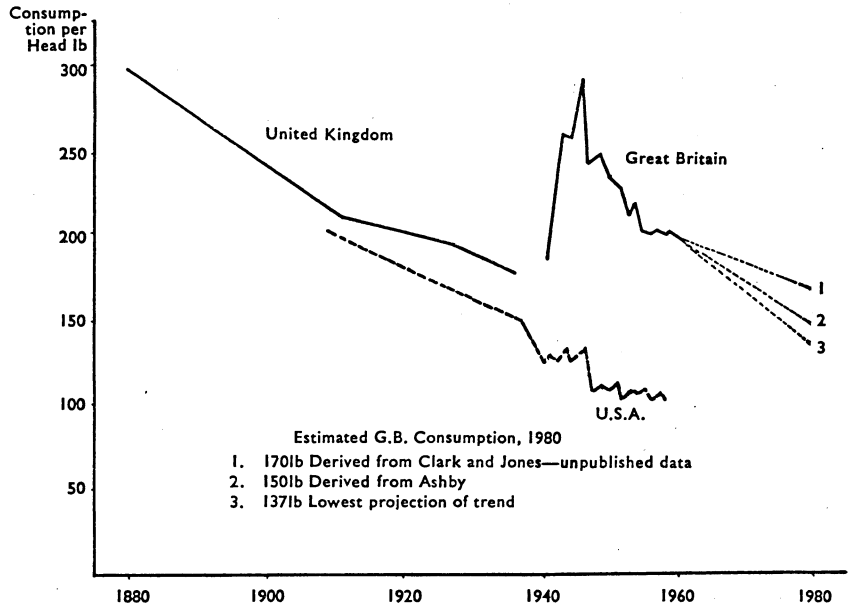
Based on ' Domestic Food Consumption and Expenditure : 1958.' H.M.S.O.

Although future levels of potato consumption cannot yet be forecast with the degree of accuracy likely to be necessary for planning production within the next couple of decades, approximate forecasts can be made. It is a phenomenon characteristic of the food economies of all Western Countries that potato consumption tends to decline with advancing economic prosperity. Thus there are strong reasons for expecting a continued decline in Britain, although at what rate is somewhat problematical. Amongst the complex forces at work the following are the most powerful : the swing away from heavy manual work, the tendency for incomes to rise, changes in dietaries particularly emphasizing protein-rich and prepared foods, changing population structure, and perhaps, inter-regional migration.

Trends in potato consumption, extending over a period of one hundred years, are shown in Figure 7. Details of recent changes in consumption per head* are given in Table J, (Appendix). The diagram shows the very marked upswing in consumption in this country during the war and post-war period of food shortage. Even today, some eight years after the ending of food rationing, potato consumption is at a high level. But for the intervention of the war it seems probable that consumption per head would be about 40lb less ; some 20 per cent. below the present level of

* An analysis of data published by the National Food Survey Committee suggests a more rapid decline in actual potato consumption than is apparent from official estimates of consumption per head.

Figure 7. **Trends in Annual Potato Consumption per Head**



200lb. Nevertheless, the British are tending to eat fewer potatoes and there are many grounds for believing they will eat fewer still in future. One estimate† indicates that by 1980 consumption per head may have fallen to 150lb per year in the United Kingdom. Possibly in Great Britain the level will be even lower, perhaps as low as 135lb per head. Even at the former level the annual rate of potato consumption per person will probably have been halved over the 100 year period ending in 1980. Taking into account probable improvements in yields, it seems likely that one acre of potatoes will be sufficient for about 145 persons by 1980, as compared with 90 today and only 45 in 1880.

RE-ADJUSTMENT PROBLEMS OF THE POTATO INDUSTRY

The repercussions of a decline in potato consumption will be serious since the latter will inevitably coincide with rising farm productivity. Thus, assuming a rate of consumption of 150lb per head by 1980, a crop of 4.5 million tons would suffice—the produce of only 500,000 acres if yield per acre should average 9 tons. In

† Ashby, Andrew W. 'The Future Pattern of Food Consumption in the United Kingdom.' Journal of Agricultural Economics, 1957.

other words, over the next twenty years the acreage of potatoes might need to fall by nearly one third, i.e., by 200,000 acres, if the necessary adjustment is to take place to avoid surpluses and maintain producers' incomes. The assumptions upon which the above estimates have been made are as follows :—

ADJUSTMENTS IN POTATO PRODUCTION

	Period I	Period II
Number of consumers	51.0 million	56.0 million
Potato consumption per head	200 lb	150 lb
less imported supplies	20	20
	180	130
Annual requirements for human consumption	4.10 million tons	3.25 million tons
Total production assuming 72% of crop saleable	5.70 million tons	4.50 million tons
Average yield per acre	8 tons	9 tons
Acreage required	712,000	500,000

In addition to a fall in acreage, it is clear that the numbers of producers will also fall considerably. By 1980, at least 20,000 growers will probably have ceased commercial production, approximately two out of every seven of the present number. (The basis for this estimate is set out in Table G, Appendix).

The above estimates do not take any account of the repercussions that would eventually result from Britain joining the European Economic Community. Recent events have made it appear likely that the United Kingdom will become a member in the not too distant future, in which event the structure of British Agriculture would inevitably change. In regard to potato production, there are grounds for expecting a considerable growth of

TABLE VI—POTATO PRICES IN EUROPE

	Denmark	Netherlands	W. Germany	U.K.
	(Farm Gate Value per ton)			
	£	£	£	£
1955-6 ...	16.4	12.1	12.8	15.2
1956-7 ...	8.4	9.9	10.6	16.1
1957-8 ...	9.9	14.2	10.2	24.4
1958-9 ...	14.3	13.1	12.0	23.0

competition. Over the period 1955-56 to 1958-59, for example, growers in Denmark, the Netherlands and Western Germany received on average close on £12 per ton for their potatoes whereas, as Table VI shows, prices in the United Kingdom averaged almost £22 per ton.

This comparison is not quite fair to home producers, however, who as a result of light crops, tended to receive abnormally high returns during this period. A more appropriate recent figure would be about £15 per ton. Even so, the British market would attract continental growers and the least efficient home producers would find their position untenable. Although there is no adequate evidence on this point, perhaps as many as one fifth of the present number of growers might fall into this category. It would seem likely that any grower who could not average at least 7 tons of potatoes per acre over a period of years, would be very vulnerable. Agreement on Common Market policies for potato production and marketing is still in the future and till then the effect of any change must largely remain a matter for speculation.

Trends in Retailing and Distribution

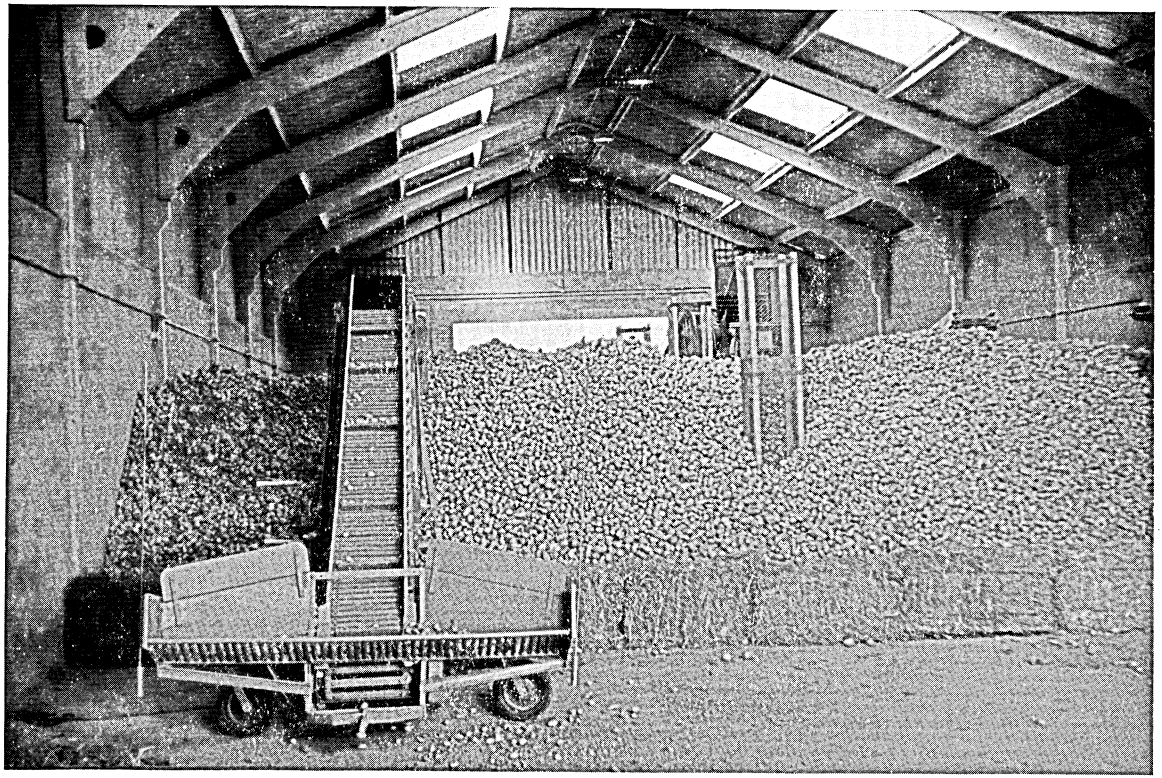
Food producers cannot stand aloof from the effects of growing retail competition. In particular, an important question is what the effect on producers will be of the increasing growth of large distributing interests. These firms look to economies of scale in order to exploit the potential of the market and one of their main competitive features is the bargaining power they enjoy *vis-a-vis* producers. A further factor is the aim of these firms to sell more and more 'services' to housewives and even in the case of those foods for which total consumption is likely to fall, this is seen as a means of expanding turnover and profits. The trend towards processed and packed potato is well under way and already the producer's share of the consumer's £ is noticeably declining.

In the case of potatoes, consumers will be sold increasing quantities of prepacked supplies. In 1960, for example, approximately one quarter of the retail sales of maincrops, almost 850,000 tons, were sold prepacked.* The prospects for expansion are obvious when it is remembered that self-service stores, at present handling one fifth of food sales, are expected to capture three-quarters of the whole market by 1970.

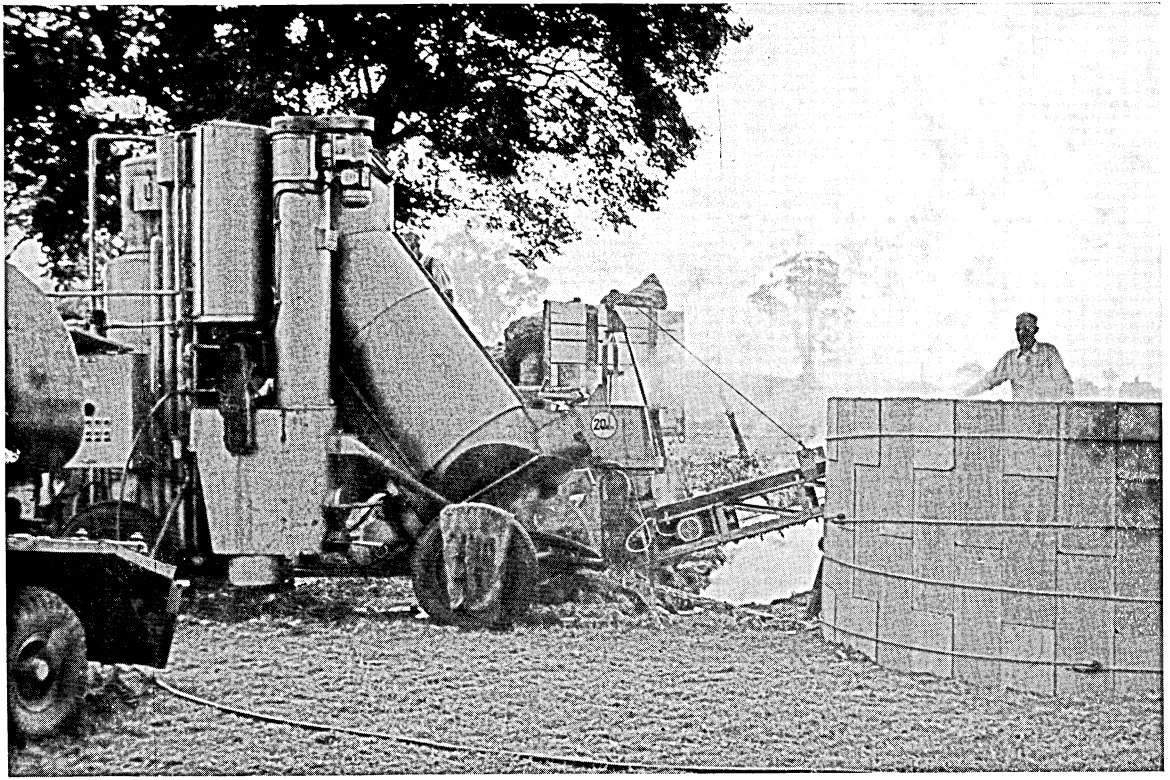
Prepared products too, such as dehydrated potato flakes and frozen pre-fried chips, will come on to the market in increasing quantities. The advantages of these uniform quality, partially prepared foods are becoming apparent to today's busy housewives. Although the development of sales of processed potatoes in Britain is likely to be delayed for income reasons, American experience indicates the rising significance of these supplies, (Table VII).

Changes towards pre-packed and processed potatoes are not likely to benefit potato producers directly, since total consumption will not be increased and the higher retail prices charged will be

* The author is obliged to Mr. Andrew W. Ashby for a communication on developments in this field.



Bulk storage of potatoes in buildings is becoming increasingly popular. Savings in costs compared with clamping in the field are not great, but the opportunities for mechanical handling and better grading associated with improved working conditions have encouraged many growers to invest the £5 or £10 per ton needed for a suitable building.



Mobile steaming plants are rapidly becoming a permanent feature of the Board's surplus disposal plan, according to the reports of the Potato Marketing Board. Four machines, similar to that illustrated above, were in operation in 1959-60 and prepared 5,000 tons of surplus potatoes for ensiling for livestock feed. In the 1960-61 season fourteen machines were in operation and 20,000 tons of potatoes were steamed. The machines have a throughput of about 2 tons per hour and the cost of preparing the cooked material was approximately £5 per ton in 1960.

TABLE VII—TRENDS IN POTATO CONSUMPTION IN THE U.S.A.

	Annual Consumption per Head		
	1950	1956	1959
	lb	lb	lb
Total Potatoes	128	106	106
Processed Potatoes	2	23	31

largely absorbed by the processors and the distributors. Nevertheless, the developments do have extremely important consequences for the producers. In order to pack and process potatoes on an adequate scale, distributors must be reasonably certain of the quality and seasonal availability of their supplies.† The latter are key factors that in the future will enable favoured producers to obtain above average returns.

It seems increasingly probable that processors and distributors will attempt to guarantee supplies by some sort of contract system.* There are strong reasons why this should be developed by the Potato Marketing Board, but the main emphasis is likely to come from the distributors, processors and packers. Integration in the wholesale and retail fields is developing apace, and the large-scale distributing and retailing enterprises which are emerging will seek to gain a firm control over their supplies of potatoes. Potato processing plants, too will need to be of considerable size in order to justify the use of expensive equipment, advertizing and other distribution costs. Much of the success of such highly organized, comparatively large businesses will depend upon the regularity of supplies of the desired qualities of potatoes. Thus contract arrangements between producer and buyer will become more common. Experience with broiler chickens has shown how producer controlled organizations can supply large distributing units on a contract basis. By this means many of the vagaries and uncertainties of the market have been removed, orderly production and marketing has been arranged, and producers have generally received good returns. Certainly, there would appear to be a strong case for groups of potato producers organizing joint storage, grading and packing plants and contracting to supply distributors, if only on a trial basis.

The prepacking of potatoes also has an economic significance to producers because of the emphasis it places upon 'quality' and upon seasonality of supplies. Supplies must be made available as the packer requires them, rather than when the farming

† The pre-packing of potatoes is considered in some detail by M. R. Haswell in 'Economic Aspects of the Production and Distribution of Potatoes,' Metal Box Co. Ltd., 1957.

* Such developments are mentioned by the Consumers' Committee for Great Britain in their 'Report on the Potato Marketing Scheme' April, 1961.

routine makes it convenient to despatch them. In particular, this will tend to encourage the provision of indoor stores and seasonal price scales may be expected to be developed to cover holding costs.

In respect of 'quality,' flavour and cooking quality will perhaps tend to become relatively less important. Over the past 10 to 12 years the acreage planted to potato varieties most favoured by consumers has increased very substantially, rising in the case of King Edwards and Red King from one tenth to approximately one quarter of the maincrop acreage. In future, producers' returns will probably be affected more by appearance and by considerations such as colour, freedom from mechanical damage and scab, than by cooking quality and flavour†. Keeping quality too, must be taken into account owing to the relatively short 'life' of washed and particularly of peeled, pre-packed potatoes. Shape and size are important factors, but grading at the packing plant to produce packs of uniformly sized potatoes, would seem to be the obvious way to deal with this problem.

It is probably true to say that the chief economic problem of the potato industry is a consequence of perishability rather than variations in yields. Thus the development of processed and partially-prepared potatoes, such as potato flakes and crisps, could be a powerful stabilizing factor in future because of the opportunities for storing these products. Probably much price fluctuation could be avoided if stocks of potato products could be carried over from years of surplus into years of scarcity.

However, there would be a very clear disadvantage to home producers from a large-scale growth of sales of processed potatoes since this would open up new opportunities for overseas growers to enter the British Market. It is not clear how soon this issue will have to be faced but it is possible that it will not long remain an academic matter.

The Role of the Marketing Authority

Despite a widespread belief to the contrary, most of the methods used by the Government and the Marketing Boards to support agricultural prices are basically efficient. In other words, they do result in higher prices and more stable incomes for producers*.

† The report of the Consumer Committee reviewing the working of the Potato Marketing Scheme, published in April 1961, lays particular emphasis on the need for improving the 'quality' of potatoes offered for sale.

* Producers are likely to be detered from investing in cost-reducing capital equipment where there is a high degree of uncertainty of returns. Price stabilization, therefore, is an important means of promoting more economic methods of production, to the potential advantage of both producers and consumers. This point is discussed by G. R. Allen in 'Agricultural Marketing Policies,' Blackwell, 1959.

It is this very success, however, that creates a need to review price support policies since the power to squeeze out the inefficient producers is greatly reduced once the normal forces of supply and demand have been overthrown. Thus, the fundamental problem thrown up by most subsidy and marketing board policies is that prices and markets are literally guaranteed to all producers virtually without limit. No real authority exists in place of the price mechanism to indicate how many producers can reasonably make a living in the protected market, nor how much produce each is permitted to supply. Future developments in marketing or in Government price support policies must be related to the basic need to regulate supplies coming on to the market.

Many potato producers, of course, will continue to look to the Marketing Board, and the Government, to provide them with satisfactory returns. But the question must be asked whether present methods and institutions are adequate to meet future needs. The proposal to establish a market support fund for potatoes is undoubtedly a step in the right direction, though some of the details of its operation and financing might be improved. For example, how necessary is it for the Government to subsidize the purchasing fund ? If producers' prices are to be maintained at adequate levels considerable support purchases will undoubtedly be needed in times of surplus. But equally, should not producers mainly finance their own 'insurance' from levies made on the very high returns obtained in years of scarce supplies ? Possibly a major obstacle to such a course is that at present the Potato Marketing Board would have difficulty in collecting funds, since, unlike the Milk Marketing Board, it is not itself involved in sales transactions. Since it would, however, relieve the taxpayer of a subsidy burden and release the industry from considerable Government direction, there is much to be said in favour of sales being invoiced through the marketing authority.

Whether or not the industry finances a market support fund from its own resources, there are other ways in which a marketing authority in future could play a more purposeful role than the present Board is empowered to do. For instance, it might itself develop a system of market supply contracts, in order to reduce the effects of yield variation and to limit the total volume of production.

The most effective way to do this would be to institute a system of quantity contracts in place of the present acreage quotas.* The latter, besides tending to force up yields, are also quite ineffective for eliminating yield variations—the main cause of price instability.

* G. R. Allen, op. cit., suggested a technique for forecasting potato yields, as a basis for improving the Potato Marketing Board's acreage controls. The method has failed to cope with the violent yield fluctuations of recent years, and acreage control must remain an imperfect method of determining the supply of potatoes.

Producers would be required to contract with the marketing authority to supply specified tonnages of potatoes and the authority in turn would make contracts with distributing firms. According to market demand, arrangements could also be made regarding quality and the seasonality of supply. Contracts would be 'sold' on a competitive price basis, with the price varying according to the demand from would-be producers.

One advantage of a contract system is that it would keep surplus potatoes off the market. As with 'surplus' hops, excess supplies would be retained on the farm where they were grown and the purchase of unwanted potatoes with market support funds would be avoided. A further advantage of a contract system is that it would avoid the creation of monopoly values for farms with potato acreage allotments. The Board's decision to seek powers to raise the levy on excess potato acreage† from £10 per acre to £25, adds to the likelihood of such farms increasing in value. A far more serious consequence of acreage quotas, however, is that they may tend to inhibit economically desirable adjustments. If the acreage is restricted to those farms and to those farming districts which in the past have grown potatoes, there is a likelihood that consumers and would-be producers will be denied the benefits of greater efficiency and enterprise. Thus there is much to be said for a system of a competitive bidding for production contracts.

Consideration should also be given to the case for setting up a small number of competitive regional marketing authorities, in place of the present single Potato Marketing Board dealing with the whole of Great Britain*. Such a development would help to protect consumers from the effects of monopoly powers in the hands of growers. It would also encourage greater flexibility and efficiency in both production and marketing. For example, production would be encouraged to develop in those areas and on those farms with the lowest costs of production. More competitive marketing would also result and market outlets would be exploited more vigorously by the regional authorities. Lastly, regional organizations would ensure that common interests were more closely recognized and there would be strong incentives to tackle local production problems more thoroughly.

† This is the acreage planted by a producer in excess of his basic allotment or quota.

* A similar case exists for creating regional marketing authorities for eggs and milk.

PART II

POTATO PRODUCTION— ASPECTS OF MANAGEMENT

INTRODUCTION

The first part of this report is concerned with questions of the adjustments facing the potato industry as a whole, and it has been shown that the next decade will involve some contraction in production. The question then arises of where this contraction should take place. From the economic point of view, the answer clearly involves the withdrawal of the least efficient producers, and it is desirable that the future policies of the Potato Marketing Board should allow this to happen. As has been pointed out, the forces that under free market conditions would push the least efficient producers out of business are to some extent absent under a system of quotas and price maintenance. In the absence of these economic pressures it will be desirable for the Board to take some positive steps, as suggested in Part I, to ensure the development of an efficient and competitive industry. In these circumstances, the individual farmer who is determined to continue growing potatoes will need to strive constantly for greater efficiency. Rising costs, particularly for labour, will demand changes in growing methods, and a greater willingness to abandon outdated and costly practices. Despite the likelihood of greater competition within the European Common Market, there is no reason why potato growing should not continue to make a useful contribution towards profits on many British farms. The remainder of this report is concerned with an analysis of what is, and what will be involved in efficient potato production, having regard to rising farming costs and changing consumer preferences.

EFFICIENCY IN THE POTATO ENTERPRISE

Efficient potato production depends firstly upon the successful integration of the crop into the whole farm economy. Discussion of this point is complicated by the many kinds of farm which grow the crop. For example, a large arable farm in the east of the country growing a considerable acreage of potatoes contrasts sharply with a small mixed farm further west growing potatoes on a small scale. Yet despite this range, the principles governing the

integration of the crop into a farm economy are always the same. Potatoes must compete with other enterprises for the scarce resources of land, labour and capital available on the farm. The farmer must seek to equalize the returns from the last acre of land, the last hour of labour, or the last £1 of capital, whether the resources are used in potato production or in some other enterprise. Some allowance must be made, of course, for the different degrees of risk involved in the various farming activities, but given adequate information about yields, prices, labour and capital requirements, etc., it is possible to calculate the best combination of enterprises for any given farm*. The disadvantage, for present purposes, is that any such solution is unique to a particular farm, and may not be applied, except in a general way, to other farms. Consequently, this discussion of efficiency will mainly be confined to management decisions within the potato enterprise, without reference to the wider implications of potato growing on any individual farm economy.

The Importance of Output

The profitability of potato production is determined by the relationship between output and costs. Attempts to maximize output without reference to costs, or to reduce costs without considering the effect on returns will not lead to maximum profits. Yet many of the costs of potato production are unavoidable irrespective of the eventual output. The land must be prepared and the crop planted and harvested, involving some minimum expenditure by the grower. The difference in cost between doing the job badly and doing it well is likely to be small—a well-grown crop may receive no extra cultivations, the difference lying in more timely work with better tackle. Moreover, during the growing season a farmer cannot predict accurately either the yield of his crop, or the prices he will receive, and he has, therefore, little opportunity to modify his production methods accordingly. Even when lifting a crop in a year of poor yields or prices there is still only limited scope for saving costs, unless the crop is sacrificed and ploughed in. Consequently, differences in profits between crops mainly arise from differences in output, with the level of costs remaining more or less fixed. This is illustrated in Table VIII which refers to a Wye College survey of maincrop potato growing in 1958 and 1959.

* The technique of budgeting or its development as linear programming would be used. The validity of the results often hinges on assumptions about the effects of different crops on soil fertility, and there is a serious lack of reliable experimental evidence on this subject.

TABLE VIII—THE DISTRIBUTION OF OUTPUT, COSTS AND PROFIT OF 137 KENTISH POTATO CROPS†

Level of Output per Acre	Less than £50	£50-£99	£100-£149	£150-£199	£200 and over
	Average Results per Acre				
	£	£	£	£	£
Output	35.3	72.4	126.2	171.6	242.2
Costs*	68.1	78.2	78.5	80.0	87.7
Profit	—32.8	—5.8	+47.6	+91.5	+154.5
Number of Results	17	31	35	24	30

† More detailed distributions of results are given in Tables L and M, Appendix.

* Costs per acre include direct costs, such as seed, fertilizer and labour, and specific overheads, such as depreciation of potato equipment. General farm overheads, such as rent, management expenses and rotational costs are not included for reasons discussed on page 44.

It must be emphasized that this table covers two years of very different yields and prices, and includes farms on various soils with varying standards of management. It would be incorrect to deduce that a specified level of outlay on any one farm in any particular year would result in the level of output and profit indicated above.

Table VIII shows a range from an average loss of over £30 per acre to an average profit of £155 per acre, with only a small rise in costs. The variation in profit appears to stem mainly from the progressive increase in the value of output across the table, from an average of £35 per acre for the lowest group to £242 for the highest. It may be concluded that profitable potato production depends on obtaining a high output per acre,* and it is therefore important to consider the causes of variations in output between different crops.

FACTORS DETERMINING OUTPUT

Output is the total value of the crop produced, and is made up of two parts—yield and price. Neither can be neglected in profitable potato production, for both the yield per acre and the price obtained per ton are, to some extent, a consequence of the methods of production adopted.

* This conclusion may become less valid in the future when output per worker employed may be of more importance than output per acre.

The eventual yield obtained depends chiefly on the following factors :—

1. the local climatic conditions,
2. the incidence of pests and diseases,
3. the soil type and its inherent fertility,
4. the level of manuring,
5. the type, variety and quantity of seed,
6. the timeliness and adequacy of cultivations.

Similarly, the economic yield depends upon the price obtained for the potatoes as influenced by :—

1. market conditions, and the effect of Potato Marketing Board and Government intervention,
2. the bargaining power of the farmer, and the amount of attention he is prepared to devote to marketing his crop,
3. the quality of the produce, resulting from :—
   a. the effect of variety, soil and cultural methods on the size, shape, colour, texture, condition and flavour of the tubers,
   b. careful grading to exclude diseased or damaged tubers and other unwanted material from the final sample.

Although he has no direct control of either the weather or market conditions, there remains much that a grower can do to influence the final output and profit of his crop. Research into potato production in Lincolnshire* indicates that the more widespread adoption of advanced techniques, such as irrigation, chemical spraying against blight and the chitting of seed tubers, has resulted in higher and more stable yields than in the past. If growers in other areas devoted similar attention to the better management of their potato crops, a good deal of the variability of yields would disappear and the problems facing the marketing authority would be lessened.

It would be unwise to attempt to lay down a comprehensive set of rules for profitable potato production. Indeed, there can be no such universal solution, for circumstances differ from farm to farm, and from season to season. The grower himself must use a great deal of economic judgement and technical skill to tackle each special problem as it arises. Nevertheless, the extensive range in methods of production found in the survey† indicates that there is a wide gap between the highest and the lowest levels of technical and economic efficiency. The best growers have little to fear from increased competition, but it is essential that the laggards make

* K.A. Ingersent, 'The Growth of Potato Production in Lincolnshire.' Farm Management Notes No. 24. University of Nottingham, Department of Agricultural Economics, 1960.

† Some of these results are presented in Table P, Appendix.

determined efforts to mend their ways in the light of improved technical knowledge and changing economic circumstances, if they hope to continue growing potatoes profitably. The following pages are devoted to an economic interpretation of recent results from experimental stations and elsewhere on production practices tending to give increased profits.

The Main Production Techniques of Economic Significance

The potato crop will respond to good management* and favourable growing conditions to an extent that is quite remarkable among farm crops. Successful production depends upon the exploitation of this potential to the fullest economic extent. Most growers appreciate the need for reliable seed and adequate fertilization, but there are other aspects of production where growers may fail to give the crop the care and attention it needs.

Early Planting

Almost every year the growth of potato crops is curtailed by blight, and in order that the crop may be well developed when this happens, early planting is essential. Experiments have shown an average loss of yield of 6 or 7 cwt per acre for every week's delay in planting after the first half of April.† The critical date varies from season to season and district to district, but it is clearly important to plant as early as possible, bearing in mind the risk of frost damage to very early plantings.

Chitting

Perhaps more important than early planting is the extra growth obtainable by chitting the seed prior to planting. The first stages of sprout development are allowed to take place under controlled conditions in a glasshouse or other building, so avoiding the risk of frost damage and giving more time for seedbed preparation. The extra yield produced depends on the type of sprout that is allowed to develop—good sturdy growths give the best results and are less likely to suffer damage in handling before planting. In a trial at Wye College over the three years 1958 to 1960 an average increase in yields of 16 per cent. was recorded for chitted seed,‡ and responses between 10 per cent. and 20 per cent. have been recorded at other centres. This might be worth some £15 per acre, and should easily repay chitting costs. These include depreciation

* The economist is concerned with finding the most economic response to inputs of seed, fertilizer, labour etc., rather than the highest possible response. In other words, he seeks the optimum, rather than the maximum response ; a distinction of considerable importance to this discussion of good management.

† G. V. Dyke, 'The Effect of Date of Planting on the Yield of Potatoes,' Journal of Agricultural Science, 1956.

‡ Information supplied by P. Innes, Department of Agriculture, Wye College.

and repairs on the chitting house and trays, heating, extra labour for boxing up and additional work at planting time. In some cases it may be necessary to buy a different planting machine, for not all types are able to handle chitted seed without damage. Higher labour costs in future will emphasize the need for a really satisfactory automatic planting machine able to handle sprouted seed with a minimum of damage.

The Control of Blight

In mid-season the tubers of a crop of potatoes in full growth are developing at the rate of about one ton per acre per week, and it is clear that anything which curtails this vigorous growth will have a serious effect on the yield. In practice, development is likely to be restricted by one or other of the two chief scourges of the potato crop—blight and drought. Such measures as protective sprays to control the former, or irrigation to correct the latter, may have important consequences on the final output.

Early planting allows the tubers to develop further before the onset of blight. Similarly, a balanced fertilizer programme gives rapid growth without the production of excessive amounts of succulent haulm highly susceptible to attack. Transmission of the infection to the tubers may be limited by thorough earthing and by destroying the haulm once it becomes badly infected. (Chemical or mechanical haulm destruction also makes subsequent digging and picking operations easier). Finally spraying with a copper or an organic fungicide restricts the spread of the fungus on the haulm. This technique is not an unmixed blessing for it may allow more time for the spread of the disease to the tubers, and the passage of the tractor and sprayer through the crop causes some loss of yield by bruising. Wheel damage may be minimized by the use of a wide spray boom and narrow wheels, or avoided altogether by aerial spraying.

The extent of control effected by spraying depends on many factors :— timeliness, the material used, the method of application, and subsequent weather conditions. On a farm scale, it is often difficult to provide the degree of protection necessary to give an economic increase in yield, particularly in a crop nearing maturity with little further growth to be made. The best solution is to plant in good time, to see that the developing tubers are well covered with soil, and to decide on the spraying programme by reference to the state of the crop when blight is forecast. An early attack demands timely and thorough spraying, but damage from a late attack can be minimized by haulm destruction. The critical date after which blight losses are insufficient to justify spraying will depend on the particular circumstances. For example, if spraying costs £2 per acre and wheel damage is estimated at 5 cwt per acre,

blight losses must exceed about 10 cwt per acre for spraying to be justified. In an early attack this might be made good by 3-5 days extra growth, but in an almost mature crop this minimum response is likely to be unobtainable.

Irrigation

The economics of installing any irrigation system depends on four factors :—

1. the availability and cost of water,
2. the capital and operating costs,
3. the frequency and extent of irrigation need,
4. the value of the response from the acreage of crops irrigated.

Both capital and operating costs vary considerably according to circumstances. Taking an example of equipment costing about £20 per acre to install, giving annual fixed charges of depreciation and interest amounting to roughly £2 10s. 0d. per acre irrigated, and with operating costs for labour, repairs and fuel of £1 per inch of water applied per acre, the following table has been calculated :—

TABLE IX—AN EXAMPLE OF THE COSTS OF IRRIGATION

Inches of water applied per acre	1″ £	2″ £	3″ £	4″ £	5″ £
Operating costs per acre ...	1.0	2.0	3.0	4.0	5.0
Fixed costs per acre ...	2.5	2.5	2.5	2.5	2.5
Total costs per acre ...	3.5	4.5	5.5	6.5	7.5

Once an irrigation plant has been installed it will pay to use it whenever operating costs are covered by the extra returns from the irrigated crop. Over a period of years, however, the extra returns from irrigation must be adequate to cover both the operating costs and the fixed charges of depreciation and interest. In the main potato growing areas in the drier eastern parts of the country, the irrigation of potatoes gives a very good response—yields perhaps half as much again, and even double in very dry years. After deducting harvesting costs, a response of this order would still be worth several times the costs of applying the water. For example, a site with an average need of 2 inches per year would require only 10 cwt per acre extra yield to cover the total costs given in Table IX. But this is not the whole story, because the installation on any farm of an irrigation system must be considered on the basis of the total acreage of all crops irrigated, and many crops do not respond so well as potatoes. The project might well prove uneconomic unless the rotation includes a good proportion of other high-value, water-responsive crops such as sugar beet and market garden crops.

Methods of Harvesting

Finally, successful potato production demands appropriate harvesting, handling and grading to avoid excessive losses and

damage. For example, a survey of maincrop potato growing in Great Britain in 1958 showed that on average, 24 cwt per acre of potatoes were left in the ground, worth perhaps £20 or more per acre.* Field trials of potato harvesting indicate that damage and loss are related less to the type of equipment, than to the way that equipment is used. The most careful attention to growing methods can be wasted by careless operation of the digger or sorting machine.

THE CONTROL OF COSTS

The last section of this report was primarily concerned with the level of output, with little attention being paid to costs. Now it is necessary to examine the other side of the coin. The kind and amount of seed, fertilizer and cultivations have a direct influence on the production, and any unnecessary expenditure on these items will result in a corresponding loss of profit. Accordingly, it is essential to consider in some detail the control of costs in potato growing.

Two main categories of inputs are involved : firstly, the provision of materials, such as seed, fertilizer, sprays ; secondly the 'services' element, comprising regular and casual labour, and tractor and machinery services.

TABLE X—AVERAGE COSTS PER ACRE OF POTATO PRODUCTION†

	cwt	£	%
Materials			
Seed	19.3	30.6	37.5
Mineral Fertilizer	12.1	12.1	14.9
Sundries		2.4	2.9
TOTAL MATERIALS		45.1	55.3
Services	**hours**		
Regular Labour	74.5	15.4	18.9
Casual Labour	68.6	12.0	14.8
Power and Machinery		6.5	8.0
TOTAL SERVICES		33.9	41.7
Machinery Depreciation and P.M.B. Levy		2.5	3.0
TOTAL DIRECT COSTS		81.5	100.0
Average total yield per acre		8.3 tons	
Average cost per ton		£9.8	
Number of records		137	

Table X lists the average costs of potato production on a sample of Kent farms in 1958 and 1959. Only direct costs and specific overheads are included. All general overheads, such as rent and managerial expenses have been excluded. These costs

* Potato Marketing Board, Rothamsted Experimental Station, National Institute of Agricultural Engineering. 'Report on the Survey of Maincrop Potatoes, 1958.'

† Detailed distributions of results are given in Tables L and M, Appendix.

are not incurred as a direct consequence of growing potatoes, and their allocation on any arbitrary basis is not necessary from the management point of view. Furthermore, no charge is included for bulky organic manures, such as farmyard manure or shoddy. These materials are generally applied to maintain soil fertility for the whole rotation, and are no more specific to the potato crop than are the the lower profits often associated with rotational grassland which may be grown for the same reasons. Many farmers believe that a potato crop depletes soil fertility. This may be so, but no rational basis for the valuation of the fertility lost exists at present. In order to avoid becoming involved in the complex economic issues of farm rotations, no account has been taken of the costs of organic manuring. The exclusion of these rotational costs and of general farm overheads too, must be borne in mind when considering the levels of expenditure and profitability in Tables VIII and X.

In each year of the survey rather more than half of the total costs fell under the heading of 'materials,' consisting chiefly of seed and mineral fertilizer, with regular and casual labour costs as the main components of the remainder. In the following pages expenditure on these different items will be considered in more detail.

Materials—Seed

There are two aspects of the economy of seed use : the quantity planted per acre, and the cost per ton, (or the value of home-grown seed).

As a consequence of the deterioration through virus infection of seed stocks grown continuously in the milder climate of England, the majority of the national maincrop acreage is planted with Scotch or Irish certified seed. The general level and seasonal movement of the prices of this seed are determined to a considerable extent by the supply situation in the growing areas—chiefly Scotland. Consequently, seed prices are subject to the same violent fluctuations as ware prices, and wise judgement of the market will often lead a farmer to considerable savings.

The second aspect of seed economy is the quantity planted per acre. Most farmers tend to plant rather less than one ton ; the average for the survey was 19.3 cwt per acre, and few farmers vary this rate very much with either the type of seed or its cost. Indeed, many farmers hold traditional views about the most appropriate spacing of setts, and they plant at these distances irrespective of either the cost or the size of the seed. This directly conflicts with experimental evidence which indicates that the weight of seed planted per acre is of primary importance in the deter-

mination of yield. Within the normal range of seed rates, more seed produces a greater yield. However, the most economic seed rate is reached when the value of the extra yield produced by a one hundredweight increase in seed rate is just equal to the cost of the extra hundredweight of seed used.

Table XI, calculated with experimental results shows the most profitable seed rate in relation to the cost of seed and the expected price of ware. It will be apparent that both expensive seed and large seed should be planted at wider spacings, so reducing the rate per acre, while small or cheap seed must be planted closer. Without the evidence of local experiments it is not possible to make any definite recommendations on the optimum seed rates for particular areas or soil types, or even for particular varieties. But these average results clearly indicate that it would often pay to adopt a more flexible approach to seed rates, varying the weight planted according to the price of seed.

Another important effect of seed rate relates to the size of the tubers produced ; increasing the seed rates beyond 15 cwt per acre increases the total yield, but the weight of tubers in the sample standing on a 2 inch riddle tends to decrease. This aspect of production has considerable importance in relation to the Potato Marketing Board's policy of changing riddle sizes according to market conditions, as the proportion of chats or oversize tubers in a sample will depend upon the seed rate.

TABLE XI—THE MOST PROFITABLE SEED RATE FOR VARIOUS SEED AND WARE PRICES

Anticipated Ware Price per Ton	£12	£16	£20	£24	£28
Seed Cost per Ton	Seed Rate cwt per acre*				
£16 ...	21	25	29	30	30
£22 ...	16	21	24	27	29
£28 ...	13	17	21	23	26
£34 ...	11	14	18	21	23
£40 ...	10	13	15	18	21

Derived from D. A. Boyd and W. J. Lessels 'The Effect of Seed Rate on the Yield of Potatoes.' Journal of Agricultural Science, 1954.

* The appropriate spacing in 28 inch rows to give any chosen seed rate can be calculated as follows :

$$\text{spacing (inches)} = \frac{\text{weight of 200 setts (lb)} \times 10}{\text{required seed rate (cwt per acre)}}$$

FERTILIZER

The manuring of potatoes is a problem involving not only mineral fertilizers, but also questions of organic manuring policy

and rotational considerations. These more general aspects can only be considered fully in relation to the place of potatoes in the whole farm economy. However, the present discussion will be mainly confined to the use of mineral or artificial fertilizers.

Potatoes respond to generous manuring to an extent exceptional among farm crops and this potential should be exploited to the economic limit for maximum profit. At the same time, the indiscriminate use of very heavy dressings of fertilizer is at best wasteful, and at worst may actually bring about a reduction in yield. Recent experiments have shown that the response of potatoes to each of the three main plant nutrients (nitrogen, phosphate and potash) depends on the amounts of the nutrient present in the soil, on the supply of the other two nutrients, both from the soil and from farmyard manure, and on other factors such as the method of fertilizer placement. Thus, any recommendations on rates of application must take account of all these factors, particularly soil type and soil analysis.

In addition, the optimal dressing depends on the price of the fertilizer in relation to the value of the ware. On the basis of recent prices, Dr. Boyd† of Rothamsted has suggested that an optimal dressing for many soils would be from 1.0-1.2 cwt per acre of N and P_2O_5 and 1.5-2.0 cwt of K_2O per acre for fertilizers distributed over the ridges or placed in bands alongside the seed. If the fertilizer is spread over the unridged ground these recommendations must be increased by about one third, or else yield will suffer by about 1 ton per acre.

Farmyard manure and certain other bulky organic manures supply some plant nutrients, and fertilizer rates on fields that have received dressings of these materials should be reduced accordingly. For example, a 10 ton dressing of farmyard manure ploughed in probably supplies approximately 0.2 cwt of N, 0.3 cwt of P_2O_5 and 0.6 cwt of K_2O per acre.

A full dressing of fertilizer to meet the recommendations suggested above for sideband placement would be supplied by about 12 cwt of 9 : 9 : 15 compound, 10-11 cwt of a 10 : 10 : 18 compound, or about 9 cwt of a 12 : 12 : 18 compound. The final choice will depend upon the most suitable plant food ratio for the requirements of the soil type in question, and upon the relative costs and merits of the different types of fertilizer available. Crops receiving appropriate dressings, properly applied at planting time, should not normally require top dressings or expensive nutrient sprays later in the season.

† Private communication to the authors.

Both seed spacing devices and fertilizer distributors on planting machines may be calibrated incorrectly, or wheel slip in wet conditions can result in serious errors in rates of application. From time to time it is wise to check that the amounts of seed and fertilizer being used are as intended. Table N in the Appendix may be useful for making such a check.

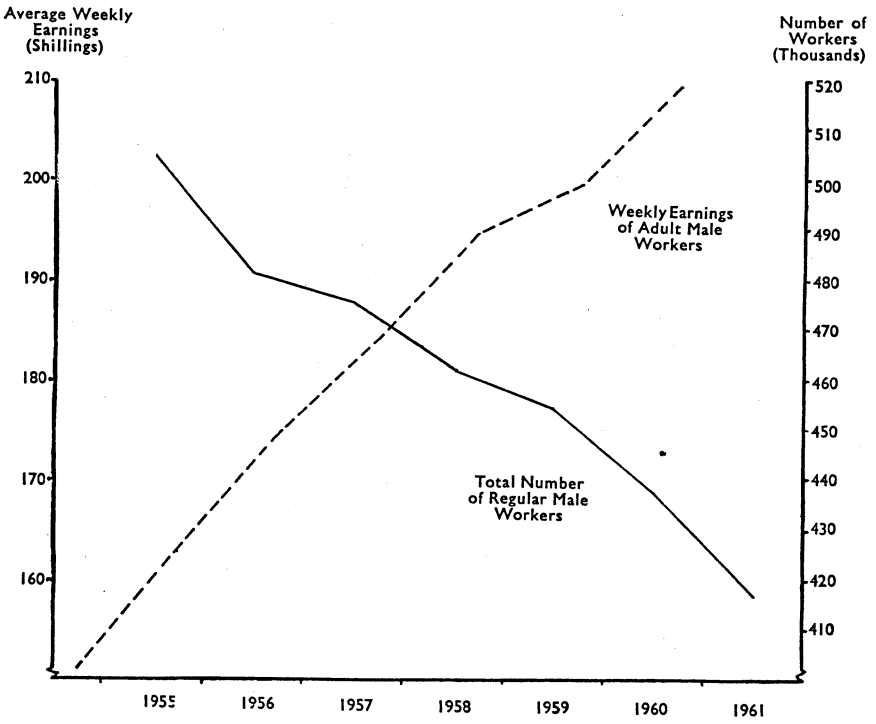
Mineral fertilizers provide the cheapest source of nitrogen, phosphate and potash, but it is widely believed that additions of organic material improve the structure and water-holding capacity of soils, and many established farming systems are based on this belief. It is often questionable, however, whether the benefits conferred are sufficient to justify the costs of making and spreading farmyard manure, or the reduced output from stock-carrying leys in an arable rotation. Experimental evidence exists which suggests that most soils do not benefit from such organic additions beyond the value of the extra nutrients supplied in the organic materials.* For example, a three year ley has been estimated to provide the equivalent of only 0.5 cwt of nitrogen for the following crop, and a 10 ton dressing of farmyard manure for potatoes replaces up to 0.3 cwt of nitrogen, 0.4 cwt of phosphate and 0.75 cwt of potash†. On this basis, a ley is worth no more than 25/- to 30/- per acre at current fertilizer prices, and manure may similarly be valued at 6/- or 7/- per ton. If this is the whole value of these materials, it would be better to rely on equivalent dressings of mineral fertilizers, unless the livestock enterprises using the ley or producing the dung can be economically justified in their own right.

On the other hand, there are certain soils, notably those with a high silt fraction, which deteriorate in the absence of sufficient soil organic matter. They tend to cap and run together, and in extreme cases may become completely unworkable. These effects have not been noticed on other soil types, but it would be unwise to dismiss the possibility that similar results may occur to a lesser extent on all soils. Clearly, it would be foolish to reject entirely the traditions of mixed farming, but perhaps some relaxing of the customary emphasis on the need for dung and leys might be justified in the light of the current disparity between the profits of arable and livestock farming. By the same token, farmers who rely on purchased organic manures, such as shoddy, might be able to reduce this expenditure, making a compensating adjustment in the amounts of mineral fertilizer applied. These are questions urgently in need of thorough experimental investigation, with more attention being paid to the vital economic considerations involved.

* For a full discussion of this point see G. W. Cooke, Journal of the Farmers Club, 1959.

† D. A. Boyd, 'The Effect of Farmyard Manure on Fertilizer Responses,' Journal of Agricultural Science, 1959.

Figure 8. **Recent Changes in the Number of Workers & Earnings in Agriculture (Great Britain)**



Based on M.A.F.F. statistics.

The Use of Labour and Machinery

Table X shows that in 1958 and 1959 just under half of the costs of growing potatoes fell under the heading of labour and machinery costs. More than three-quarters of these costs arose from the employment of about 150 hours of regular and casual labour per acre. This is a very heavy labour requirement by comparison with most other farm crops. For example, cereals may be grown and harvested employing as little as 10 labour hours per acre, and sugar beet, mechanically harvested, requires about 100 labour hours per acre. It follows that the future trend in labour costs will be of prime importance to potato growers. Figure 8 shows what has been happening to agricultural wages and to the number of farm workers employed over the past few years. If these trends continue, one in

four of the present labour force will have left the land by 1970, and those remaining on farms will be earning about one and a half times the present average wage.

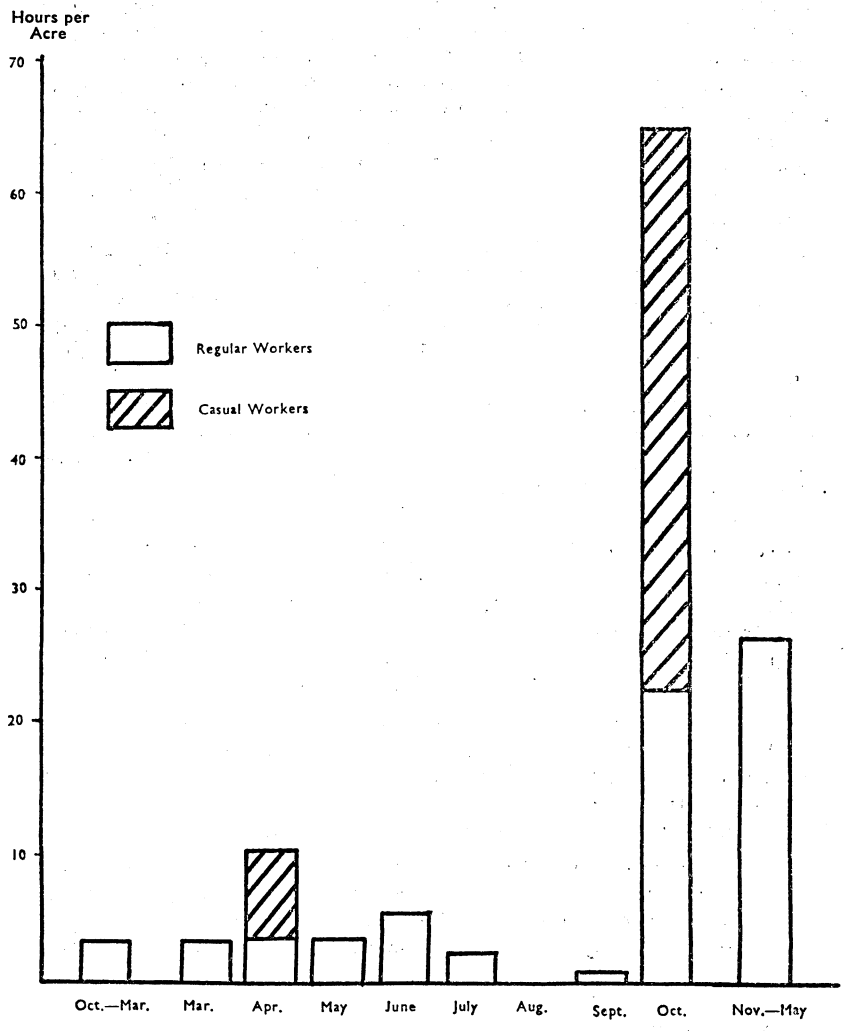
In addition to the rising overall labour costs for potatoes, the seasonal demand for labour is very irregular, as indicated in Figure 9. The organization of labour to meet such variable needs, and the integration of the enterprise into a farm organization, are complex problems. Few farmers are able to do all the work with the regular farm staff, so it is usual to employ some casual help, chiefly for planting and harvesting. In areas where casual labour is in short supply, it may be impossible to cope with a large acreage of potatoes ; about five acres for every worker available at picking time would probably be the maximum.

There is an important distinction to be drawn between the direct costs, and the 'real' costs of labour on any farm. The direct labour cost is a convenient measure of the labour input based on average wage rates, and is valuable for comparative and control purposes. The real cost of labour, however, will depend on the way the potato enterprise fits into the farming organization. Thus the real (or opportunity) cost, is the cost of foregoing one activity in order to accomplish some other. For example, an hour spent on potatoes in June might have a very high opportunity cost if the alternative is saving a field of hay before the weather breaks. On the other hand, the alternative value of time spent riddling potatoes in a barn on a dark, wet winter's afternoon is very low. Therefore, if some change in farm organization is under consideration, which appears to save labour hours, it is necessary to be sure that this saving can be turned into cash. A reduction in overtime or casual labour is clearly a direct cash saving, but a cash saving of the ordinary time of regular workers can only be realized by dismissing them. The alternative is to find some other productive work for the free labour. On the larger or more diversified farms there may be good opportunities for alternative employment, but on smaller farms the labour economy may be much more rigid, with fewer ways of cashing in on a few hours' freed labour.

It will be appreciated, therefore, that the irregular seasonal labour needs of the potato crop tend to disrupt the labour economy on many farms, so inflating the real costs of labour. This emphasizes the need for potato growers to keep their production methods under constant review, avoiding unnecessary work and delays.

Table O in the Appendix gives a breakdown of the typical labour and tractor hours recorded for each of the major tasks in potato growing, together with the range within which most of the results fall. These figures, which are based on a study of the methods of Kent potato growers, can be used as a guide to check present performances, and to predict future methods.

Figure 9. **Seasonal Labour Requirements for Maincrop Potatoes**



NOTE. The labour used varies according to the machines used, the methods adopted, the yield, etc. For a more detailed analysis of labour requirements see Table O, Appendix.

Planting

The proportion of the potato acreage planted by machine has been increasing steadily in recent years, but although mechanization results in considerable savings in labour, comparison of the economy of different methods is complicated by differences in the quality of the work. In general, machine planting gives results as good as, or possibly better than hand planting, but this statement must be qualified in three important respects. Firstly, the placement of mineral fertilizer has an important effect on yield.* When hand planting, the best response is obtained by spreading the fertilizer over the open ridges, but this method is not normally possible when planting by machine on unridged ground. Equivalent results can only be obtained by sideband placement, and not all machines are marketed with suitable attachments for this purpose. Secondly, some types of planting machine, especially the simple dropper attachments and fully automatic models, cause too much damage to the sprouts for satisfactory planting of chitted seed. Finally, there are differences in the overall rates of work of different planting methods. This may be very important on farms with a large acreage of potatoes to be planted. If the work is not carried out quickly enough some of the acreage may be planted too late, with a consequent loss of yield.

The economics of mechanization also depend upon the labour situation on the individual farm. If hand planting can be undertaken by the regular farm staff without serious interference with other jobs, then mechanization of planting will not be worthwhile. In the more common situation, where a planting machine replaces hand planting by casual workers, the economics of different methods can be compared, as shown in Table XII.

For unchitted seed, fully automatic machines give the lowest costs on 10 acres or more, but on less than 5 acres investment in a new planting machine is not likely to be worthwhile. Small-scale growers may seek a solution in the purchase of fairly cheap second-hand machines, or in co-operation in machinery syndicates.

Differences in cost between the types of machine suitable for chitted seed are small, but mechanization can be justified on 15 acres or more, the cheaper 2 row machines being the best buy on the lower acreages, and 3 row models giving slightly lower costs on the higher acreages.

Row Crop Work

Row cultivations of potatoes can be beneficial in several ways. Crop growth may be encouraged by the control of weeds and by

* G. W. Cooke, M. V. Jackson, and F. V. Widdowson, 'Placement of Fertilizer for Potatoes Planted by Machine,' Journal of Agricultural Science, 1954.

TABLE XII.—THE COSTS OF POTATO PLANTING

Method	Capital Cost £	Hours per Acre Labour	Hours per Acre Tractor	Annual Capacity Acres	Total Cost per Acre 5 acres £	10 acres £	20 acres £	50 acres £
Hand planting	nil	18.0	3.3	—*	3.51	3.51	3.51	3.51
2 row dropper attachment	87	9.7	2.8	45	4.26	3.14	2.57	—
2 row machine	175	9.7	2.8	45	6.56	4.30	3.16	—
3 row machine	280	9.6	2.1	60	9.19	5.57	3.75	2.67
2 row automatic machine	200	2.7	1.6	80	5.86	3.27	1.98	1.20

The table refers to planting unchitted seed only. It is assumed that 100 hours of machine planting time are available before yields suffer.

* Variable according to the number of workers in the gang.

breaking any soil 'cap' which would inhibit root growth. In addition, 'earthing-up' is necessary to prevent greening of the developing tubers and to reduce blight damage. But cultivations cause damage to both roots and aerial parts of the plants, particularly when growth is well advanced, and constant loosening of the soil causes drying-out and speeds the breakdown of humus. These points, added to the rising cost of tractor work, emphasize the need to avoid unnecessary cultivations. Similarly, there may be scope for savings in the amount of hand-hoeing undertaken ; an aspect of production which shows very considerable variation between farms. It could be argued that, since potatoes are a cleaning crop, expenditure on weed control should be charged to the whole rotation, yet with the advent of chemical weed control in cereals, the traditional role of roots as cleaning crops has to some extent been lost. A properly conducted cereal spraying programme would probably be cheaper than expensive and often damaging row work in the potato crop.

HARVESTING

The most important problem the potato grower has to face is the provision of enough labour to pick the crop. Some idea of the magnitude of the problem can be gained from the fact that an average of about 80 hours per acre, or more than half of the total labour used, is associated with harvesting. This average covers a vast variety of conditions and ways of tackling the job, the actual amount of labour employed in a particular instance depending to a considerable extent upon the yield, and also upon the organization of the gang, the machinery and equipment used, weather conditions, and many other factors. Experience has shown that there are many opportunities for raising labour productivity at harvest by the use of work study.*

Digging

The economy of different types of potato lifting machines depends chiefly on differences in the quality of work. The ease of subsequent picking, and the quantity of potatoes damaged or left covered with soil are more important than the comparative speeds of the machines, since the actual rate of work is generally determined by the output of the picking gang.

Ease of picking depends on how well the tubers are exposed, and on the width of the band in which they fall. The elevator-digger is usually considered to uncover the tubers more efficiently and to drop them in a narrower band than other machines. Under normal conditions, however, the difference is small, and especially where piece-work is adopted, the effect on the cost of picking is negligible.

* See for example, C. J. Black, 'Potato Harvesting,' Economic Report No. 41, The Edinburgh and East of Scotland College of Agriculture, 1957.

Similarly, efficient separation and the prevention of damage are largely questions of the careful adjustment of the machine and the choice of the best working speed. Differences, between the types of digger are relatively less important, although it is often suggested that the spinner causes more serious damage than other machines. No evidence was found of any difference in the price paid for potatoes harvested by different machines, suggesting that few merchants have any marked preference in that respect.

From what has been said it will be evident that the elevator-digger has a slight advantage over the plough or spinner in terms of quality of work. But this is not the whole story. Potatoes are grown most frequently on the heavier soil types, and are usually harvested in the autumn when wet weather is all too common. Elevator-diggers may be unable to operate under such conditions. They also tend to be more expensive than spinners or lifting ploughs in both depreciation and repair costs. A new single-row digger normally costs about £175-£225, compared with £80 for a new spinner and £20 or less for a plough. A subsidiary investigation into repair costs undertaken by this Department* indicated an average cost of nearly 6/- per acre harvested for spinners, compared with just over £1 per acre for elevator-diggers.

It is these considerations which explain why the spinner is the most commonly used implement for digging potatoes, and why the potato plough still finds a place on some modern mechanized farms.

The labour and tractor requirements for the three types of digger will be more or less the same, although the elevator-digger may require a more powerful tractor. At a digging speed of 2½ m.p.h. plus a generous allowance for turning, blockages, etc., a man with a tractor and digger should be able to keep pace with a gang working at an overall rate of 3½-4 acres per 8 hour day; a rate seldom attained except by the largest gangs. Under normal conditions, therefore, a rate of digging of much less than ½ acre per hour suggests that the picking gang is not keeping the digger working to capacity, and either the gang size could be increased, or else alternative useful work might be found for the tractor driver.

Picking

The actual picking up of the crop is normally undertaken by casual labour, which may be of rather doubtful quality, so that there is much to recommend some system of piece-work payment. The normal method in Kent is to pay each picker individually

* Unpublished work by R. H. Clough, Wye College.

according to the weight lifted, a common rate for maincrop potatoes being 1/- per cwt bag, including picking the first harrowings. The rate is increased when additional work such as weighing is required. This method has two disadvantages ; it precludes any system of bulk handling where the output of each picker cannot be identified, and it requires a good deal of book-keeping by a reliable foreman. The Lincolnshire system of payment to the whole gang on an acreage basis does not have these drawbacks, if the workers can be persuaded to accept it.

Rates of payment should never be regarded as fixed. Work study investigations have shown than an important factor determining the rate of picking is the number of tubers to be handled, although soil and crop conditions play an important part. If the yield is light with a high proportion of small tubers, or if conditions are particularly difficult, then it will be necessary to step up the rates of payment to allow the workers to earn a reasonable sum. As a rough guide, a competent and experienced picker should be able to earn between $1\frac{1}{4}$ and $1\frac{1}{2}$ times the minimum rate of pay, whilst a really skilled worker will earn even more. On this basis, it is fairly safe to assume that the farmer is getting at least as good a bargain as he would be paying on an hourly rate. Payment on a piece-work basis reduces the amount of supervision needed, but it is still necessary to make sure that the quality of the work is up to standard.

The farmer must keep all the workers supplied with unpicked potatoes by restricting the gang size to the capacity of the digger, and if possible, stint lengths should be arranged so that the faster pickers are not held up unnecessarily by the slower. Both picking and digging will be easier if the haulm and any weeds have been destroyed, either chemically or mechanically before harvest begins. New chemical sprays are now on sale to replace those containing arsenic which were formerly available.

The typical labour requirements for picking, as recorded in the survey, are given in Table O, Appendix. It will be seen that labour requirement varies with yield, the time taken to pick one ton declining as yield increases. The figures quoted refer to picking into aprons or baskets, and tipping into bags. More time would be required if extra work such as weighing were involved.

Crop Handling

Many Kent farmers sell a proportion of their potatoes direct from the field. Perhaps as a consequence, the organization of the carting gang is frequently poor when a crop is to be stored. Sacks are usually used for carting, but an increasing number of farmers are finding this method unsatisfactory for potatoes which are to be stored in bulk. The difficulty of successfully tipping potatoes into a sack causes considerable delay to the pickers, loading is not easy, and

finally the potatoes must be tipped out again at the store or clamp. One solution is to load the potatoes direct from basket to trailer. This requires no additional equipment, apart from more baskets, and has much to recommend it. However, the loading is heavy work, and other less laborious methods are now being tried, the most popular being the use of stillages or bins which can be picked up and tipped by a special attachment to a hydraulic fore-loader. Wooden stillages can usually be made on the farm for the cost of the materials, so that the investment is not heavy.

The capacity of the stillage is a matter for careful consideration. While it is easier to handle one large stillage rather than two small ones, the larger stillages increase the carrying distance for the pickers. A 5 cwt stillage can be regarded as a fair compromise. It may be tipped either into a trailer for transport to the store, or carried to the side of the field and tipped ready for clamping.

Potato Harvesters

Research continues to advance slowly in the design of complete potato harvesters. Modern machines are able to work under a much wider range of soil conditions than earlier models, but the mechanical problem of separating potatoes from clods and stones still awaits a really satisfactory solution.

The rate of work and the associated labour requirements of a complete harvester depend on :—

1. land speed, crop yield and the degree of mechanical separation of potatoes from soil, stones, haulm, etc.,
2. the number of workers and the rate of hand sorting attained,
3. time lost through turning, blockages and breakdowns,
4. the organization of the carting.

The Savings in Cost

Although the amounts of labour used will vary from farm to farm and from one machine to another, the available evidence suggests that a harvester will often cut labour needs for picking by about half. If carting costs remain unchanged, the saving resulting from the use of a harvester would be the value of the picking labour saved and the saving on repairs to a spinner or elevator-digger. Depreciation on the latter machine though small, would probably not be saved as it is usual to keep the old digger as a reserve for bad weather and breakdowns.

The running costs, depreciation of the harvester, and interest on the capital invested must be set against these savings. Running costs vary, but 30/- per acre would cover fuel and repairs in most cases. Thus the saving in operating costs might typically be calculated as shown overleaf.

Costs saved per acre, assuming an 8 ton yield, by the introduction of a potato harvester :

	£
Picking labour saved, 30 hours @ 3/-	4.5
Repairs to elevator-digger	1.0
Total savings	£5.5 per acre
Extra costs per acre :	
Repairs and fuel for harvester	1.5
Margin	£4.0 per acre

(available to pay fixed costs and to increase profit.)

Higher labour costs will tip the balance more in favour of mechanization. Thus if the labour saved was worth 5/- per hour instead of 3/- as assumed above, the margin to cover fixed costs and profits is increased to about £7 per acre. This might well be typical of the situation on many farms in 5 or 10 years time.

One way of considering this question is to calculate the period of years needed to repay the investment in a complete harvester. The following table has been prepared on the assumption that the whole margin (£4 or £7 per acre) is devoted to this purpose.

TABLE XIII.—THE ECONOMICS OF A POTATO HARVESTER

Acreage of Potatoes Harvested Annually	Years to Repay Investment	
	Labour at 3/- per Hour	Labour at 5/- per Hour
10	15+	13
20	11	6
30	7	4
40	5	3
50	4	2
60	3	2

Based on a machine costing £600 with interest on capital charged at 6%.

A complete harvester is already an economic proposition on the higher acreages, even though it may not be used every year. It is clear that with better machines and higher costs of labour, harvesters will be profitable and necessary investments on a wide range of farms.

STORAGE

There has been a marked trend in recent years towards indoor storage. The full economic implications of this development can only be appreciated by a review of the circumstances of the individual

farm. Indoor storage can save labour both at harvest and when the crop is being riddled. No general statement can be made as to whether this saving is sufficient to justify the heavy investment of capital needed to build a suitable store. If an existing shed or barn can be cheaply converted for use as a potato store, then the arguments in favour of indoor storage are appreciably strengthened.*

A more significant question is whether it pays to store potatoes at all, and if so for how long. This depends on the relative costs of carting, storage and sorting, as compared with the costs of selling direct from the field. In addition, it is necessary to assess the loss of weight over the storage period and to take account of interest on the capital locked up in stored potatoes.

Sound potatoes will store with very little loss over the winter, but the rate of loss increases as the potatoes begin to sprout in the spring. Sprouted potatoes take longer to riddle at a time when the real cost of labour on many farms is high. From November to February it may be possible to riddle potatoes with 'spare' labour. By March and April, however, spring work mounts up and the demands on labour increase. On some farms late riddling may have to be done in the evenings on overtime rates, and sometimes sorting may so interfere with spring cultivations that the yields of other crops are adversely affected.

TABLE XIV.—THE ECONOMICS OF POTATO STORAGE

Month	Weight Loss in Store (%)	Riddling (Labour hours per ton)	Price Rise Needed to Justify Storage	
			Years of Heavy Maincrop Supplies (Shillings)	Years of Light Maincrop Supplies (Shillings)
NOVEMBER	½	3¼	2—20	4—22
DECEMBER	1	3¼	4—22	8—26
JANUARY	1½	3¼	6—24	12—30
FEBRUARY	2	3¼	8—26	16—35
MARCH	4	3¼	14—32	27—46
APRIL	7	4	21—46	43—67
MAY	11	5	33—64	65—96
JUNE	14	6½	42—84	84—125

A price of £10 per ton is assumed for maincrop potatoes in October in years of surplus, and of £20 per ton in years of relative scarcity. The range in price relates to the value of labour used in sorting. Further details are given in the text.

Some estimates of the rise in potato prices needed to make storage worthwhile are given in Table XIV. When riddling labour has no alternative value, storage becomes worthwhile at the lower limit of the price range indicated. At the upper limit of the range,

* For a more detailed analysis of this subject see G. B. Bisset, E. Dawson and R. Bennett Jones, 'The Economics of Potato Storage,' Universities of Reading, Leeds and Nottingham, 1959.

riddling labour has been charged at the overtime rate of 5/6d per hour. It has been assumed that the costs of sorting, bagging and weighing for direct sale are equivalent to the costs of carting and putting into store. Interest has been charged at an annual rate of 6% on the value of the crop in October.

The seasonal pattern of maincrop potato prices over the last few years have been discussed in Part I (see Figure 5). On the basis of past experience it seems that in years of heavy supplies, it seldom pays to keep potatoes after January or February. In years of relative shortage, however, prices tend to rise steeply in the spring, and potatoes sold in April have made very attractive prices. As a consequence of the loss of quality in badly sprouted potatoes, late storage into May or June is probably best left to the expert with a specially equipped store.

Sorting

Well grown and carefully stored crops are often spoiled by poor grading. The trend of consumer preferences indicates that this problem, which is already serious, is likely to become even more important in the future. Most riddling machines on farms cause some damage to practically every tuber handled. Better and more uniform grading might result from some system of centralized potato sorting and packing.

Until such developments occur, the output of the sorting team may often be improved without detriment to the quality of the final product. Frequently, a single worker, usually the man loading into the riddle, determines the rate of work of the whole gang. Perhaps extra help at this point, or some system of sharing the hardest work in turn, would speed up riddling considerably. Both the rate of work, and the quality of the final product are likely to be considerably improved when riddling takes place in a building.

Future Trends in Potato Growing

The pace of change in potato production is rapid, and significant developments are likely to take place over the next ten years. Technical advances will provide a key to more economic methods of production so that the more efficient potato producers can be reasonably sure of good returns.

This investigation has provided a basis for a review of these developments. The methods of the most efficient farmers of today are a guide to the general levels of performance that will be necessary under conditions of greater competition. Many of these better practices have been discussed in the previous pages. Similarly, there are aspects of production where important technical developments can be anticipated. Some of these have already been out-

lined, such as better automatic planting machines and complete harvesters. Economic pressures will determine the exact nature and pace of these changes. Probably the most significant factor will be the marked advance of labour costs, relative to the costs of capital and land, over the next 10 to 15 years.

Against this background, two main types of development in production methods can be expected to have occurred by 1970. Firstly, many of the tasks at present making heavy demands on labour will have been mechanized, and some jobs, such as hand-hoeing, will have been completely cut out. Secondly, work routines will be more carefully organized in order to overcome unnecessary delays and to cut out unremunerative tasks. Incentive payments are likely to assume far greater importance, even for the normal jobs of regular workers.

Table XV indicates the labour requirements for potato growing which it is expected will be typical on most farms by 1970.

TABLE XV.—ESTIMATED LABOUR REQUIREMENTS FOR POTATO PRODUCTION IN 1970*

Job	Man Hours per Acre†
Chitting	3
Ploughing and Seedbed Preparation	5
Planting and Fertilizing	2
Cultivating and Spraying	3
Lifting and Carting	35
Sorting and Loading	20
TOTAL ...	68

* Estimates prepared by J. S. Nix, 'Labour for Cash Crops, 1930—1970,' Agriculture, 1961, indicate a total labour requirement for potatoes of 60 hours per acre by 1970. Nix's estimates for the individual jobs vary slightly from the values in the above table, but the lower total figures arises mainly from the assumption that harvesting, carting and clamping will require only 28 labour hours instead of the 35 hours allowed above. The attainment of a higher rate of harvesting depends on the speed at which better potato harvesters are developed and brought into farm use.

† Assuming a total yield of 10 tons per acre at lifting.

The estimates in the above table have been derived from present day labour requirements, set out in Table O, (Appendix), and on the basis of the potential scope for economy within each separate activity. Changes in the methods adopted have also been assumed where appropriate. The labour requirements suggested for chitting for example, allows for the seed to be boxed up, but it assumed that there would be no subsequent handling prior to planting. Seedbed preparations are expected to remain basically unchanged, although more powerful tractors and wider implements, often coupled in tandem, will give some savings. Planting and fertilizing will be undertaken by one man using a fully automatic planting machine capable of handling chitted seed. If machinery manufacturers cannot produce such a machine at an acceptable

price, then high labour costs will make chitting a much less attractive proposition by 1970.

Row cultivations will be reduced to a minimum. The crop will be earthed up and sprayed once or twice. It can be confidently expected that research will have produced new chemicals giving more satisfactory control of weeds and blight. No estimate is included here for work involved in irrigating the crop, since this is unlikely to become a general farm practice owing to the scarcity of water supplies.

The estimate for lifting assumes the use of an efficient complete harvester, and the carting, handling and storage of potatoes in bulk. Both this figure, and the estimate of labour used for machine riddling leave scope for further savings to be made. It is possible, for example, that the storage and grading of potatoes may eventually be taken out of farmers' hands altogether.

By 1970 the overall saving in labour might amount to more than half of the present average requirements of 150 man hours per acre. Even if wages were to increase by 50 per cent. during the period concerned, this reduction would cut direct labour costs by £10 per acre. Part of this sum, of course, would be absorbed by higher machinery costs and perhaps slightly increased expenditure on sprays, etc. But the remainder would be available to add to profits, or more probably, to offset the decline in prices resulting from more competitive conditions.

Two main questions will become increasingly important to farmers in the years ahead. Firstly, enterprises must be chosen and combined together to yield the highest possible returns to land, labour, capital and management. Secondly, greater efficiency must be sought within the selected enterprises.

In the light of the probable future development of the potato industry, many present producers will be forced to consider whether it will pay them to stop growing potatoes. Before a decision to stop potato production is reached it is necessary to consider, preferably by means of budgets, the relative advantage of the farm for potato production, In other words, it is necessary to take account of the extra income that might be attained by replacing potatoes with some other cash crop or crop for feeding to livestock.

Those farmers who decide to stay in production must find ways of improving their economic efficiency, particularly by the adoption of cultural practices which give higher and more stable yields. These measures include the chitting of seed, the control of blight and drought, and harvesting and handling methods designed to minimize the loss of potatoes. Secondly, all expenditure on potato production must be justified by the resulting returns. For example, opportunities to reduce costs may occur through the mechanization of planting or harvesting, while there is frequently scope for savings to be made by better job organization.

CONCLUSIONS

Agriculture has a vital contribution to make to Britain's economic progress, and its record over the last twenty years is second to none. But it is its role over the next twenty years that must now be decided. The problem has two facets : ' what contribution can agriculture make to the country's future economic well-being ?' and ' how can those who work on the land earn incomes comparable with those in other occupations ?'.

The future prospects of British Agriculture will depend upon three main factors : the rate of growth of productivity in farming, the continuing development of an affluent society, and the influence of European economic integration. Undoubtedly, by 1980 farming will show remarkable technical advances. Labour in particular will be much more productive, which means, without any doubt, that there will be fewer farmers and farm workers. In other words, appreciable amounts of labour, and perhaps other resources too, must move to non-farm employment.

But developments in the rest of the economy will result in a considerable expansion in consumer purchasing power, to which can be coupled a substantial growth in population in Europe as a whole. Patterns of food consumption are bound to change appreciably. Demand for commodities such as meat and fruit will continue to expand but for others, such as bread and potatoes consumption is likely to fall. Thus the farming scene as we know it to-day must change appreciably over the coming years. These changes are inevitable and only those farmers who appreciate their significance, and who are willing and able to meet them, can turn them to their advantage. For the remainder, the prospects in farming are meagre.

Potato growers are clearly one group of farmers facing considerable change. Their productive potential is bound to rise because of better management and new methods and materials. By these means it is likely that by 1980, seven producers will grow what ten produce to-day. Furthermore, despite a bigger population and the expansion of sales of prepacked and processed potatoes, it seems inevitable that the total demand will shrink. Thus, in twenty years time, the potato acreage will probably have declined by one third, thereby releasing for other use some 200,000 acres of land. Similarly 20,000 growers or more will have ceased production.

Unless the necessary adjustments in production are efficiently brought about, many potato producers will suffer falling incomes in future. The alternatives are heavy Exchequer support or high consumer prices. It seems that the existing methods and powers of the Potato Marketing Board are not adequate for future needs, and various alternatives have been suggested. Further study might

reveal an even wider range of solutions, though this is not the point at issue at the present time. What is vital is that the potato industry should have a marketing authority that is clear as to the long-term issues confronting it, that is making a serious economic examination of these problems, and that has a basic objective a thriving, efficient industry.

Perhaps it is inherent in a producer-controlled organization that there should be an excessive preoccupation with the short-term, day to day, month to month issues. These matters are certainly important, but many short-term economic difficulties, such as abnormal seasonal price fluctuations, may be a manifestation of underlying long-term weaknesses.

The problem of preventing surplus production needs to be tackled at the farm level. On the one hand, the marketing authority should have powers to regulate supplies leaving farms, preferably by means of monetary rather than physical controls. Secondly, producers should be given strong economic incentives to iron out yield fluctuations. The evidence is that good management and scientifically advanced techniques, such as the chitting of seed and the control of blight and drought, are decisive factors in this field. It is important to recognize the part that management can play in improving the economic return from potato growing, in the production of high quality potatoes and in the stabilization of supplies.

The inevitable reshaping of the potato industry over the next 10 or 20 years will force the least efficient producers to transfer resources out of potato growing into other farm enterprises, or even to non-farm activities. Efficiency has been shown to be closely related to the level of output obtained, and farmers growing potatoes on poor soils or under unfavourable climatic conditions may soon find it advantageous to cease production. For those remaining, larger-scale, mechanized production with good management and strict control of expenditure and labour will be the best answer to rising costs and narrowing margins.

In the foreseeable future the country's food economy will continue to depend upon the potato to fulfil a vital nutritional role. To this end, more efficient methods of production, coupled with improved market organization will be essential. Further technical and economic research is required, but whether the industry really prospers in the latter part of the twentieth century depends upon the producers' and distributors' ability to exploit every opportunity for advancement.

APPENDIX TABLES

TABLE A.—EARLY POTATO PRODUCTION IN THE MAIN GROWING AREAS, Circa 1960.

County	Earlies per 1000 Acres of Crops and Grass	Percentage of Earlies in Total Potato Acreage	Acreage of Earlies as a Percentage of 1948
	acres	%	%
HOLLAND	42	21	49
PEMBROKE	23	80	80
BEDFORD	14	27	54
KESTEVEN	11	21	51
KENT	10	28	69
CHESHIRE	9	38	39
CORNWALL	6	39	22
ISLE OF WIGHT	4	21	22

TABLE B.—TOTAL SUPPLIES OF POTATOES FOR HUMAN CONSUMPTION. (Great Britain)

Crop Year	Earlies			Ware			All Potatoes
	Im-ports	Home-Grown	Total	Im-ports	Home-Grown	Total	
	('000 tons)			('000 tons)			('000 tons)
1954-5	179	443	622	203	3985	4188	4810
1955-6	244	340	584	530	3394	3924	4508
1956-7	222	404	626	55	3793	3848	4474
1957-8	237	377	614	440	3492	3932	4546
1958-9	266	416	682	468	3228	3696	4378
1959-60	314	424	738	123	3676	3799	4537
1960-1	302	449	751	75	3731	3806	4557

Imports include supplies from Northern Ireland and the Channel Isles.

TABLE C.— NEW POTATO IMPORTS—GREAT BRITAIN.

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
					tons					
January	504	486	346	1000	1101	319	836	8735	2875	2839
February	1584	3410	2884	1000	7001	3821	5470	12901	14917	9375
March	8676	10859	14931	20000	17138	18908	12256	26341	20498	22633
April	20957	15100	35011	36000	25157	47601	30902	47867	55984	46591
May	64635	45694	64390	69000	70668	84684	92990	112854	134522	118051
June	41039	35143	55780	86941	89502	56107	96063	73651	56077	51196
July	2921	4156	3863	33110	10756	24856	29233	30908	14694	42115
August	1	—	—	4831	—	—	—	—	—	—
September	1	130	5	—	—	—	—	—	—	—
October	—	4	6	—	—	—	—	—	—	—
November	5	329	362	—	—	—	—	328	—	—
December	271	1226	1036	—	—	—	1563	1666	566	—
Total ('000 tons)	141	117	179	244	222	237	266	314	302	294

Imports include supplies from the Channel Isles.

TABLE D.—WARE POTATO IMPORTS—GREAT BRITAIN.

Harvest Year	1954	1955	1956	1957	1958	1959	1960
			'000 tons				
July—August	—	1	3	—	—	1	1
September—October	—	12	2	6	6	6	1
November—December	16	134	22	36	159	35	24
January—February	35	99	12	69	140	36	21
March—April	52	251	8	209	126	33	25
May—June	100	33	8	120	37	12	3
Total Ware Imports	203	530	55	440	468	123	75
Imports from N. Ireland (included above)	127	161	53	91	75	123	75

TABLE E.—TOTAL PRODUCERS' RECEIPTS FROM G.B. POTATO CROP.

Harvest Year	1955	1956	1957	1958	1959	1960
Total Production ('000 tons)	5,521	6,659	5,030	4,982	6,194	6,455
	£m	£m	£m	£m	£m	£m
All Sales :—						
Earlies	5.3	5.4	5.3	11.1	7.5	4.9
Maincrop	73.8	50.8	81.8	85.5	53.4	48.5
Support Payments	0.4	12.4	—	—	5.3	6.6
	79.5	68.6	87.1	96.6	66.2	60.0
Average Value per ton Produced	£14.4	£10.3	£17.3	£19.4	£10.7	£9.3

TABLE F.—THE CHANGING PATTERN OF POTATO GROWING*

	Acres of Potatoes per Farm						
	Under 1	1—5	5—10	10—20	20—50	Over 50	All Farms
Number of growers—1956-7	8	11	10	13	6	1	49
Number ceasing potato production ...	3	1	1	—	—	—	5
Number reducing potato production ...	3	1	5	6	2	—	17
Number expanding potato production ...	—	4	3	6	4	—	17
Number of new growers	4	5	—	—	—	—	9
Number of growers—1959-60	9	12	13	8	10	1	53
Total Potato Acreage—1956-7	4.7	31.2	72.3	183.5	184.0	56.0	530.0
Total Potato Acreage—1959-60 ...	3.0	30.0	93.5	100.2	294.3	55.0	576.0
Percentage change in Number of Growers	(+)12.5	(+)9.1	(+)30.0	(—)38.5	(+)66.6	—	(+)8.2
Percentage change in Acreage of Potatoes	(—)36.2	(—)3.9	(+)29.4	(—)45.4	(+)60.0	(—)1.8	(+)8.7

* Results from an analysis of 53 potato growing farms in South East England.

Table F shows the changes resulting from the expansion and contraction of potato growing on a sample of 53 farms in South East England during the four years, 1956-7 to 1959-60. Over this period production was expanded due to new producers taking up potato growing and because of greater acreages being grown by some of the original producers.

The number of new producers starting potato growing was equal to 18 per cent. of the original number of growers, but since most were very small producers this increased the original acreage by only 3 per cent. About one third of the original growers expanded production and this increased the original acreage by 14 per cent. Practically one grower in two with more than 10 acres of potatoes in 1956-7 had expanded his acreage by one third on average by 1959-60.

Approximately 10 per cent. of the original growers had ceased potato production by 1959-60 and although their operations were mainly on a small-scale, this reduced the acreage grown by 6 per cent. Production was cut back by one in three of the original growers, but the overall effect was small and amounted to only 2 per cent. of the original total acreage. As with those giving up potato growing, the main effect was felt on the smallest size group, i.e., less than one acre of potatoes.

TABLE G.—ADJUSTMENTS IN POTATO PRODUCTION—ESTIMATED NUMBERS OF PRODUCERS

Potato Acres per Farm	Period I		Period II	
	No. Growers	Total Production '000 tons	No. Growers	Total Production '000 tons
1—5 ...	42,000	845	28,800	640
5—10 ...	13,000	895	8,900	700
10—20 ...	8,600	1,185	5,900	910
20—30 ...	3,100	745	2,400	600
30—40 ...	1,250	435	900	350
40—50 ...	850	385	675	320
50—100 ...	1,000	695	775	600
over 100 ...	200	315	150	270
	70,000	5,500	48,500	4,400
Under 1 ...	—	150	—	100
		5,650		4,500

Reduction in Number of Growers 21,500.

The probable decline in the requirements for potatoes, (see page 31) will lead to a reduction in the number of producers. The extent of the adjustment will depend upon the relative efficiency of potato production on farms varying of sizes and upon the alternatives to potato growing. The evidence presented in Tables F & H suggests that larger growers enjoy a comparative advantage in production. It is probable, too, that future developments in mechanization will strengthen the relative efficiency of these growers.

To illustrate the consequences of these changes a time period covering approximately twenty years has been selected. Thus period I represents recent conditions, while period II refers to the situation as it might be about 1980. It has been assumed that if improvements in efficiency on farms growing less than 20 acres of potatoes are taken as 100, the rise in efficiency will be 5 per cent. greater where 20 to 40 acres of potatoes are grown, and 10 per cent. more where there are more than 40 acres. These assumptions have been used to show the effect of future changes on the size structure of potato production.

It has also been assumed that by period II individual growers will have increased their volume of sales by an average of 10 per cent. in order to maintain an economic level of turnover.

These assumptions are thought to be conservative, but more precise estimates depend on further research into the significance of long-term trends in production. Table G probably indicates the *minimum* degree of change that can reasonably be expected by 1980.

TABLE H.—CHANGES IN THE DISTRIBUTION OF THE POTATO ACREAGE*

Size of Holding (acres)	Distribution of the Maincrop Acreage 1948 %	1960 %	Decline in Maincrop Acreage 1948—60 %
under 20	5	3	—67
20—50	10	8	—58
50—100	17	13	—60
100—250	35	31	—51
over 250	33	45	—28
Total	100	100	—47

* Derived from M.A.F.F. statistics for England and Wales.

TABLE J.—ANNUAL POTATO CONSUMPTION PER HEAD GREAT BRITAIN

(M.A.F.F. Estimates)

	1954/5	1955/6	1956/7	1957/8	1958/9	1959/60	1960/1
	lb per Head						
Earlies							
Imported	8	11	10	10	12	14	13
Home-grown	20	15	18	17	19	19	20
Total	28	26	28	27	31	33	33
Ware							
Imported	12	23	2	19	21	5	3
Home-grown	179	151	168	155	143	165	163
Total	191	174	170	174	164	170	166
All Potatoes	219	200	198	201	195	203	199

Imports include supplies from Northern Ireland and the Channel Isles.

TABLE K.—ANNUAL POTATO CONSUMPTION IN VARIOUS COUNTRIES.

	Sweden	Switzerland	U.K.	U.S.A.
		lb per Head		
1880 ...	295	n.a.	296	n.a.
1909—13 ...	280	280	208	182
1934—38 ...	265	200	176	138
1956—58 ...	200	180	209	100

SOURCE OF DATA—

Sweden ... Communicated by Gunnar André, Sveriges Lantbruksforbund, Stockholm.

Switzerland Lamartine Yates, 'Food, Land and Manpower in Western Europe.'

U.K. ... Potato Marketing Board & E. M. H. Lloyd, 'Food and Money: Some Reflections on Changes in Food Consumption and Prices,' J. Ag. Econ. Soc.

U.S.A. ... U.S. Department of Agriculture.

TABLE L.—DISTRIBUTION OF RESULTS IN A SURVEY OF POTATO GROWING IN KENT.

	Number of Results		
	1958 Harvest	1959 Harvest	Total
I Direct Costs per Acre			
Less than £70 ...	19	19	38
£70—£79 ...	11	19	30
£80—£89 ...	22	14	36
£90 and over ...	12	21	33
II Output per Acre			
Less than £50 ...	—	17	17
£50—£99 ...	3	30	33
£100—£149 ...	16	17	33
£150—£199 ...	16	9	25
£200 and over ...	29	—	29
III Profit per Acre			
Loss ...	—	35	35
£0—£49 ...	8	23	31
£50—£99 ...	20	9	29
£100—£149 ...	21	5	26
£150 and over ...	15	1	16
IV Total Yield per Acre			
Less than 6.0 tons	11	22	33
6.0—7.9 tons ...	16	15	31
8.0—9.9 tons ...	23	18	41
10.0 and over ...	14	18	32

TABLE M.—THE RELATIONSHIP BETWEEN YIELD AND COSTS IN POTATO GROWING*

Yield per Acre (tons)	Under 5.0	5.0—6.9	7.0—8.9	9.0—10.9	11.0—12.9	13 & over
Average Yield	3.5	5.7	7.9	9.7	11.5	14.3
			Average Costs per Acre			
	£	£	£	£	£	£
Direct Labour	18.6	20.7	26.6	29.9	28.4	40.6
Power and Machinery	3.9	5.2	6.4	7.2	6.6	8.0
Seed	30.4	30.6	31.9	31.8	35.1	33.7
Fertilizer	8.3	13.6	13.5	11.3	13.2	13.4
Total Direct Costs	63.1	72.9	81.2	83.0	87.2	98.7
Number of Results	8	19	18	14	9	6

* Based on a survey of maincrop potato growing in Kent in 1958 and 1959.

TABLE N.—LENGTH OF ROW SOWN BY ONE CWT OF SEED OR FERTILIZER.

Rate per Acre cwt	26in. rows	28in. rows	30in. rows
5	1340	1245	1160
7½	895	830	775
10	670	620	580
12½	535	500	465
15	445	415	385
17½	385	355	330
20	335	310	290
22½	300	275	260
25	270	250	230

TABLE O.—LABOUR REQUIREMENTS FOR POTATO GROWING.

Job	Typical Method	Labour Range	Labour Standard	Tractors Range	Tractors Standard
		Hours per ton of seed			
Chitting	Boxed in autumn, turned once	Nil or 4.0– 9.0	Nil or 6.0	—	—
		Hours per acre			
Ploughing	Once, wheeled tractor, two furrow plough, 9 inches deep	1.5– 4.5	2.9	1.5–4.5	2.9
Seedbed Cultivation	Three times	0.5– 5.5	2.9	0.5–5.5	2.9
Applying Fertilizer	One man, tractor and distributor loading and carting included	0.6– 2.0	1.2	0.7–1.5	1.0
Ridging & Covering	Three-row tractor-mounted ridger	1.4– 2.4	1.7	1.4–2.4	1.7
Hand Planting	Women planting 3/5 acre each in 7½ hours. Carting included	11.0–17.0	14.5	0.4–1.9	0.9
Machine Planting	With or without fertilizer attachment. Carting included				
	a. Two-row machine	6.2–11.2	9.7	2.0–3.8	2.8
	b. Three-row machine	6.9–11.3	9.6	1.8–3.0	2.1
	c. Two-row automatic machine	1.3– 3.2	2.7	1.0–2.5	1.6
Row Cultivations	Harrowed once, tractor hoed three times, earthed up once	2.5– 7.5	3.3	2.5–7.5	3.3
Hand Hoeing	Variable according to weed growth	Nil or 1.5–18.5	Nil or 8.0	—	—
Blight Spraying	Nil, or three times. Often contract work	Nil or 1.0– 2.0	Nil or 1.5	Nil or 1.0–2.0	Nil or 1.5
Haulm Destruction	Chemical spray. Often contract work	Nil or 0.3– 0.7	Nil or 0.5	Nil or 0.3–0.7	Nil or 0.5
Digging	One man & tractor, possibly not fully occupied. Harrowing included	2.0– 8.0	5.0	2.0–8.0	4.0
	Tons/acre		Hours per ton		
Picking	Women picking into aprons or baskets and tipping into bags. Picking harrowings included. Time-work only* 4	5.8–11.2	8.5	—	—
	6	5.3–10.3	7.8	—	—
	8	4.7– 9.3	7.0	—	—
	10	4.2– 8.4	6.3	—	—
	12	3.6– 7.4	5.5	—	—
Carting & Store Work	Three men, one tractor & trailer				
	a. Clamping	1.8– 4.2	2.5	0.3–1.2	0.7
	b. Storage in buildings	1.3– 3.2	1.6	0.3–1.2	0.7
Riddling & Loading	Four men. Engine-driven riddle	1.5– 4.5	3.0	—	—

* Labour for picking is reduced by one quarter when employed on piecework. Labour costs 22/- per ton for 8 tons, plus or minus 1/- per ton for every ton below or above this yield, irrespective of the system of payment.

The above results show the amount of labour used for potato growing on a sample of farms in Kent in 1958 and 1959. They do not necessarily indicate desirable levels of performance.

TABLE P.—CURRENT PRACTICES IN MAINCROP POTATO PRODUCTION.
TWO AREAS OF KENT, 1958 & 1959

	Hoo Peninsula	Romney Marsh
1. Rotational Manuring	% acreage	% acreage
Dressed with F.Y.M. ...	24	11
Dressed with shoddy, etc. ...	16	—
Following ley ...	3	5
2. Planting Date (1958)	% acreage	% acreage
Planted by 1st April ...	1	22
Planted by 15th April ...	39	73
Planted by 1st May ...	86	100
3. Application of Fertilizer	% crops	% crops
Broadcast on flat ...	81	11
Broadcast on ridges ...	13	32
Planting machine attachment	16	57

4. Mineral Fertilizer Rates (cwt per acre)	Nitrogen % crops	Phosphate % crops	Potash % crops
Less than 0.80	20	7	2
0.80 to 1.39	40	55	23
1.40 to 1.99	27	31	35
2.00 and over	12	7	40

5. Planting Method	Chitted Seed % crops	Not Chitted % crops	Total % crops
Hand planted	9	12	21
Machine planted*	13	65	79
Total	22	78	100

6. Hand Hoeing (Man hours per acre)	Nil %	Up to 10 %	10 to 20 %	20 & Over %
Number of crops ...	44	31	15	10

7. Method of Paying Pickers	Piece-work %	Time-work %
Number of crops ...	54	46

8. Method of Storage	In Buildings %	In Clamps %	Sold off Field %
Number of crops ...	64	31	5

9. Blight Spraying	1958 % crops	1959 % crops
Not sprayed	44	77
Sprayed once	15	10
Sprayed twice	15	10
Three times or more	26	9

10. Method of Lifting	% crops	% crops
Spinner	67	43
Elevator-digger	27	47
Lifting plough	5	9
Harvester	1	1

* Less than 4% of the planting machines used were fully automatic.

DIAGRAMS

TABLES

APPENDIX TABLES

The following reports, and others on Horticultural Economics and Rural Land Use, are available from the Secretary, Wye College, Ashford, Kent.

THE SMALL FARM ON HEAVY LAND.

THE RECESSION IN FARM PROFITS IN SOUTH EAST ENGLAND.

STUDIES IN BEEF PRODUCTION.

FARM BUSINESS STATISTICS FOR SOUTH EAST ENGLAND.

KENT OR ROMNEY MARSH SHEEP.

A GUIDE TO THE FEED ECONOMY OF THE DAIRY FARM.

A GUIDE TO THE ECONOMY OF PIG PRODUCTION—
BREEDING & REARING.

A GUIDE TO YOUR USE OF CONCENTRATE FEED.