Sugarbeets - Cost of production

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SUGAR BEET PRODUCTION

SOME ECONOMIC CONSIDERATIONS

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C O N T E N T S

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INTRODUCTION

Sugar beet is a high value cash crop and, apart from potatoes, normally yields a higher gross margin per acre than any other non-vegetable field crop. In addition it provides a useful root break as well as supplying in the tops a valuable by-product either for feeding on stock farms or for ploughing in as green manure. A more significant advantage perhaps is that unlike most other crops there are no marketing problems with sugar beet. The price is determined well before the crop is harvested or even drilled and within the limits of the acreage quota all the beet grown is accepted by the British Sugar Corporation. The grower is thus enabled to devote all his attention to the problems of growing and harvesting the crop. In the process of administering the crop the Corporation, through its technical and field staff, can provide a valuable advisory service and keep growers in touch with new developments.

PART 1. GENERAL CONSIDERATIONS

1. Progress in Sugar Beet Growing

The latest annual report* of the British Sugar Corporation states that the average yield of sugar beet over the past ten years at 14.14 tons per acre, represents a 27 per cent, increase over the average of the previous decade. This progress is attributed to the adoption by growers of modern cultural methods, improved seed and more effective disease control, and has been achieved despite the substantial decline in the labour force on the land. Precision drilling rose from 10 per cent, of the acreage sown in 1957 to 85 per cent, in 1967 and this factor, together with chemical weed control now being used on half the crop, has significantly reduced the amount of hand labour required to single the crop. The use of pelleted monogerm seed

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* For the year to September 30th 1967.

allows for a further saving in labour, as well as contributing to better yields through higher plant population. Genetic monogerm seeds are now being sown in commercial quantities and the performance of several varieties approaches that of the best established multigerm seed. The adoption of mechanical harvesters by growers has also contributed greatly to labour saving and 95 per cent. of the crop is now harvested mechanically compared with about 50 per cent. in 1957. Cleaner-loaders, introduced in 1961, are now widely used on the larger farms and handle 58 per cent. of the beet delivered, a factor contributing to lower haulage costs for growers as well as savings on soil disposal at factories. A significant factor contributing to increased yields is seen in modern methods of disease control. It is estimated that in 1957 virus yellows was responsible for the loss of the equivalent of one million tons of beet. New systemic insecticides now available provide effective control of disease and when they are correctly employed losses from virus yellows are now negligible.

The development of new methods and practices in sugar beet growing clearly have important implications for growers. The attitude of growers towards the adoption of these techniques at any time however will be influenced by their own particular circumstances and also by a consideration of the economic outlook for sugar beet growing.

2. Economic Trends

An indication of the changing economic situation of sugar beet growing in England and Wales over the past fifteen years is given in Table 1. The cost series is an estimated trend based on survey data from sample studies in the North West in 1953, 1963 and 1964. Similar data for other years and for other beet growing areas suggest the series to be reasonably

TABLE 1

SOME INDICATORS OF ECONOMIC TRENDS IN SUGAR BEET GROWING 1953-1967

	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
1. Est. Total cost £/acre	59	61	63	65	67	67	68	68	69	70	71	71	72	73	74
2. Average price sh/ton (16.5% sugar content)	122/3	125/7	125/7	128/1	130/6	130/6	130/6	128/0	128/0	128/0	129/8	133/0	135/6	135/6	138/0
3. Yield required to cover Total Cost. Tons/acre	9.7	9.7	10.0	10.1	10.3	10.3	10.4	10.6	10.8	10.9	10.9	10.7	10.6	10.7	10.7
4. Average Yield. Tons/acre (England & Wales)	12.8	10.5	10.8	12.3	10.6	13.3	12.7	16.8	14.1	12.7	12.6	14.2	15.3	15.1	15.5
5. Yield available for profit Tons/acre	3.1	0.8	0.8	2.2	0.3	3.0	2.3	6.2	3.3	2.2	1.7	3.5	4.7	4.4	4.8
6. Average profit £/acre	19.0	5.0	5.0	14.0	2.0	20.0	15.0	40.0	21.0	14.0	11.0	23.0	32.0	30.0	33.0
7. Average Profit. Less efficient grower (a) £/acre	-3.0	-18.0	-18.0	-9.0	-21.0	-3.0	-8.0	17.0	-2.0	-9.0	-12.0	1.0	8.0	6.0	9.0
8. Average Profit. More efficient grower (b) £/acre	41.0	28.0	28.0	37.0	25.0	43.0	38.0	63.0	44.0	37.0	34.0	47.0	56.0	54.0	57.0
9. Total Acreage Sugar Beet (England & Wales) '000 acres	401	420	409	409	412	420	415	416	409	406	407	429	446	439	450

Estimate total cost = Total direct cost + 10 per cent to cover overheads. No credit for the value of tops is included.

(a) Yield 2 tons per acre less than average. Costs £10 per acre higher than average

(b) Yield 2 tons per acre more than average. Costs £10 per acre lower than average

} these variations are not uncommon in any year from 1953 to 1967

representative of average conditions for the whole of England and Wales. Some allowance is made for the effect of seasonal influences on costs but no account is taken of the value of tops. The price of beet represents the guaranteed price adjusted over the period to a 16.5 per cent. sugar content and the average yields and total acreage are also those for England and Wales.

Average costs increased by about £1 per acre per year indicating that the average rate of adoption of cost reducing techniques was less than sufficient to offset the effect of cost inflation. The price of beet was also increasing but prior to 1964 at a slower rate than average costs and during the 1950's growers were faced with a steadily worsening cost:price relationship indicated in the table by the steady increase in yield required each year to cover average costs. The fall in the price of beet in the early 1960's accelerated this trend and by 1963 the yield required to cover average costs was 24 cwts. per acre more than that required in 1953. If average yields had been increasing at an equal or greater rate than this there would have been less cause for concern since growers could have at least maintained or even improved their profit margins. The indications are however, that, allowing for seasonal fluctuations, average yields remained static at a relatively low level during the first half of the decade and margins per acre during this period were therefore generally declining. Yields, and therefore margins, however were better during the second half of the period and the record yield achieved in 1960 still remains outstanding. The general economic outlook for sugar beet growing has shown a further improvement since 1963; price increases have kept pace with cost increases and the cost:price ratio has changed in favour of the grower. The yield of beet required to cover estimated costs fell in 1964 and has since remained steady at about 10.7 tons per acre. At the same time

the trend towards better yields has continued and in each of the last three years the average has exceeded 15 tons per acre.

In common with most other farm enterprises, costs and yields in sugar beet growing vary considerably between farms and these technical and economic trends will have affected growers according to their own particular conditions and level of efficiency. The information set out in lines 7 and 8 of Table 1 clearly demonstrates the sharp contrasts between the fortunes of the more efficient and the less efficient growers and emphasises, on the one hand, the penalties attached to producing a lower than average yield at a higher than average cost and, on the other, the rewards of producing a higher than average yield at a lower than average cost. Some of the reasons for these contrasts are discussed in Part 2 in relation to location, type of farm and size of crop and, at a later stage, attention is directed to some of the more specific causes of variation in yields and costs between farms.

PART 2. ADJUSTMENTS IN RESPONSE TO TECHNICAL AND ECONOMIC TRENDS

The total acreage of beet grown in England and Wales remained fairly steady during the 1950's but declined slightly in the early 1960's when the guaranteed price fell, although at no time was the acreage quota under subscribed.* Since 1964 however there has been a significant expansion in the acreage grown, a response presumably to the improved economic outlook and to the increased acreage quota. Within the broad national trend however, more discernible adjustments are apparent in the regional distribution and in the size distribution of sugar beet acreage.

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* The quota which had remained at 400,000 acres during the preceding years was raised to 420,000 acres in 1964, to 427,250 acres in 1965 and rounded off to 427,400 in 1966.

1. Regional Changes

Total acreage of beet in the North West* during the past fifteen years has, except for a short period in the early 1960's, been slowly declining and, surprisingly, at a more rapid rate since 1963 despite the better economic prospects. This trend is in fact a common feature of sugar beet growing in other Western areas and in direct contrast to the situation in Eastern districts. The Eastern counties for example have been steadily increasing their share of total acreage over the same period and at a faster rate over the last few years. Their share of the total acreage (England and Wales) was 61.5 per cent. in 1953, 62.6 per cent. in 1963 and 66.1 per cent in 1967. The comparative share of the North West for the same years were 5.2, 5.5 and 4.1 per cent. respectively (Table 2). Environmental conditions in the Eastern counties favour arable cropping and most of the farms are therefore geared to cash crop production. Yields of beet are also usually heavier than the national average. These two factors account for the dominant share of Eastern counties of the national total and also largely explains their ready absorption of additional acreage. In the North West, on the other hand, topography and climate limit arable cropping to areas which often have a high potential for both grass and arable crop production. This leads to a more varied pattern of farming, and except for certain areas, less dependence on cash cropping and therefore not surprisingly a more varied response to changing circumstances in sugar beet growing.

2. Changes in size distribution of sugar beet acreage

Most, but not all, of the beet grown in the four counties of the North

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* Lancashire, Cheshire, Shropshire and Staffordshire. Shropshire had 77 per cent of the beet grown in the province in 1967.

TABLE 2

COMPARATIVE SUGAR BEET ACREAGES AND SHARE OF E & W TOTAL

EASTERN COUNTIES AND NORTH WEST

1953 to 1967

	England & Wales	Eastern Counties*		North West	
	Beet Acreage '000 Acres	Beet Acreage '000 Acres	Percent E.&W. Total	Beet Acreage '000 Acres	Percent E.&W. Total
1953	401	248.6	61.5	21.3	5.2
1959	415	261.9	62.6	20.7	4.9
1963	407	255.6	62.6	22.6	5.5
1965	446	289.4	64.9	21.1	4.7
1967	450	297.8	66.1	18.8	4.1

* Includes the counties of Bedford, Cambridge and Isle of Ely, Essex, Hertford, Huntingdon and Peterborough, Lincoln (Holland), Norfolk, Suffolk and since 1965 also Greater London (Part)

West is processed at Allscott Sugar Factory and the returns of contract acreages and growers at that factory (Table 3A) provide an indication of the changes occurring in the province. There has been a dramatic decline in the numbers of small growers between 1953 and 1963 accompanied by a steady increase in the number of larger growers. The total number of growers fell by a third but average acreage per grower increased from 11 to 18 acres. A large number of mostly small and medium dairy and mixed farms have been steadily abandoning beet whilst the larger arable and mixed arable farms have been expanding their acreages. Most of the acreage shed by the smaller growers during the 1950's was taken up by the larger ones and total acreage grown in the area declined only slowly during this period. After a short lived increase in acreage in the early 1960's however the total acreage grown declined more rapidly and nearly 4,000 acres less were grown in 1967 than in 1963 (Table 2). This seems to indicate one of two things: either 1) that the decline in the number of small growers has accelerated over the past few years and the acreage shed was more than could be readily absorbed by larger growers in the area, or 2) that the rate of increase of large scale growing in the area has slowed down.

A similar trend is apparent in the West and South West of England, areas even more dominated by small dairy and mixed farms. Total acreage of beet grown in the Western region* declined only slowly from 9979 acres in 1953 to 9648 acres in 1963 but more rapidly to less than 7700 acres in 1967. In the South West** however the decline has been steady throughout the period, from 2495 in 1953 to 1239 acres in 1963 and to less than 400 acres in 1967.

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* Gloucester, Hereford, Somerset, Warwick, Wilts and Worcester.
** Cornwall (Including Scilly Isles), Devon and Dorset.

TABLE 3

CONTRACT ACREAGES AND GROWERS

A ALLSCOTT FACTORY

1953/54	No. of Growers	Total Acreage	1963/64	No. of Growers	Total Acreage
Under 5 acres	649	2205	Under 6 acres	232	857¼
5.1 - 10 acres	424	3343½	6 - 10.9 acres	283	2280½
10.1 - 30 acres	354	6468½	11 - 20.9 acres	206	3097¼
Over 30 acres	104	4819	21 - 40.9 acres	186	5562
			41 - 60.9 acres	73	3661
			61 - 100.9 acres	25	1851
			101 acres and over	7	940
Total	1531	16836		1012	18249
Average per grower		11 acres			18 acres

B KIDDERMINSTER FACTORY

1953/54	No. of Growers	Total Acreage	1961/62	No. of Growers	Total Acreage
Under 5 acres	899	2791	Under 5 acres	395	1159
5.1 - 10 acres	429	3310	5.1 - 10 acres	364	2377
10.1 - 30 acres	279	5025½	10.1 - 20 acres	269	3390
Over 30 acres	39	1852	Over 20	224	7024
Total	1646	12978½		1252	13950
Average per grower		7 acres			11 acres

The returns of contract acreages and growers for Kidderminster Sugar Factory, where beet from these two areas is usually processed (Table 3B) indicate that between 1953 and 1961, the decline in total acreage grown has also been accompanied by a considerable decline in the number of small growers particularly those with less than five acres. The number of growers with more than ten acres however has steadily increased, but large scale growing is still uncommon in these two areas. This trend away from small scale growing has no doubt continued since 1961, with the more rapid decline in total acreage grown over the past few years. The decline of small growers is partially a feature of the decline in the number of small farms and of the trend during recent years towards specialisation and concentration on fewer enterprises on farms. Their more spectacular decline in the North West and in other Western areas however is an indication of the particular problems of small livestock farms in adjusting to economic changes and technical advances in sugar beet growing.

3. Small Scale Growers

Economic surveys usually indicate that there is a wide range of yields from small acreage crops and that the range diminishes as acreage increases. Thus whilst high yields are obtained from acreages of all sizes, the lower yields tend to be concentrated amongst the smaller acreage crops. Costs are also usually higher on small acreages. These factors apply to the generality of small farms but more so to the small dairy and mixed farms than to small arable farms. On small dairy farms sugar beet is much less important to the farm economy than dairying and whenever labour is stretched, preference is normally given to operations necessary for the success of the main enterprise.

Yields of beet therefore often suffer on such farms when vital operations such as singling and cleaning are delayed or neglected in favour of early grassland harvesting operations. The economic situation of many of these small farms over the past fifteen years is therefore likely to have been as depicted for the less successful growers shown in Table 1, producing a lower than average yield at a higher than average cost and for the most part at a small, or often non-existent, profit. The response of many such growers to the steadily worsening cost:price ratio characteristic of the 1950's and early 1960's was to give up the struggle and abandon beet altogether. This drift still continues despite the improved prospects for beet growing over the past few years. Often their small scale of sugar beet production and sometimes their inclination inhibits small farmers from availing themselves of newer methods and practices which help to increase yields and reduce costs. On small arable farms, on the other hand, sugar beet is often an important source of revenue and, since these farms are geared to cash cropping, sugar beet fits in better with the rest of the farm. Sugar beet growing is a fairly stable element in the economy of these farms and the number of small growers in arable areas is therefore likely to decline only slowly. Their main problems are those usually associated with operating on small acreages. Thus, in the absence of co-operation between farms, the costs of adopting newer labour saving methods of handling the crop either through ownership of machinery, contracting or a combination of both is a heavy burden for these small growers and can often cancel much of the benefit of the higher yields their location enables them to achieve.

4. Large Scale growers

The larger beet acreages in general are located on medium to large arable and mixed arable farms where sugar beet is a major source of revenue and a

stable element in the farm economy. Those growers at the lower end of this acreage range have similar problems to those of smaller growers, but as acreage increases the benefits of large scale growing become progressively greater. These benefits arise from the ability and often greater willingness of the large growers to exploit new methods and techniques on a greater scale and at an earlier stage than small growers. The range in yields is therefore somewhat narrower and very low yields are less common than on small acreages and this factor together with the wider use of labour saving methods ensures that a combination of very low yields and high costs is rare amongst the larger scale growers. In fact the economic situation of many of these farms over the past fifteen years is likely to have been as depicted for the more successful growers shown in Table 1. It is not surprising therefore that farms in this category have been increasing their acreages whenever possible, since it adds to their existing advantages of scale. The largest growers, with say about 60 acres and more, are usually in the van of progress with sugar beet growing and are the earliest adopters of new methods and practices. It is therefore perhaps surprising to note that economic surveys often indicate a tendency for yields to fall and costs to rise as these largest acreages are reached. The reason for the lower yields may be due to such factors as less attention to detail and greater soil variability on large farms, and the higher costs can often be attributed to the high obsolescence costs involved in keeping abreast of developments in mechanisation. However, even these largest growers usually have higher yields and lower costs than the average small grower, and therefore their margins are generally better than the average of all acreage sizes. In addition the size of the acreage generally ensures that sugar beet yields a relatively large total income on these farms.

The economic position of the larger growers over the past fifteen years has therefore been considerably more favourable than that of most small growers. Their larger acreages have enabled them to exploit more fully the benefits of advancing techniques and practices and to maintain and often improve their profit levels even during that part of the period when average costs were rising at a faster rate than prices. They have also been able to reap the advantage of a continuous increase in scale over the period through their absorption of the acreage shed by the smaller growers. The constantly widening gap between the returns from small acreage crops indifferently grown on small livestock farms and those from large acreages efficiently grown and handled on the larger and more progressive arable and mixed arable farms suggests that pricing policy over the past fifteen years has played an important role not only in the rationalisation of sugar beet growing towards more favourable areas and onto more economic acreages but also in stimulating the search for and adoption of techniques and methods leading to improved yields and lower costs. If, as is likely, these trends continue over the next few years, sugar beet growing is likely to be abandoned by all but the most efficient growers on small dairy and livestock farms in Western areas and the quota acreage released and not taken up by the larger growers in these areas is likely to continue to be absorbed by growers in Eastern areas. There is however a warning in this analysis against a too hasty abandonment of beet by many reasonably successful and not too small growers who may currently be tempted to go out of beet growing. The improved margins arising from a combination of a more advantageous cost:price ratio and better yields over the past few years has already been noted. More important perhaps is that current progress, in the use of precision drilled monogerm seed with more effective chemical weed control and mechanical thinners, promises to provide a solution

to the heavy demand which singling makes on manual labour in the Spring. The rapid adoption of these practices by growers in general can not only lead to a substantial reduction in costs, and labour in particular, but also contribute to a further improvement in yields. In addition, developments in harvesting techniques not only contribute to lower labour requirements and therefore reduced costs but also to quicker harvesting which is an important factor during adverse weather conditions. If the smaller growers are to benefit from these developments in the same way as the larger growers the cost of mechanisation needs to be spread over a larger acreage than that normally grown on small farms. This calls for a much greater degree of co-operation amongst small growers than has been in evidence hitherto and for a more rapid development of machinery syndicates either for individual machines or more logically for a complete range of equipment. Such a range of modern equipment consisting of a precision drill, mechanical thinner and harvester might cost up to £1200 at current prices with an annual maintenance and depreciation charge of up to £240. As the accompanying table indicates such a scale of mechanisation is clearly uneconomic for individual small growers but would be reasonable if shared by growers having 30 acres or more, between them. Second hand equipment, although considerably cheaper may lack important refinements incorporated in newer machines whilst the greater risk of breakdown can be a serious drawback especially during unfavourable weather. The timing of certain operations is often of crucial importance for success in sugar beet growing and, whereas the disadvantages and risks attached to second hand machinery might well be acceptable to one and possibly two growers, they would very likely impose a considerable strain on the degree of co-operation necessary for the smooth running of a syndicate.

Machinery Costs in relation to Size of Acreage

Total Annual Costs £240

Acreage	3	5	10	15	20	30	40	60	100
Cost per acre	£ 80	48	24	16	12	8	6	4	2.4

Some small growers however may wish to preserve their independence and to continue as in the past to mechanise different stages as and when second hand machines become economic for their acreage. Particular conditions on their farms may in fact enable some growers to do this for some time. In general however, the indications are that during the next few years small growers, if they are to benefit in the same way as the larger growers, will have to consider how they can economically provide for themselves the services of a range of equipment essential to the adoption of the newer methods and techniques in sugar beet growing already referred to. The contribution of high yielding strains of monogerm seed and more effective weed control to reduced manual labour requirements and to improved yields can only be fully exploited by the use of efficient and modern precision drills and mechanical thinners. Similarly with harvesters, the advantages of single operator high output machines are likely to become increasingly important, not only because of uncertain weather but also because of the likelihood that in the future lifting will be concentrated into a narrower and optimal time period.

PART 3 THE CHANGING STRUCTURE OF COSTS

A study of the comparative cost structure of growing sugar beet over a long period provides a clearer picture of the contribution of technical development than is possible by noting the relatively small year to year changes in total costs. This is done in Table 4 where the structure of costs, based on farm sample studies in the North West is shown for 1953 and 1963. An attempt has also been

TABLE 4

CHANGES OVER TIME IN THE STRUCTURE OF COSTS OF GROWING SUGAR BEET

	Average Costs per acre					
	1953		1963		Forecast 1973	
	£	%	£	%	£	%
Manual Labour	20.58	38.5	20.45	31.5	16.20	23.1
Tractor Labour	5.62	10.5	4.84	7.4	5.00	7.2
Machinery Costs	4.38	8.2	8.49	13.1	9.50	13.6
Contract	0.77	1.5	1.72	2.6	2.50	3.6
Total Labour & Machinery	31.35	58.7	35.50	54.6	33.20	47.5
Seeds	1.22	2.3	2.27	3.5	2.75	3.9
Manures (Net)	13.05	24.4	15.27	23.5	17.50	25.0
Sprays	-	-	2.58	4.0	3.50	5.0
Rent	1.99	3.7	4.93	7.6	8.00	11.4
Marketing	5.79	10.9	4.42	6.8	5.00	7.2
Total Direct Costs	53.40	100.0	64.97	100.0	69.95	100.0
Labour Requirements			Man hours per acre			
Preparatory Cultivations (Including Drilling)	8.0		7.0		6.0	
Post Drilling to Harvest	61.0		51.0		18.0	
Harvesting and Carting (excluding loading lorry)	52.0		14.0		12.0	
Total	121.0		72.0		36.0	
Average Yield * Tons per acre	11.0		13.0		16.0 (est)	
Man hours per ton of beet	11		$5\frac{1}{2}$		$2\frac{1}{4}$	

* Average of three year period

Note. The main assumptions underlying the estimated figures for 1973 are as follows: a continuation of present developments and their wider adoption, which presupposes fewer small acreages of sugar beet, so that each specialised machine is used, on average, for 40 acres of sugar beet. This implies co-operative machinery use and /or many fewer small growers. The general adoption of new methods and practices and more efficient use of specialised equipment enables the labour requirement to be further substantially reduced.

made to forecast the likely structure of costs for a similar sample of growers in 1973. The most significant change during the decade to 1963 was the dramatic reduction in manual labour requirements brought about mainly as a result of the near complete adoption of mechanical harvesting by 1963. During the latter half of the decade the wider use of rubbed and graded seed in conjunction with precision drills and chemical weed control also helped to reduce labour requirements on singling and cleaning. Thus, although average hourly earnings of agricultural labour rose by 70 per cent. between 1953 and 1963, total labour cost per acre was similar for both years; this result was achieved with an average increase of only £5 per acre in machinery costs and contract services and an average expenditure of 30s. 0d. per acre on herbicides.* Increased costs of materials, notably fertiliser and seed, reflected an improved technological content as well as price trends whilst the higher rents charged in 1963 were a reflection of the trend in land values over the decade. Marketing costs were in fact lower in 1963 since by that time more farmers owned and used their own lorries for haulage than in 1953. The further substantial decline in labour requirements anticipated by 1973 assumes that on most farms hand singling and cleaning will be completely eliminated through the use of the most advanced techniques in precision drilling, mechanical thinning and chemical weed control and that manual labour will be limited to machine operation. On the less progressive farms however a certain amount of manual labour for tidying up may be required and a nominal average of 10 man hours per acre is included in the estimate to allow for this. Farms in 1973 still practising methods in general use in 1963 are however likely to be as exceptional as were farms harvesting by hand in that year. As the table shows,

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* The balance of cost of sprays in Table 4 is for pesticides.

further savings in manual labour can be expected through improvements in harvesting techniques. Although average hourly earnings of labour are again anticipated to be 70 per cent. higher than in 1963 total labour costs per acre may in fact decrease because of the reduction in labour hours and the elimination of costly piecework on singling. The estimated increase in machinery costs and contract charges assumes that there will be a considerable development in the co-operative use of specialised machinery amongst small acreage growers and that each machine will be operated on about 40 acres of sugar beet. The increases in costs of other factors are rough estimates based on past trends, which in the case of seed and fertilisers may again incorporate the cost of further improvements as well as price trends. The figure for manures however assumes a small decrease in the use of artificial fertilisers. There is strong evidence that at the higher levels of application, a reduction in nitrogen can lead to improved yields as well as higher sugar content.

The change over time in the relative importance of different cost items shown in table 4, illustrates the rapid progress in the substitution of "off farm" science based innovations for an "on farm" resource, manual labour. This process has been characteristic of most aspects of farming since the war. Thus, in sugar beet growing the proportion of total direct costs attributable to manual labour is seen to decline from nearly 40 per cent. in 1953 to 31.5 per cent in 1963 with the prospect of a further decline to 23 per cent. by 1973; whereas the proportion attributable to machinery and contact costs, seed and sprays, is seen to increase from 12 per cent. to 26 per cent.

This process has led to a high rate of increase in labour productivity, as measured by the rapidly declining labour requirements per acre. With the steady improvement in yield over the same period, the rise in labour productivity as

measured by physical output per man hour is even more dramatic than when related to acreage.

PART 4 FARM LEVEL CONSIDERATIONS

Within the broad general economic framework of sugar beet growing, individual growers are concerned with those factors which lead to higher returns, lower costs and therefore better margins. In this section an attempt is made to identify and measure the influence of some of these factors by reference to physical and financial data available for a sample of 64 farms in the North West for 1963 and 1964. Except for 18 located on intensive arable farms in South West Lancashire and three in Staffordshire all the crops are on farms scattered over the arable and potentially arable areas of central and East Shropshire. Weather conditions for the crop were generally more favourable in 1964 and average yields were nearly two tons per acre higher than in 1963. Sugar content as well as beet prices were also higher in the second year and since there was little change in average costs (Table 5) margins per acre were also higher than in 1963. Average results however conceal the wide variations between individual farms, a feature clearly illustrated in Tables 6, 7 and 8, which show respectively the range in net costs, net margins and yield per acre for 1964 only.

1. Returns per Acre

The financial returns per acre from a crop of sugar beet are determined by the yield and the price per ton received. Price has always varied with sugar content and in 1963 this was modified in order to encourage a greater emphasis on quality. Reducing the tonnage handled for a given quantity of sugar is of benefit not only to factories but can also reduce growers' haulage and harvesting costs. Seed variety is probably the most important single factor influencing sugar content but even under trial conditions the difference in economic performance between the few top varieties is usually relatively small. Under

TABLE 5

AVERAGE COSTS AND RETURNS PER ACRE

64 CROPS

	1963	1964
	£	£
Total Costs	72.07	71.60
Value of Beet	79.33	97.37
Margin	7.27	25.77
Credit for tops	4.33	5.16
Final Margin	11.60	30.92
Yield per acre (tons of clean beet)	11.94	13.83
Average sugar content. percent:	16.88	17.30

TABLE 6

RANGE IN NET COSTS* PER ACRE 1964 CROP

£ per acre

	Under 50	50 - 59.9	60 - 69.9	70 - 79.9	80 - 99.9	Over 100
Number of Farms	5	18	19	10	10	2
Acreage of S.B. per Farm	43.4	44.8	36.5	27.1	10.8	6.0

TABLE 7

RANGE IN YIELD PER ACRE 1964 CROP

Tons of Clean Beet

	Under 10	10 - 11.99	12 - 13.99	14 - 15.99	16 - 17.99	Over 18
Number of Farms	5	11	18	15	9	6
Acreage of S.B. per Farm	11.7	39.2	39.6	33.3	26.1	28.5

TABLE 8

RANGE IN NET MARGINS** PER ACRE 1964 CROP

£ per acre

	Loss	0 - 9.9	10 - 19.99	20 - 29.9	30 - 39.9	40 - 49.9	Over 50
Number of Farms	3	6	8	13	14	12	8
Acreage of S.B. per Farm	11.9	18.9	18.4	39.8	29.6	38.9	51.9
Yield of S.B. per acre (tons)	6.96	10.55	13,28	12,78	14.82	15.06	17.35

* Net Cost = Total Costs (Including share of overheads) less value of tops and adjusted for residual manurial values.

** Net Margin = Value of sales of beet less net cost

typical farm conditions the net effect on yields of sugar of a change of variety is often difficult to measure because of the interaction of other factors. Furthermore, many growers, either from experience or on advice, usually concentrate on a variety or combination of varieties which suit their own particular conditions and the range in sugar percentage between farms therefore tends to be narrow. In this survey, for example, over 70 per cent of the growers in both years produced beet with a sugar content within the range 16.5 to 17.5 per cent. The range in yield of roots on the other hand (Table 8) is much wider on farms, indicating that growers have a much greater opportunity of increasing their returns per acre by concentrating on factors leading to higher root tonnages per acre. This is not to deny the importance of improving root quality but to point out that growers with low root yields of average sugar content are likely to find it easier and more profitable to achieve an increased weight of roots than a further improvement in sugar content. Further, an attempt to improve root quality in high yielding crops might well lead to a reduction in tonnage and result in a net decline in total returns per acre. Attention is therefore directed to an examination of some of the more important factors influencing root yields per acre.

2. Factors Affecting Yields

The wide range in yields usually observed in farm survey studies arises because of differences between farms in the management of the crop and in the natural conditions under which it is grown. Natural factors such as weather and soil are outside the control of the farmer and analysis is therefore restricted to management. Some aspects of management take the form of measurable inputs, variations in which can be related to variations in yields. Others are of a qualitative nature and take the form of practices or actions, many of which

are difficult to define and relate to yields in a meaningful way. Under typical farm conditions these factors are combined in different ways and in different proportions on farms and the specific effect of one factor on yield is difficult to measure because of the combined effects of other factors. Only broad general relationships can therefore be illustrated from data based on farm studies. The evidence of experimental work is more precise but, because of the controlled conditions, may lack general applicability. Success in sugar beet growing is therefore more likely on farms employing the methods and practices known to lead to better yields but adapted where necessary to suit the grower's own particular conditions.

The importance of a high level of management is illustrated in Table 9 below where the average survey yields are compared with those of seed variety trials conducted by the N.I.A.B.*. The variety trials results represent average yields of plots located in the main sugar beet growing areas and since the aim is to compare not only the relative performance of different varieties but also their full potential, it is assumed that a consistent but high level of management techniques is applied to all varieties. The survey results on the other hand represent the average of a wide range of management skills and conditions. Results were reported for trials of fourteen varieties in 1963 and sixteen in 1964. The survey farms also grew a large number of different varieties, most of which are represented in the trials, but predominant was one variety, Sharps Klein E, which was sown on about 45 per cent. of the acreage in both years.

Amongst other things, the table demonstrates how a consistently high level of management in the variety trials leads to high yields and high quality roots. A significant factor perhaps is that these performances can be achieved and even surpassed on commercial farms since five of the sample farms in 1963 and three

*National Institute of Agricultural Botany, whose trials are reported annually in the British Sugar Beet Review.

TABLE 9

YIELD AND SUGAR CONTENT

A COMPARISON OF SAMPLE AND NIAB VARIETY TRIALS RESULTS

Sample Farms (64 Crops)

	All Varieties		Sharps Klein E. Only	
	1963	1964	1963	1964
Yield of Roots (tons per acre)	11.94	13.83	12.75	13.67
Sugar Content %	16.88	17.30	17.00	17.29

Variety Trials

	Mean of recommended Varieties		Sharps Klein E. Only	
	1963	1964	1963	1964
Yield of Roots (tons per acre)	15.7	18.7	16.5	19.1
Sugar Content %	17.5	18.8	17.3	18.7

in 1964 achieved yields in excess of the average trial yields. The benefits of good management are also shown to be higher when weather conditions are more favourable. Thus the 1964 average trials yield was nearly five tons per acre greater than the average sample yield compared with a difference of under four tons in 1963. Similar yield relationships are also evident when the results of one particular variety, Sharps Klein E, are compared.

In so far as individual aspects of management are concerned and within the limits of the information available on the survey farms, only two factors, namely 1) date of drilling and 2) manuring policy, were found to be significantly related to variations in yields.

a. Date of Drilling and Yields

The timing of drilling is an important consideration since it affects sugar content as well as yields. Sugar content continues to rise until full maturity is reached and experimental evidence indicates that early drilling leads to higher yields of sugar per acre. Because of the demands of singling on manual labour and also often because of variable weather conditions, staggering of drilling has always been a feature of sugar beet growing. The anticipated general reduction in manual singling should lead to a progressive concentration of drilling within the optimal time period and this, together with the increasing use of higher performance monogerm seed, should in time eliminate some of the variations in yields. The evidence in Table 10 below lends general support to the experimental evidence about early drilling. It is clear that most growers are aware of this since under the more favourable weather conditions in 1964 the majority of them drilled most of their beet during the first two weeks in April. The 1963 results suggests that the more changeable conditions in that year delayed the completion of drilling on many

TABLE 10

YIELD AND DATE OF DRILLING

A. 1963 Crop

	Date of Drilling					
	March	April 1st - 7th	April 8th - 15th	April 16th - 22nd	April 23rd - 30th	May
Number of Farms	2	14	17	13	16	2
Yield of Roots (tons per acre)	7.00	13.96	11.47	11.85	11.38	11.59
Yield of Sugar (cwts per acre)	23.72	46.59	38.36	40.68	38.68	39.75

B. 1964 Crop

Number of Farms	3	16	31	9	4	1
Yield of Roots (tons per acre)	12.67	16.05	13.90	12.89	9.23	11.13
Yield of Sugar (Cwts per acre)	44.10	55.81	48.27	43.77	31.78	37.46

farms. The highest average yields were obtained from crops drilled in the first week of April and the results of the few farms that drilled earlier than this indicates that it may also be unwise to sow too early in the season.

b. Manures and Yields

Manures consist of a variety of different types such as artificials, farmyard manure, salt and lime which are applied to sugar beet in varying quantities and proportions on different farms. A comprehensive measure by which the comparative value of different quantities and proportions of these different items can be related to yields is however impossible to calculate and even if it were, might be of doubtful value since under farm conditions a rational manuring policy has to take account of particular conditions on farms. The response to a current level of fertiliser application may be influenced by different soils, and the previous manuring and cropping of land on which sugar beet is grown. In Table 11 the average application of the plant nutrients (N, P & K) per acre from artificials together with average quantities of FYM and salt applied are shown for different acreage size groups. Individual application rates varied considerably between farms but the total was similar for the two years. There was however a tendency for the level of nitrogen to be increased in the second year on the larger acreages and to be curtailed on the smaller. The higher rate of FYM application on the smaller farms is attributable to the quantity available since they carry relatively more livestock than the larger farms.

c. Farmyard Manure and Yields

Farms which carry livestock produce a quantity of FYM annually and the usual practice is to apply it to root crops where they are grown. Farmyard

TABLE 11

THE AVERAGE USE OF FERTILISERS ACCORDING TO THE ACREAGE OF SUGAR BEET

Size Group	Plant Nutrients from Artificials				
	N	P	K	FYM	Salt
1963	units per acre			Tons/ac	Cwts/ac
Under 15 acres	130	113	197	10.5 (14.5)	2.73 (4.47)
15 - 29.9 acres	145	98	147	5.9 (10.0)	3.08 (4.40)
30 - 59.9 acres	134	123	178	5.2 (7.4)	2.92 (3.55)
Over 60 acres	143	105	174	3.6 (6.5)	3.83 (4.31)
All farms	138	109	173	6.7 (10.2)	3.05 (4.06)
1964					
Under 15 acres	122	98	157	9.2 (13.8)	1.41 (4.06)
15 - 29.9 acres	131	100	163	6.0 (10.0)	3.28 (4.37)
30 - 59.9 acres	149	122	200	3.1 (5.2)	3.25 (4.60)
Over 60 acres	155	120	183	1.4 (6.5)	3.51 (4.51)
All farms	137	110	174	5.5 (9.8)	2.82 (4.41)

Note: The figures in brackets represent the actual dressing on the acreage on which FYM and salt were applied

TABLE 12

YIELDS AND FARMYARD MANURE

	1963		1964	
	FYM	NO FYM	FYM	NO FYM
Number of farms	34	30	31	33
Nitrogen from artificials (units per acre)	127	142	135	139
Estimated Nitrogen from FYM (units per acre)	31	-	29	-
Total Nitrogen (units per acre)	158	142	164	139
Average Yield (tons per acre)	11.38	12.77	13.70	14.18

manure no doubt has a beneficial long term effect on soils but its value as a source of plant nutrient for a particular crop is often a matter of controversy. Since FYM however has to be disposed of, the important question raised is not whether or how much of it should be applied on particular crops but how far can it substitute for artificial fertilisers. About half the farmers in this survey* applied FYM but their average yield of beet was in fact slightly lower than that of those who applied no FYM in both years.

In 1963 those farms which applied FYM, (Table 12) applied on average 15 units less nitrogen per acre from artificials (equal to 1¼ cwts of a standard compound, say 12 12 20) than those which applied no FYM but in 1964 application rates were nearly equal. It would be wrong to conclude from this evidence that FYM leads to lower yields since other factors affecting yields may not be equally distributed within the two groups of farms. There is however a strong case for asserting again that the application FYM on sugar beet does not seem to allow for a significant saving on artificials without sacrificing yields.

3. Yield response to nitrogen

There now remains the question of the quantity of plant nutrients required to secure optimal yields of sugar beet. The need for adequate supplies of phosphate and potash is well known and is provided by most compounds recommended for sugar beet Although application rates vary between farms these two nutrients are not applied in excess and even if they

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* Some farms applied FYM on part of the crop only and where the average application on all the crop was less than enough to supply 10 units of nitrogen per acre these farms were classed as applying no FYM. The quality of FYM clearly varies according to its source and its effectiveness according to storage and time of application, but for the purpose of table 10 it is assumed to be of standard quality and each 10 tons estimated to contribute 30 units of nitrogen in the year of application.

were, have no harmful effects. A considerable weight of experimental evidence on the other hand, shows that an excess of nitrogen can depress both yields and sugar content and suggests that there would appear to be little justification for applying more than about 100 - 110 units of nitrogen per acre except under the most unusual conditions. More recently, an analysis based on data from a sample of Yorkshire farms* supports the conclusion that nitrogen depresses yields over and above the optimum, but from the information available defines the optimum only as being less than 140 units per acre. It is evident from the results of Table 11 and also from the Yorkshire Survey that during the cropping years 1963 and 1964 most growers were applying nitrogen considerably in excess of the experimental recommendation. There are a number of plausible reasons why many growers pursue this policy, amongst which may be noted that farm conditions are usually different from the controlled environment of experimental plots. It was therefore thought worthwhile to attempt to test the yield response to variation in nitrogen application by reference to the data available from this sample of farms in the North West. The difficulty associated with attempting to relate variations in one specific factor to variations in yields from farm sample data has already been stressed because of the wide variation in environmental conditions and in management practices between farms. On the basis that these differences are likely to be considerably less on the same farm for two consecutive years, a more refined method of measuring response to nitrogen was evolved in the Leeds survey. Since both surveys relate to the same cropping years, the same method with some modifications, is used in this analysis. The method is made possible by the fact that despite the similarity in the average level of plant nutrient

* Sugar beet. An Economic Study based on a survey on Yorkshire, 1963/64 and 1964/65. by John W. Wood. University of Leeds, Department of Agriculture, Economics Section.

applied in the two years (Table 11), 54 of the 64 farms applied different dressings of nitrogen in the second year. Thus a measurable difference, being either an increase or a decrease in the quantity of nitrogen per acre applied, between the two years is available and these differences can be related to differences in yields. The distinction between an increase and a decrease is important and the yield response associated with each is shown separately in Table 13. Because of the lack of evidence in the survey as to the influence of FYM, the figures of nitrogen application refer to that contributed by artificials only.* In the first part of the table all the farms which increased nitrogen in 1964 are grouped according to the level of nitrogen applied in 1964, and for each group the average change in yield is shown. A similar procedure is followed in the second part of the table for farms which decreased nitrogen in 1964. Part of the yield increase shown in each group is clearly due to the more favourable growing conditions in 1964 and a correction for this factor is necessary. Ten farms in the survey applied equal amounts of nitrogen in both years but their average yield in 1964 was 1.45 tons per acre greater than in 1963. This increase is assumed to represent seasonal influences and is deducted from the actual yield increase shown in each group. The resulting seasonally adjusted change in yield is assumed to reflect the net yield response to the changes in nitrogen application shown for each group.

It will be noted that only 37 of the 64 farms in the sample are represented in the table and this requires some explanation

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* This is probably reinforced in the case of nitrogen by the possibility 1) that between application and availability there may be some losses and 2) by the fact that nitrogen compounds derived from FYN are stable and long lasting, so that the amount available to crops currently dressed may be no greater than that available to crops grown on land dressed in previous years.

TABLE 13

YIELD RESPONSE TO NITROGEN

A. Response to increase in nitrogen

Level of Nitrogen Usage in 1964	Number of Farms	Change in Yield of Clean Beet 1963 - 64	Change in Yield adjusted for seasonal differences 1963 - 64	Change in Nitrogen Usage 1963 - 64	Change in adjusted yield per increase of 10 units of Nitrogen
Units		Tons	Cwts	Units	Cwts
up to 120	4	+ 1.93	+ 9.60	+ 11.5	+ 8.35
121 - 150	10	+ 1.56	+ 2.20	+ 22.6	+ 0.97
Over 150	10	+ 1.41	- 0.80	+ 32.8	- 0.24

B. Response to decrease in nitrogen

					per decrease of 10 units of Nitrogen
up to 120	8	+ 0.33	- 22.4	- 40.0	- 5.60
121 - 150	3	+ 0.70	- 15.0	- 38.7	- 3.88
Over 150	2	+ 1.79	+ 6.80	- 24.5	+ 2.77

A number of farms were excluded because their change in yield was greater than that which could reasonably be attributed to changes in nitrogen application. Thus, apart from the ten farms already noted and which did not change their nitrogen levels, all farms with yield changes exceeding four tons per acre were also excluded. In addition one farm was kept out since the change in nitrogen was uncommonly large. The nature of the analysis combined with the relatively small number of observations in some of the groups prohibit anything but tentative conclusions, and the trend of the relationships rather than their magnitude is likely to be the more important. In general the analysis supports the findings of the Leeds survey and the results of experimental evidence that the excessive use of nitrogen depresses yield. The table demonstrates that the yield response to additional units of nitrogen declines as the level of application rises and in fact becomes negative as the higher application rates are reached. A similar trend, in reverse is seen for decreases in nitrogen. This indicates that although it cannot be precisely defined, optimum nitrogen application appears to be somewhere within the range 121 to 150 units per acre, and as such is somewhat higher than the figure suggested by experimental evidence. The analysis does not mean that farms which apply the heavier dressings of nitrogen cannot achieve high yields, but rather that if they applied a little less, their yields might have been higher still. At the other end of the scale growers who decrease nitrogen from an already low level are likely to suffer a drop in yield, whereas an increase from a low level is likely to be rewarded with an increased yield of considerably greater value than the increased cost. A point worthy of note in the table is the fact that during this period and despite the well publicised experimental evidence, the largest increments of nitrogen in the second year were in fact applied on those farms already

dressing at the higher rates. Similarly the second part of the table indicates that of the farms decreasing nitrogen, the smallest decrease also occurred on farms applying at the higher levels.

These changes in nitrogen applications from one year to the next may have occurred on some farms as part of a rational fertiliser policy decision. The previous manuring and cropping of the field used for beet in one year may be different from that of the field used for beet in preceding years and may logically dictate a change in the quantity of artificials applied to the current year's crop. If, as is usual, farmers apply the same compound as on the previous crop, such a change in quantity, unwittingly perhaps, leads to a significant change in the amount of nitrogen available to the current crop, possibly with consequences as depicted in the Table. Just as important perhaps is the fact that more farmers were increasing than decreasing nitrogen. On some farms the increase took the form of a top dressing after singling: this is a practice to be deplored since, according to experimental evidence, it encourages top growth and delays maturity. This analysis therefore suggests that many farmers might benefit from a more objective assessment of the nitrogen requirements of their sugar beet crop. It also carries the suggestion, however tentatively, that the practice of most growers in exceeding the experimental optimum nitrogen level is not supported by the evidence of this survey. There is however some evidence that under typical farm conditions, the optimum level may in fact be a little higher than the experimental norm.

4. Reducing Costs of Production

The possibilities of reducing costs of production in sugar beet, as in most other crops, usually take the form of considering methods by which machinery can be economically substituted for manual labour, traditionally a heavy item in sugar beet growing. Mechanisation involves more than direct cost saving since it also ensures a greater speed of working and thus reduces the time required to complete specific tasks. Another important feature is that mechanisation also often reduces the gang size required for specific operations, an important consideration in view of the continuous decrease in the size of the labour force on farms. Other technologies, incorporated in weedkillers and better seed, have also in recent years contributed significantly to lower labour requirements, although their use normally demands further mechanisation. The benefits of mechanisation are also usually associated with scale of enterprise, large scale growers benefiting the most since the costs involved can be spread over a large acreage, and small growers the least since heavy mechanisation on small acreages is clearly uneconomic. Economic surveys therefore generally indicate that larger growers have lower total costs per acre than small growers. In table 14 the component parts of operational costs, together with other relevant data, are shown for the farms in this survey grouped according to acreage of sugar beet.

The table shows clearly that on farms with more than 30 acres of beet total operational costs were £11 per acre less than on farms with the smallest acreages. It is however interesting to note that a large part of the saving is in marketing costs, arising from the fact that most large growers save on haulage costs by using their own lorries. The saving on specialised machinery costs on large acreages is perhaps less than might be expected. This is accounted for, in the first place, by the fact that more small growers drilled one or two of their neighbors' crop and thus reduced the

TABLE 14

OPERATIONAL COSTS, LABOUR REQUIREMENTS AND MECHANISATION

IN RELATION TO ACREAGE OF SUGAR BEET

1964 CROP

	Acreage groups			
	Under 15 acres	15 - 29.9 acres	30 - 59.9 acres	Over 60 acres
Number of Farms	16	19	21	8
Acreage per Farm	7.6	19.8	45.3	82.1
Operational Costs	£ per acre			
Labour	19.6	20.2	18.3	19.2
Tractor	4.9	4.0	4.0	4.8
Contract	1.8	3.7	0.6	-
Special Machinery	4.7	2.7	2.6	2.1
Share of general Machinery	5.7	4.9	5.0	5.7
Marketing	9.8	6.5	5.0	3.3
Total Operational Cost	46.5	42.0	35.5	35.0
Labour Requirements	Man hours per acre			
Preparatory Cultivations	8.1	7.4	6.1	7.1
Growing Operations	51.6	51.4	48.4	47.6
Harvesting operations (excluding loading lorry)	17.4	12.7	11.7	15.0
Total	77.1	71.5	66.2	69.7
Mechanisation	Number of farms with			
Precision Drill	7	14	19	7
Mechanical Thinner	-	3	11	3
(Acres done per thinner)	-	(0.4)	(8.1)	(5.4)
Harvesters - own	12	13	21	8
contractors	3	6	-	-
Cleaner/Loaders used	3	5	10	4
Own	-	3	9	4
Haulage Contractors'	3	2	1	-

machinery costs attributable to their own crop. Finally, the figure of specialised machinery costs on the larger farms, represents a much higher total investment in machinery partly because they have a wider range of equipment and partly because they operate more modern and more expensive machines. This is particularly true of harvesters many of the smaller farms being equipped with cheaper secondhand machines. These factors, and the latter in particular, might reasonably have been expected to reduce manual labour use on the larger farms by a greater amount than that shown in the table. The possession of a wide range of modern machines however does not automatically lead to their full and efficient use. For example, a number of the medium and larger scale growers were equipped with mechanical thinners but as the table shows they were in fact little used. Under conditions existing in 1964 this was probably justifiable since most of the growers who used them on a trial basis reported adversely on their performance. The crop was therefore hand singled on most farms and on this operation there is little if any advantage to be derived from scale. All the growers except one employed complete harvesters, mostly of the side elevator type, but it is again surprising to note that the manual labour on harvesting was higher on the largest acreages than in the two preceeding size group. This tendency towards increasing costs on the largest crops has been noted before in this report, and in this particular instance the higher use may be due to the fact that these farms employ larger staffs and it is likely on occasions that more men are available for certain operations than the number strictly required. In these circumstances any further mechanisation designed to reduce manual labour should satisfy two criteria; 1) that the saving in labour costs should be greater than and at least equal to the additional machinery maintenance costs and 2) that alternative profitable employment is available for the released labour.

Most of the likely developments in sugar beet growing over the next few years

and their impact on the level and structure of costs, and particularly on labour requirements, have been outlined in this report. The most important of these developments consist of methods designed to eliminate hand labour in singling and cleaning. In fact labour requirements are already being drastically reduced on a growing number of farms through the progressive use of currently available techniques. The eventual solution to the problem, and its adoption by the generality of growers predicted within the next six or seven years should lead to a reassessment of the value of beet as a crop on many farms and therefore to a greater stability of sugar beet growing on those farms and within those areas best suited to grow the crop.