THE WEST OF SCOTLAND AGRICULTURAL COLLEGE

TURNIPS
A DECLINING FORAGE CROP?

An Economic Appraisal of the 1969 Crop

by

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With the Compliments of the

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C O N T E N T S

APPENDICES

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Note:

Turnips and Swedes

The vast majority of fodder roots grown in the West of Scotland are swedes rather than turnips. However, by common usage the term turnip has come to be used to describe both crops.

In this report the term turnip is used to describe both swedes and turnips except where circumstances call for a differentiation between the two types of crop.

SUMMARY AND CONCLUSIONS

1. Turnips in the West of Scotland and elsewhere are a crop of declining importance.

2. The main advantage of the crop is a high output of nutrients per acre at a reasonable level of variable cost.

3. The main disadvantage is the high labour requirement for growing and harvesting the crop (and possibly feeding) relative to self feed systems.

4. Precision seeders and mechanical harvesting methods (topping and tailing machines and complete harvesters) have considerably reduced the labour requirements. Further future reductions may be possible through using pre-emergent weed sprays. Even so, the crop still has a high labour input.

5. Areas as small as 4 acres can justify a topping and tailing machine.

6. Based on cost savings, a small advantage can be gained by using a complete harvester instead of a topping and tailing machine with about 60 acres or more.

7. Apart from taking the drudgery out of the harvesting operation, a complete harvester can result in reducing size of the gang employed and eliminating casual labour. This could justify the use of a complete harvester for areas less than 60 acres.

8. The high cost of mechanical harvesting equipment and the experience of farmers in the study, suggests that co-operative ownership of machines is a workable and worthwhile way of providing adequate scale of operation. The harvesting operation can in fact be spread over a reasonably long period.

9. Comparisons of turnips with other forage crops are difficult to make without comparing complete systems of farming, but the crop is economical in terms of relative capital costs for production, harvesting and storage. However, turnips as part of a two forage system could mean having to provide two basic sets of equipment.

10. Ease of handling rationed turnips as against rationed silage in byres suggests that there is still a place for turnips in the feed economy of many dairy farms in Scotland, as 88% of cows are still milked in byres.

11. Pressures to expand herd size through loose housing systems and to save concentrate feed costs by providing higher quality roughages, will no doubt encourage a further decline in turnip acreages, but technical developments in growing and handling the crop could slow down this rate of decline.

12. Any improvement in genetic potential of dairy cows could change the emphasis from self-feed to controlled mechanical feeding and turnips may merit consideration as a high output crop, that could fit into this type of system.

SECTION A

INTRODUCTION

1. BACKGROUND TO THE STUDY

At the request of the Crop Husbandry Committee of the Scottish Agriculture Improvement Council, the Agricultural Economics Department of the College carried out a survey of methods and costs of growing turnips, particularly by newer methods. Some results of a 1968 survey were published in March, 1969*. In 1969 the study was extended to include more crops with mechanical harvesting methods, with a view to making comparisons with more traditional methods.

The trend in turnip and swede acreages in recent years suggests emphatically that this is a declining crop. Over the ten years from 1959 to 1969 the acreage in the West of Scotland has dropped from 44,366 to 19,251.

Table 1

Turnip and Swede Acreages in the West of Scotland based on June 4th Returns

Year	Acres '000
1959	44.4
1965	29.7
1966	25.2
1967	23.3
1968	21.1
1969	19.3

Although the decline in acreage is likely to continue, the trends in the use of precision seeders and turnip harvesters indicate that the decline could become less severe and that a re-appraisal of the value and role of the turnip crop deserves some consideration.

*Turnip Cost Operations Survey, 1968 (John Reid
(Lennox C. Lindsay
(- Statement No. 138

Table 2

Trends in the use of Precision Seeders and Turnip Harvesters

West of Scotland Area

based on Machinery Census - February

Year	Number of:-	
	Precision Seeders	Turnip Harvesters
1964	1336	392
1967	1390	443

Table 2 shows that use of precision seeders increased marginally from 1336 to 1390, between 1964 and 1967. The comparable increase in the use of turnip harvesters from 392 to 443 although not great, is probably more significant especially in relation to the decline in turnip acreage.

2. WHY GROW TURNIPS?

In view of these various trends, it is tempting to ask why some farmers should swim against the tide. When the majority are giving up turnips, why are a minority incurring even greater capital expense in order to remain turnip growers?

One of the main advantages suggested by turnip growers is the high output of starch or energy food per acre. Against this, must be set the labour involved in growing and harvesting the crop, although ease of handling the end-product can be a favourable factor. On the other hand, ground set aside for turnip growing is normally not available for other crops for a period of twelve months or even longer. Hay and silage, however, do enable aftermath and winter grazing to take place.

A major argument in favour of silage-making which could increase in importance as intensive grassland systems become more generally acceptable, is that silage provides a flexible means of pursuing a policy of intensive grassland management, associated with greater use of nitrogen. Fields for silage can be cut or grazed to suit the needs of the livestock and according to variations in the pattern of seasonal growth. The hay/turnip producer does not have the same opportunity for intensive management because of the problems of securing heavy crops of hay. However, he does have the option of pursuing intensive systems of paddock grazing, even though the hay crop may be less heavily manured.

Even so, intensive systems are usually associated with loose housing and as Table 3 suggests, the byre is likely to remain the method of milking for some time to come.

Thus, where bulk rations have to be fed individually to cows, the turnip as part of a hay/turnip ration has an obvious advantage over silage. Hay is still the predominant forage crop in the West and silage making, although on the increase, is not advancing at a great rate (See Table 4). On many farms the problems of slurry and effluent disposal have caused some farmers to revert from silage to more traditional systems and may have inhibited the expansion of silage making.

Although the turnip is low in dry matter, 10% under West of Scotland conditions, compared with 25% for silage and 85% for hay, it is still possible to produce a high output of this 'nutritious water' per acre.

Table 3

Trend in Milking Systems (Scotland)

System	1964	1969
	per cent	per cent
Byre (bucket)	87	46
Byre (pipeline)	9	42
Parlour	4	12
	100	100

Table 4

Trend in grass Conservation (Scotland)

Year	Hay	Silage
	'000 Acres	'000 Acres
1956	483	56
1963	523	181
1968	554	225

Table 5

Tonnage of Turnips, Hay and Silage required to produce 2 tons of Starch Equivalent (S.E.) together with the Associated Digestible Crude Protein (D.C.P.)

Crop	Tonnage required to produce 2 tons S.E.	(D.C.P.) Assoc.with 2 tons of S.E.
	Tons	Cwt.
Turnips (Swedes) (7% S.E.) (1.1% D.C.P.)	28.6	5.2
Hay (32% S.E.) (4.0% D.C.P.)	6.3	3.2
Silage (10% S.E.) (2.2% D.C.P.)	16.7	8.8

The figures quoted are for average quality hay and silage. Where grass of high digestibility can be conserved, the importance of protein and provision of part of the production ration from roughage, becomes a more telling factor than the mere output of starch. However, in terms of yield of bulky forage, the achievement of a 6 ton yield of hay or 16½ tons of silage represents a fairly high level of intensive management requiring high inputs of fertiliser per acre. The comparable yield of 28½ tons of turnips is, however, just below the average achieved on the crops studied.

There is, therefore, some weight in the argument that turnips produce a high output of feed per acre. The main question arising is whether recent developments in mechanisation of various operations can make the crop competitive when labour requirements are examined in detail.

3. FARMS STUDIED AND CULTURAL PRACTICES

This report summarises the results from 31 turnip crops on 29 farms, covering 314 acres for the 1969 harvest year. The study was concentrated in the counties of Dumfries, Lanark and Ayr but 3 farms from other counties were included because of the mechanisation involved. Turnips were grown mainly for feeding to dairy cattle but some were fed to other cattle and some folded by fattening sheep.

Table 6

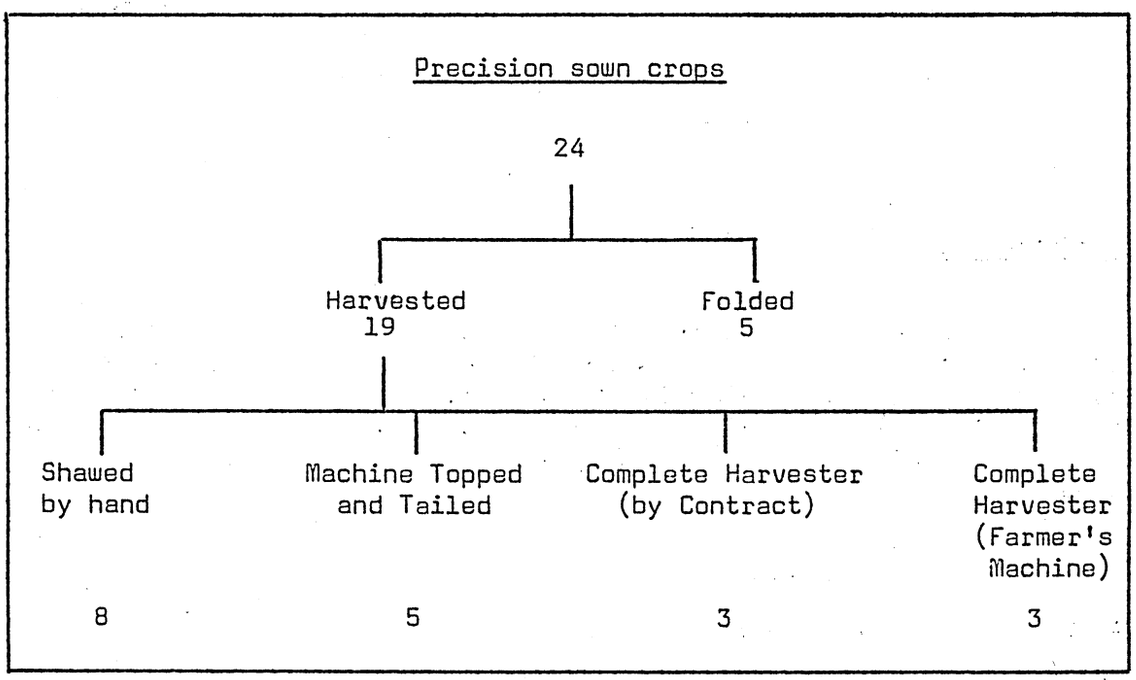
Distribution of turnip crops studied by counties and type of farm

County	Number of Crops	Type of Farm	
		Dairy	Stock Rearing
Dumfries	16	10*	6
Lanark	8	6*	2
Ayr	4	4*	-
Stirling	1	1	-
West Perth	1	1	-
Wigtown	1	1	-
Total	31	23	8

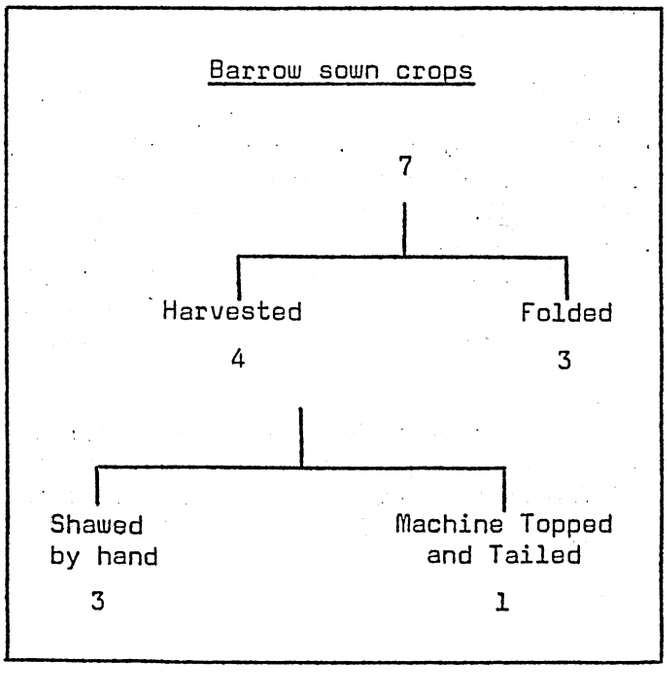
*Some of the dairy farms had a ewe flock and fattening sheep on turnips.

In terms of sowing and harvesting practices, the 31 crops were handled as below:

(a)



(b)



Previous cropping

Previous cropping was as follows:

No. of crops	Following after:
17	Cereals
8	Grass
2	Potatoes
4	Grass/Stubble

Varieties used

On each farm records were kept of the different varieties grown. The main harvested crops were all swedes but some small acreages of yellow turnips were also grown chiefly on the sheep feeding farms. Irrespective of the method of sowing, all but a very few used graded and dressed seed and the following is a list of the swede varieties found in alphabetical order.

Acme	Doon Major	Ideal	Pentland Harvester
Ailsa	Doon Spartan	Magnificent	Teviotdale
Benefactor	Emerald King	Peerless	Victory
			Wilhemsburger

Annandale yellows was the main turnip variety grown for sheep feeding.

Manuring practices

Farmyard manure was applied to 10 of the crops following stubble and 2 of crops out of lea while a further crop had F.Y.M. applied to half of the stubble land for turnips. Exact quantities of F.Y.M. or slurry were not always recorded, as in some cases the turnip field was near the farm steading and the daily manure from the byres was spread on the field as weather permitted. Where estimated records were kept, the range of application was from 8 to 25 tons per acre so some crops only had a light dressing whilst others had quite a heavy application. Lime was applied in only two cases, one following lea and the other after oats.

Quantities of compound fertiliser used varied according to the use of farmyard manure and slag. The position is summarised in Table 7 although complete figures of fertiliser analysis were not available.

Table 7

Quantities of Basic Slag and Compound Fertiliser used

Crop Treatment	Basic Slag	Compound Fertiliser
	cwt/acre	cwt/acre
Dunged crops - slagged	9.64	5.39
Dunged crops - not slagged	-	7.41
Crops not dunged but slagged	19.21	6.91
Crops not dunged or slagged	-	7.38

All but one farmer used boronated turnip fertilisers. The compositions of the Basic Slags used were not always available but the application rates per acre ranged from 6.66 to 29.20 cwt, the latter rate being for a very low grade slag. The range of rates of compound fertilisers applied per acre was from 3.70 to 10.29 cwt.
Where crops were not slagged 10 farms kept records of the composition of fertilisers and on these, the average rate of turnip fertiliser applied per acre was 6.94 cwt. giving an average application of plant nutrients as follows:

Plant nutrients on crops not receiving slag

Units Per Acre		
Nitrogen (N)	Phosphate P_2O5	Potash (K_2O)
49.1	134.2	70.7

As regards cost of fertilisers, the overall average for all crops was £10.39 per acre embracing lime, slag and compound fertilisers. Excluding lime and slag the average cost for compound fertilisers alone was £8.47 per acre. The average cost of basic slag on the 14 farms which applied slag was £5.86 per acre. Only two farms applied lime, one at the rate of 40 cwt. per acre and the other at 27 cwt. per acre. Average fertiliser costs were largely influenced by the previous and intended subsequent cropping of the turnip field.

SECTION B

WAYS OF LOOKING AT COSTS

1. GENERAL COMMENT

It is possible to look at costs in several different ways. Indeed it is logical to do so if the various purposes of keeping cost records are to be fulfilled. In the case of the turnip crop, three purposes can be identified:-

(i) To enable useful cost comparisons to be made with other sources of winter fodder.

(ii) To provide information which will enable changes in fodder production policy, to be planned, using facts rather than guesswork.

(iii) To provide a guide for the valuation of the growing crop for tenantright purposes at various stages of crop maturity.

The third function is regarded as subsidiary to the first two, but as the information is frequently asked for, a note of costs at different stages is included in Appendix 4.

Thus, the main function of this report on cost factors, is to throw light on (a) the making of cost comparisons and (b) the provision of planning information. These two aspects are obviously inter-related.

To make valid comparisons of one forage crop with another, it is necessary to have some sort of common denominator in order to compare both costs and nutrients. At the nutrient end, there is scope for debate, but even more controversial is the problem of finding acceptable yard-sticks for costs of growing and feeding the crops in question. Costs of production can be expressed in monetary terms but herein lies the greatest danger of oversimplification.

The production of forage crops not only entails annual expenditure to grow and harvest these crops but also involves different degrees of associated capital expenditure for equipment. In addition, there could be considerable variations in capital expense involved in fodder storage and in labour used in actual feeding. All these factors illustrate the complexity of the problem and the range of choice open to the farmer. They are discussed in greater detail on pages 22 to 24.

Using the gross margin method, we can tackle the logic of the type of thinking required. In the case of turnips, the initial emphasis is placed on variable costs, relating these to the value of livestock and livestock products produced. In this way, we can see the costs that would be saved (i.e. the variable costs) if turnips are no longer grown.

There would be a cash saving of:-

Seed
Fertiliser
Sprays
Contract charges
Casual labour
Miscellaneous items e.g. straw bought etc.

There would be a saving in acres which would be made available for alternative crops (but no saving in rent). There would be a saving in regular labour (hours rather than cash).

There would be a saving in tractor variable costs (i.e. fuel and repairs) and the tractor running hours released would be made available for other alternative jobs.

Both the labour and tractor hours made available would have a seasonal pattern related to the particular demands of the turnip crop.

Finally, on the costs side, any realisable capital tied up in specialised equipment for turnip growing would be freed for other purposes.

On the output side, the loss of a crop foregone can be measured in terms of the nutrients no longer produced, but if livestock production is to continue, the choice of substitute nutrients, their variable costs, and seasonal labour and machinery requirements, as well as any capital outlays, must come into the calculations.

Thus in looking at costs of the turnip crop, it is important to ask not just 'what does the crop cost?' but 'how does it fit into a farming system?'.

These two questions must be answered not so much in terms of one cash figure for turnips, which can be compared with another cash figure for hay or silage, but in terms of capital investment, labour requirements, team size, rates of work, for hand and mechanical methods for particular jobs, together with the running costs of the machines for carrying out these jobs or operations.

To provide satisfactory answers to all these questions just mentioned, is obviously both difficult and fraught with all kinds of dangers of misinterpretation. In order to simplify the presentation of relevant facts and to encourage a sensible interpretation, it is suggested that certain costs such as those for labour and machinery are better expressed in hours rather than in cash costs. This kind of approach is particularly important when using information in a planning context. However, to a limited extent it can also be useful to try and develop some broad yardsticks for making comparisons between alternative fodder crops for livestock production.

2. VARIABLE COSTS AND OUTPUT

With a relatively small sample and considerable diversity of crop treatment, it would be misleading to quote averages for variable costs according to such groupings as systems of harvesting. It is important to distinguish in this connection, between figures which reflect genuine differences in cultural and harvesting practices and those which are merely fortuitous. Thus, although the crops harvested by a complete harvester had lower fertiliser inputs per acre, this was related to the crop rather than the method of harvesting. The figures shown overleaf are therefore standard rather than average figures and represent typical regimes of input and cost related to some of the variations likely to be found in practice.

In the case of casual labour, on singling and shawing, some of this was done by piece-work, some by regular labour (normal rates or overtime) and some at gang rates. The figures quoted give an indication of cost on the assumption that all the work was done on a casual basis.

Table 8

Standard Variable Costs per acre and per ton

(a) Standard examples per acre based on different crop treatments

Variable Cost Items	Crop Treatment	
	Precision sown Hand singled (casual labour) Mechanically shawed	Barrow sown Hand singled (casual labour) Shawed by hand (casual labour)
	£ per acre	£ per acre
Compound Fertilisers (1) N 50 units P 125 units K 80 units	8.50	8.50
Lime and Slag	2.50	2.50
Seeds	0.32	0.57
Sprays - weed control (2)	£2 - £5	£2 - £5
- flea beetle	0.60	0.60
Casual Labour - singling (3)	6.30	7.00
- shawing	-	8.40
Total of Variable Cost Items Shown	20.22 - 23.22	29.57 - 32.57

(b) Standard Variable Costs per ton at different levels of cost per acre

Yield Level tons	Variable Cost per acre		
	£14 (materials only)	£20 (casual labour - singling)	£30 (casual labour singling and shawing)
	£ per ton	£ per ton	£ per ton
20	0.70	1.00	1.50
25	0.56	0.80	1.20
30 (approx. average of study)	0.47	0.67	1.00
35	0.40	0.57	0.86
40	0.35	0.50	0.75

(1), (2) and (3) see Page 13.

Footnote to Table 8

(1) Fertiliser costs including slag for folded crops, not singled, averaged £9.00 per acre which probably reflects a more typical input for this type of crop.

(2) Although spraying is shown as a standard cost, the majority of farms in the sample did not use sprays in the year studied. The spraying costs of folded crops, not singled, did in fact approach the lower figure shown in the table.

(3) Although mechanical harvesting means a reduction in casual labour, this is offset by higher fixed costs of mechanisation.

Note that both crop treatments in this Table assume all the singling was done by casual labour and that where hand shawing was used this was also carried out by casual labour.

3. LABOUR AND MACHINERY ASPECTS

The degree of mechanisation possible and the consequent saving of labour will vary at each stage of growing and harvesting the crop and the degree of sophistication of existing methods. Obviously, to justify mechanisation, whether of parts of the process or the complete series of operations, it is necessary to be able to quantify both the costs involved and also the likely savings. In this study it was possible to collect some information on labour requirements for various operations carried out in different ways. In the case of mechanical harvesting, however, a special study was made, so that a separate and more detailed discussion is made of this particular aspect. (See Appendix 2 page 27)

Information was not available in sufficient detail to specify the gang involved on specific operations but where possible, the level of performance is shown in terms of man hours per acre and tractor hours per acre. To give a more concrete picture of possible rates of work, the different operations have been expressed per 8 hour man day. This does not mean that 8 hours is a typical working period, as time will be lost travelling to and from fields and farms with a small labour force may well have to stop for milking. Also, the days available to do particular jobs will vary according to the season and the importance of timeliness for certain operations. Other factors such as the weather, ground conditions and daylight hours will all affect rates of work.

Table 9 shows the various operations, giving alternative methods where the information is available, in terms of man and tractor hours per acre and acres per 8 hour man day. No figure for costs of these operations is given, mainly to emphasise the point that cash costs of labour and tractor work do not represent the amount that would be saved if the particular operation was not carried out. However, some overall cost comparisons are included later in Table 14, page 22.

Table 9

Man and Tractor hours per acre and acres per 8 hr. man day for the various operations in growing and harvesting turnips

Operation	Manual Labour	Tractor Labour	Acres per 8 hour man-day*
	hours/acre	hours/acre	acres
Loading and Spreading F.Y.M.			
Machine loaded and spread	6.00	6.00	1.34
Hand loaded, machine spread	8.60	6.50	0.93
Ploughing			
Double furrow (reversible)	1.67	1.67	4.79
Double furrow (normal)	2.29	2.29	3.49
Single furrow (reversible)	4.00	4.00	2.00
Single furrow (normal)	4.71	4.71	1.70
Cultivations (pre-sowing)			
Discing, harrowing, rotovating	2.33	2.33	3.36
Sowing Fertilisers - spinner	0.51	0.51	15.69
Drilling or ridging (3 row ridger)	1.13	1.13	7.08
Sowing turnip seed			
Precision seeder	1.06	1.06	7.55
Turnip barrow	1.58	1.25	5.06
Apply pesticides	0.61	0.53	13.11
Singling			
After precision sowing	17.83		0.45
After barrow sowing	19.76		0.40
Cultivations (post-sowing)			
After precision sowing	2.83	2.19	2.83
After barrow sowing	4.75	2.95	1.68
Harvesting			
Shawing by hand	24.32	-	0.33
Carting crops shawed by hand	15.66	12.91	0.51
Machine topping and tailing	3.30	3.30	2.42
Carting in machine topped crops	16.95	11.26	0.47
Complete harvesting (excl. carting)	3.83	3.00	2.09
Carting in complete harvested crops	12.50	10.02	0.64

*Where the gang size is greater than one man, output achieved in an eight hour period will obviously be increased in proportion.

Comments on Table 9

Much of the data in Table 9 confirms existing knowledge of relative rates of work. For example, the time-consuming jobs are singling (0.45 or 0.40 acres per man day), hand shawing (0.33 acres per man day) and carting in the crop (0.51 and 0.47 acres per man day). The first two operations can be speeded up by increasing the gang size, but carting in the crop can be an expensive bottleneck in the harvesting process.

The savings achieved through mechanisation are seen throughout the various operations. Farmyard manure, machine as opposed to hand-loaded can mean a saving of 2.64 man hours per acre. The use of a double-furrow reversible plough instead of an ordinary single furrow plough can save 3.04 man hours per acre.

Precision seeding

The savings through reduction in seed used by precision seeding are presented in Table 10 below and show a saving of 5/- per acre for actual cost of seed.

Table 10

Seed rates and costs per acre for precision and barrow sown crops

Item	Precision Sown Crops	Barrow Sown Crops
Average seed rate/acre	0.64 lb	1.20 lb
Seed cost/acre	£0.32	£0.57
Saving in cost of seed by precision sowing £0.25 per acre		

Apart from the saving in cost of seed, the main advantage of precision sown crops is seen in the time taken in the subsequent operation of singling and cultivations (post-sowing).

Table 11

Man hours for Key operations on precision and barrow sown crops

Operation	Precision Sown Crops	Barrow Sown Crops
	Man hours per acre	
Sowing seed	1.06	1.58
Singling	17.83	19.76
Cultivations (post-sowing) (Hand and Machine)	2.83	4.75
Total (these operations)	21.72	26.09
Saving in man hours due to precision seeding 4.37 man hours/acre		

Looking at Table 11 the savings of nearly 2 man hours on both singling and post-sowing cultivations, suggests that the overall saving of over 4 man hours per acre is justified.

The barrow-sown crops that were harvested, had yields ranging from 24 tons to 35 tons per acre, with an average of 29 tons, so that no conclusions can be drawn from the sample as to the effect of precision seeding on yield.

Effect of scale of operation on Harvesting Costs

Probably the crucial factor in deciding whether to mechanise the harvesting operation is - is the area sufficient to justify the high capital outlay involved in buying the machine? In the case of a top and tailing machine or a complete harvester, this outlay must be balanced against the savings that are likely to be made.

It is not always easy to quantify cash savings but where overtime working and casual labour are involved, the hours saved can be a good guide to actual cash savings. Where there is no actual cash saving but one of man hours of regular labour, the timing of the hours saved becomes critical. At peak periods the labour may be worth far more than its nominal cost, but where no alternative jobs are available, the saving may be negligible.

In order to assess the likely savings from mechanical harvesting, the man hours and tractor hours required are set out in Table 12 for:-

(a) Hand-shawing
(b) Mechanical topping and tailing
(c) Complete Harvesting

Labour is assumed to be worth 7/- per hour. Where tractor hours are involved, it has been assumed that a saving equal to the estimated variable costs (fuel & repairs) will be made. Variable tractor costs are estimated at 2/6d per hour.

Table 12

Man hours, tractor hours and costs according to method of harvesting per acre

	(a) Hand Shawed	(b) Top & Tailed Mechanical	(c) Complete Harvester
	Man hours per acre		
Shawing	24.32	3.30	3.83
Carting	15.66	16.95	12.50
Total	39.98	20.25	16.33
Labour Cost per acre @ 7/- per hour	£14.00	£7.09	£5.72
	Tractor hours per acre		
Shawing	-	3.39	3.00
Carting	12.91	11.26	10.02
Total	12.91	14.56	13.02
Variable Tractor Cost per acre @ 2/6d per hour	£1.61	£1.82	£1.63
Total Man and Tractor Variable Costs per acre	£15.61	£8.91	£7.35

From Table 12 it can be seen that there is very little difference in tractor costs between the three methods of harvesting, but that both mechanical methods can achieve substantial savings in labour costs. Thus, the mechanical methods can achieve savings of between £6.70 and £8.25 per acre provided that sufficient acres are harvested to justify the capital outlays involved.

To find the acreage required to justify a topping and tailing machine or a Complete Harvester, it is necessary to make assumptions about the extra capital outlays involved and the consequent annual fixed charges to be met.

The annual fixed costs are estimated as follows:

	£ per annum
1. Topping and Tailing Machine £150 Depreciated @ 15% say £25	25
2. Complete Harvester £400 Depreciated @ 20% = £80 Extra trailer £250 Depreciated @ 15% say £40	120

The break-even acreages required to justify the annual fixed charges and estimated cost savings can be calculated using the following formula:-

$$\text{Break Even Acreage} = \frac{\text{Difference in Annual Fixed Costs of two methods}}{\text{Difference in value of savings between two methods per acre}}$$

The results of this calculation are presented graphically in figure 1 and show that

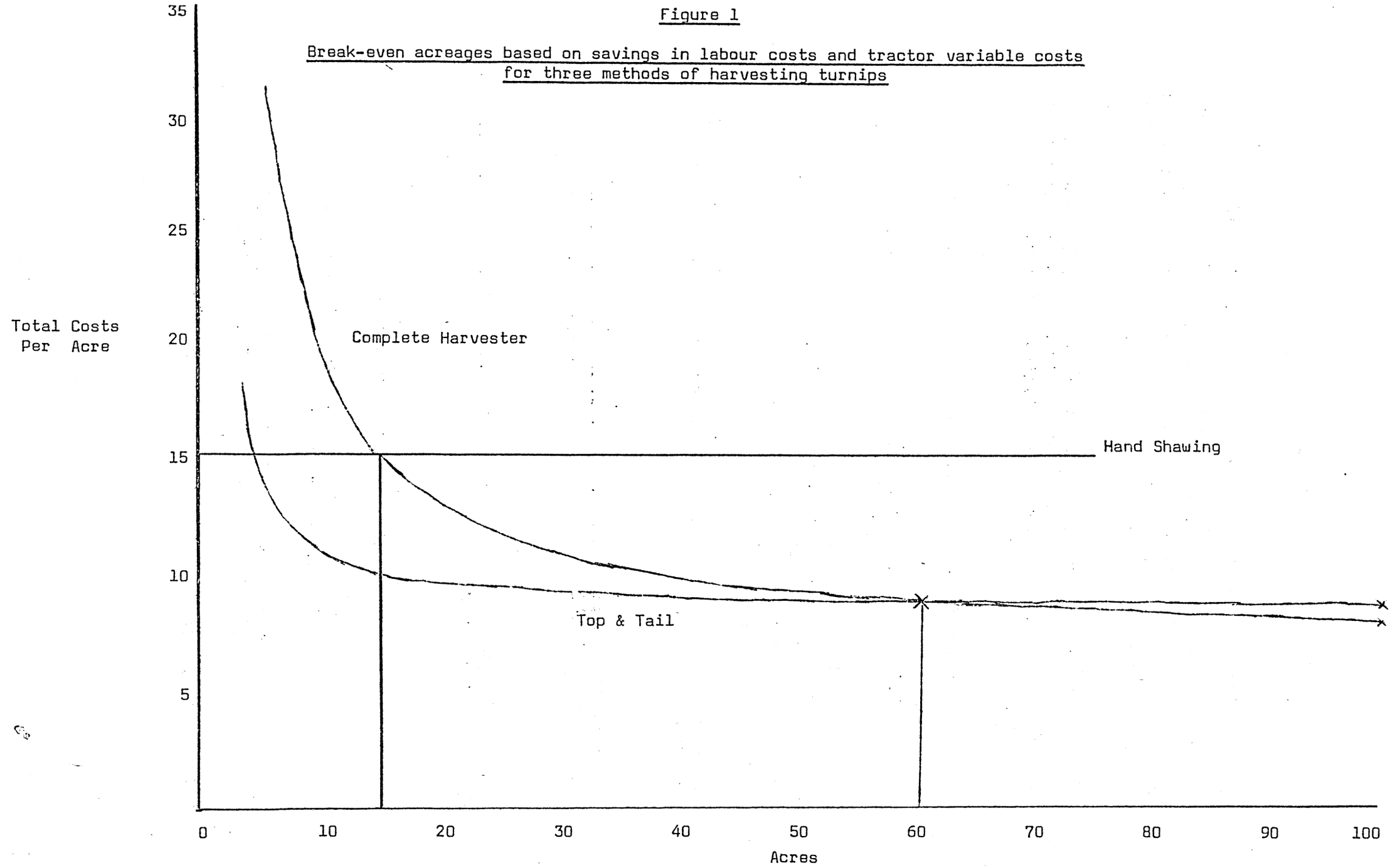
4 acres or more can justify a Topping and Tailing machine as preferable to hand shawing

15 acres or more can justify a complete Harvester as preferable to hand shawing

61 acres or more can justify a complete Harvester as preferable to a Topping and Tailing machine.

Figure 1

Break-even acreages based on savings in labour costs and tractor variable costs for three methods of harvesting turnips



Interpretation of Figure 1

Because of the assumptions made about capital costs and value of labour saved and the fact that a small sample of crops was studied for one year only, any conclusions drawn can only be of a very general nature. Decisions on mechanisation must obviously be related to the particular conditions on the individual farm. For example, a farm having a skeleton labour staff and difficulty in getting casual labour, will place a higher value on potential saving of man hours.

On the basis of the assumptions made about costs and savings, the value of mechanical harvesting is clearly demonstrated. From upwards of 4 acres a top and tailing machine can lead to savings of cost of up to £5 per acre when compared with the hand method. However, the complete harvester does not, on the basis of costs alone, appear to justify the extra outlay involved. Above 60 acres there is a marginal advantage over a topping and tailing machine but up to 100 acres shown on the graph and even above this level the advantage is still not very great.

There are, of course, other valid reasons for mechanising the turnip harvest, notably those associated with attracting and keeping a skilled labour force. Quite apart from the boost to morale of using up to date methods, getting rid of the chore of handling turnip shaws on a wet or frosty morning is something most workers will fully appreciate. In this latter respect, the complete harvester, as opposed to a top and tailing machine, avoids also the 'back-bending' task of manually loading the roots.

In addition, the complete harvester has the added advantage of speeding up the rate of work and reducing or eliminating the use of casual labour and overtime working. Thus, the break-even calculation, although a broad guide, must be considered in the light of other circumstances on the individual farm.

4. OVERALL YARDSTICKS FOR COMPARISONS

It is very debatable whether many useful conclusions can be drawn from comparisons which apply a common cash value to fixed costs such as labour and machinery hours, involved in the production of a crop. However, such figures do give a broad yardstick which takes account of the fact that the turnip crop does make considerable demands on labour and machine time. Putting a cash value on all the operations carried out will not tell us the likely cash savings that will be made if we give up turnip growing or reduce the acres grown. However, it can give a broad measure of the intensity of labour and machine use involved in growing turnips.

Also, if an allowance is to be made for overhead costs, then the traditional (and rather involved method of calculation) could mean an addition of up to £30 per acre to the costs. However, experience on the College farm suggests that a figure of £10 per acre should be adequate to cover the share of overheads that cannot be allocated other than by arbitrary means, to the turnip crop. In Appendix Table VI costs per ton are shown at three levels of overheads cost £10, £20 and £30 per acre.

The figures for variable costs in Table 13 are a reflection not so much of the different methods of harvesting, and the grouping of crops in this way is mainly to indicate the magnitude of differences in the fixed costs, particularly for labour. Thus, the labour content of costs for group 4 is £12 per acre lower than that of group 1.

The fact that variable costs of growing turnips represent a very small proportion of total costs, highlights the need to make sure that fixed cost aspects are given full consideration. Even so, the dangers of using a simple cash common denominator cannot be too strongly emphasised. The saving of £12 per acre in labour costs of mechanical harvesting could well mean a cash saving on a farm where casual labour is involved, but where regular labour is saved, the seasonal timing of the saving will determine its value to the farmer. Where labour is at peak requirement for more than one enterprise, its actual value may be considerably in excess of the actual wage paid.

Conversely, if there are few profitable alternatives for labour saved, then the value of the savings may not be worth the hourly wage paid. However, regular labour on farms at present has been reduced so much that many maintenance tasks such as clearing ditches, hedge cutting, repairing of buildings etc., are not being done and there is no doubt that on most farms there can be profitable alternatives for labour saved. On turnip growing farms, perhaps farmers are employing more labour, but by so doing they ensure that all farm tasks are being given attention, and the farm is being maintained according to the rules of good husbandry.

NOTES ON TABLE 13

All lime and fertilisers under sub total (A) are at net cost after deducting subsidies.

All other Variable Costs under sub total (B) are charged at actual costs or estimated where produced on the farm (e.g. straw for covering pits). Total Variable Costs do not include Casual Labour. The latter was charged at actual rates paid and included in the Manual Labour section of the Direct Fixed Costs.

Rent has been charged at the rate paid by tenants and for owner occupiers it was charged at a figure in line with currently up-to-date rents being paid for similar land in each locality.

The figures for all Manual Labour include Casual Labour and Farmer and Wife labour was charged at 7/10 and 5/10 per hour respectively. Family Labour for which actual costs were not known was charged at standard wage rates for regular labour as specified in Wages Order No. 12.

Farm Tractor Costs were calculated at 4/9d. per hour excluding the Tractorman.

Specialised Machinery charges included depreciation on Precision Seeders at 15%, on harvesting machines at 20%. For very old equipment whose purchase price was unknown a charge was made to cover all repairs for the season.

Overheads are very difficult to estimate but have been charged at a flat £10 per acre rate. No doubt they will vary greatly from farm to farm.

Averages throughout this report are all unweighted except where stated otherwise. Unweighted averages are obtained by adding together the average per acre figures for each farm in a given group and dividing this total by the number of farms in the group.

Table 13

Average Variable and Fixed Costs per Acre
for 4 Groups of Harvested Crops

	Crops Shawed by Hand	Machine Harvested		
		Topped and Tailed	Complete Harvester by Contractor	Complete Harvester by Farmer
	Group 1	Group 2	Group 3	Group 4
No. of farms in Group	11	6	3	3
Variable Costs	£			
Lime and Slag	2.23	5.34	0.95	-
Other Fertilisers	8.43	8.71	8.25	8.11
Sub Total (A)	10.66	14.05	9.20	8.11
Seed and Seed Dressings	0.45	0.42	0.29	0.38
Sprays, Dusts and Herbicides	0.20	0.09	-	0.69
Straw for covering Pits	0.34	0.10	0.07	0.27
Contract Work	0.67	1.12	9.60	-
Sub Total (B)	1.66	1.73	9.96	1.34
Total Variable Costs (A + B)	12.32	15.78	19.16	9.45
Direct Fixed Costs				
Rent	4.80	4.83	4.16	6.00
All Manual Labour	26.92	18.19	17.28	14.82
Farm Tractor Costs	6.73	6.35	5.03	5.40
Specialised Machinery Charges	1.56	3.77	1.52	3.67
Sub Total (C)	40.01	33.14	27.99	29.89
Total Cost (excluding overheads) (A + B + C)	52.33	48.92	47.15	39.34
Estimated Overheads (D)	10.00	10.00	10.00	10.00
Total Cost per Acre (including Overheads)	62.33	58.92	57.15	49.34
Average yield per acre (tons)	27.61	27.08	31.47	31.86
	£			
Average Costs per ton				
Variable Costs	0.45	0.58	0.60	0.29
Direct Fixed Costs	1.45	1.22	0.90	0.94
Estimated Overheads	0.36	0.37	0.32	0.31
Total average costs per ton	2.26	2.17	1.82	1.54

5. GENERAL CONSIDERATIONS OF FORAGE PRODUCTION

It is not possible to quantify or assess in this report all the factors which should be taken into account when deciding on a policy for forage production. However, it may be worthwhile trying to ennumerate the major factors for consideration and to discuss briefly the problems of assessing the weight that might be given to each, under the varying circumstances likely to occur in practice. Three major forage crops - Turnips, silage and hay are considered.

(a) Output of Nutrients per acre

Comparisons of nutrients per acre of turnips, silage and hay present several problems. Apart from the advantages of greater flexibility and suitability for intensive management of the silage crop, the fact that silage and hay can also provide early and aftermath grazing, complicates the issue. Thus the Area required to provide winter feed may be of the order of 1, 2 and 3 acres to produce 2 tons of S.E. from turnips, silage and hay respectively. However, taking account of any grazing, or assuming a "conservation only" policy, the output from one acre of each crop at an average level of intensity might be as follows:-

Turnips, 30 tons - Silage, 12 tons - Hay, $3\frac{1}{2}$ tons
From one acre sole use.

The total yields required to produce 2 tons of S.E. are 28.6 tons of turnips, 16.7 tons of silage and 6.3 tons of hay respectively. The acreages required to produce 2 tons of S.E. at the average levels of yields would therefore be:-

Turnips, 1 acre - Silage, 1.7 acres - Hay, 1.8 acres

(b) Variable Costs per ton of S.E.

The comparison is further complicated on the costs side by the fact that turnip growing involved, on the crops studied, various permutations of casual, overtime and regular labour. Thus, although it is assumed in Table 8 that all labour on singling was done by casual labour, the average for the sample worked out at only £0.60 per acre for casual labour on singling. The table below therefore compares mechnically harvested turnips at two levels of variable costs with Silage and Hay at average levels of intensity.

Table 14

Output (Starch Equivalent) and Variable Costs of Turnips, Hay, and Silage, compared

ITEM	Output from Turnips Mechanically Harvested		Output from Grassland assuming acreage used solely for conservation (i.e. no grazing)	
	No casual Labour on Singling	All Singling by Casual Labour	Silage	Hay
Yield per acre	30.0 tons	30.0 tons	12.0 tons	3.5 tons
Acres to produce 2 tons S.E.	1.0 acres	1.0 acres	1.7 acres	1.8 acres
Variable Cost per acre	£14.0	£20.0	£12.0	£10.0
V. Cost per 2 tons of S.E.	£14.0	£20.0	£20.4	£18.0

Obviously variable cost per ton is only one side of the cost coin but it can give a guide to the effect that proposed changes might have on a system. However, changes in forage production policy are likely to be major ones and therefore could affect fixed costs (i.e. especially labour and machinery costs).

(c) Overall Labour Requirements - production and harvesting

Labour required must be related to nutrients provided rather than labour input per acre. If turnips are harvested mechanically and casual labour for singling is included, the total requirements for production and harvesting would be approximately:-

Turnips	32 man hours)	For 2 tons of Starch Equivalent
Silage	16 man hours)	
Hay	24 man hours)	

The casual labour content of growing turnips means that the crop need not demand any extra regular labour for a given output of nutrients. On the other hand the labour requirement for turnip growing is critical at singling time, but the need for good labour organisation is by no means peculiar to the turnip crop.

(d) Capital Cost of Storage

Again it is difficult to make specific comparisons and a major criterion for deciding any change in policy may be based on the extra capital outlay, together with any realisable cash from the existing system. Thus, turnips and hay may well make use of existing buildings, with no realisable value, but silage may require additional capital outlay.

The weight of forage which can go into 1 cubic foot of space suggests that silage and turnips at 50 and 30 lb. per cubic foot have the advantage over hay at 7 lb. per cubic foot. However, the quantity of nutrients must also be considered. On a nutrient basis, 2 tons of S.E. require:-

1884	cubic feet	for Turnips
1000	"	" for Silage
2016	"	" for Hay

The apparent advantage of silage is offset by the fact that for silage in a clamp, there is a limit to the height of silo that can be used, particularly if self-fed and any usable space above a covered silo must be used for storage of straw and hay. In the case of hay, the full height of a dutch barn type building can all be used for hay storage.

(e) Convenience of hand-feeding

Self-feeding of silage is now relatively commonplace, but there is also no reason why similar but modified systems could not be adopted for hay and turnips. It is worth recording that one of the farmers using a Complete Harvester loaded the turnips into a moving floor trailer and then hitched a turnip pulper behind the trailer. In this way he was able to distribute pulped turnips to his dairy cows in the loose housing feeding area, provided with yokes for easy feeding. However, where food is to be hand-fed in the byre, ease of handling favours hay, then turnips and lastly silage.

(f) Capital Cost of production and harvesting

For any type of forage a minimum investment is required. Silage as the sole source of forage has the advantage of only one set of equipment. Hay and turnips are more frequently part of a "two forage" ration and as such, require minimum equipment for handling both hay and turnips. With any forage crop, the use of second-hand machinery or contractors can keep investment down to a minimum especially on small acreages. Capital investment is, therefore, very much dependent on the individual farm conditions and the farmer's choice. However, as a general rule, even for the more mechanised crops, silage equipment is likely to require a higher basic investment than turnips and where a baler is owned, hay is likely to warrant an even higher basic investment for production and harvesting.

The foregoing comments could perhaps be summarised by awarding stars for the various factors involved, although the problem still remains, of deciding the weights to be attached to each factor, as this will depend so much on individual farm circumstances.

Table 15

Some Factors affecting choice of forage crops

Key: Factors can be described as:- (x not very favourable
(xx about average
(xxx very favourable

Factor	Crop		
	Turnips	Silage	Hay
Output per Acre (S.E.)	xxx	xx	x
Variable Cost of S.E.	xx	xx	xx
Overall Labour Requirement	x	xxx	xx
Economy in Capital Cost - Production & Harvesting	xxx	xx	x
Economy in Capital Cost - Storage	xxx	x	xx
Convenience for Hand Feeding	xx	x	xxx

In conclusion, it will be noted that comparisons of turnips with other forage crops are difficult to make without comparing complete systems of farming. The pressures in dairy farming are to expand herd size and although over 80% of herds in Scotland are still milked in byres, the trend to loose housing is inevitable as labour becomes more scarce and expensive. This could mean an expansion of silage making, particularly self-feeding at the expense of turnips. A further factor favouring silage is the ability to save concentrates by producing higher quality roughage. On the other hand, the loss in Scotland of dried sugar beet pulp as a palatable feed, may suggest turnips as a suitable alternative, given a reasonable degree of mechanical handling.

As the genetic potential of dairy cows improves, there could be emphasis on controlled mechanical feeding systems rather than self-feeding of silage alone. This may mean that the turnip crop could again come up for re-appraisal as a high output per acre forage that might well fit into this type of future system.

APPENDIX 1

Turnip Acreages and the use of Precision Seeders and Turnip Harvesters in the West of Scotland

Table I

Turnip and Swede Acreages - 4th June Returns - 11 Counties in the West of Scotland

County	1959	1965	1966	1967	1968	1969
Argyll	2838	1822	1583	1456	1301	1239
Ayr	6103	4522	3909	3656	3405	3329
Bute	975	629	537	511	460	421
Clackmannan	367	180	157	139	112	104
Dumfries	9611	6623	5863	5415	4790	4442
Dumbarton	902	567	450	396	406	440
Kirkcudbright	6062	4339	3588	3294	2749	2254
Lanark	6252	3759	3019	2683	2531	2370
Renfrew	1189	677	581	571	516	459
Stirling	2195	1249	963	912	846	781
Wigtown	7872	5374	4573	4314	4015	3412
Total	44366	29741	25223	23347	21131	19251

Table II

Numbers of Precision Seeders by County in 1964 and 1967

County	No. of Precision Seeders	
	1964	1967
Argyll	82	112
Ayr	246	252
Bute	31	27
Clackmannan	10	9
Dumfries	294	304
Dumbarton	26	32
Kirkcudbright	228	234
Lanark	229	227
Renfrew	34	35
Stirling	57	68
Wigtown	99	90
Total	1336	1390

Table III

Numbers of Turnip Harvesters by County in 1964 and 1967

County	No. of Turnip Harvesters*	
	1964	1967
Argyll	44	39
Ayr	62	75
Bute	12	15
Clackmannan	5	7
Dumfries	80	82
Dumbarton	7	11
Kirkcudbright	53	67
Lanark	79	74
Renfrew	3	6
Stirling	24	24
Wigtown	23	43
Total	392	443

*Turnip Harvesters includes Complete Harvesters and Topping and Tailing Machines.

APPENDIX 2

Case studies on three Complete Harvesters covering work performance and incorporating notes on conditions and problems encountered during the harvesting study (1)

Table IV

General Information and Work Data relating to 3 crops harvested by Complete Harvesters

(2) Machine Identity	1	2	3
Data on Crops			
Drill width in inches	28"	27"	27"
Average length of drills in yards	273 yards	190 yards	280 yards
Break of drills being worked	36 drills	67 drills	40 drills
Average yield of crop in tons/acre (estimated from samples)	33.3 tons	32.25 tons	35.25 tons
Data on Machines and their performance			
Observed performance of machine (hours/acre)	3.5	2.5	2.5
Date of observed performance	2/12/69	19/11/69	10/2/70
Time spent in machine stoppages (min/hour)	23	8	10
Potential performance if no stoppages (hours/acre)	2.25	2.1	2.0
Average speed of machine during travel (miles/hour)	2	2.5	2.25
Number of workers in the team (carting turnips to storage point)	3	5	3

(1) This work, including the preparation of the notes was carried out by Messrs. R. Turner and R.D. Murray - Work Study specialists in the Economics Department. Assistance in the field was given by the Area Mechanisation Advisers.

(2) Machines 1 and 2 were the same make of machine.

Reports on the machines are summarised in the following paragraphs.

Machine No. 1 was observed working on 2nd December, 1969, in a moderately sloping field in very wet conditions.

The machine was jointly owned by 3 farmers with about 12 acres of turnips each. It was in its third season and was estimated to have harvested about 100 acres to date. The machine was in good condition and had all the guards intact. The sprocket driving the spider above the lifting web had been replaced and was again requiring renewal. The same operator drove the machine on each of the 3 farms.

The main cause of the stoppages was probably the very wet conditions, the turnips and wet earth tending to pile up on the lifting elevator. This occurred more frequently on the downhill runs, where 87% of the total stoppages took place. This may have been due to the increased slope on the elevator being too great under the heavy conditions. From time to time the floating roller at the top of the lifting web required clearing, and occasionally a turnip wedged between the fingers at the top end of the loading elevator. The crop consisted of green topped swedes and had been previously grazed by sheep. For this reason the shaws were not in themselves a source of trouble.

The harvester was drawn by a Massey-Ferguson 165 tractor. A tractor and trailer drove alongside the machine, the trailer being filled normally in one drill length. The full trailer was driven to the field clamp adjacent to the N.E. corner of the break. After the machine made its headland turn the second tractor and trailer manoeuvred into position.

The work of Machine No. 2 was observed on 19th November, 1969, working in a nearly level field.

The machine was 3 years old and it was estimated that it had covered about 100 acres. The web was the original one. It was old and worn and required replacement. This was probably the main cause of the stoppages, as tops were sticking at the floating roller at the point of discharge to the loading elevator, instead of falling on to the ground. The type of turnip was purple top swede and these are said to be variable in size and are liable to lie to one side and be out of line in the drill. This also tends to bring shaws into the machine and is another possible cause of choking.

The machine was drawn by a Massey-Ferguson 165 tractor. One man sat on the machine, clearing the shaws, but even this did not prevent some stoppages. If the machine were working correctly his services would probably not have been required. A tractor and trailer drove alongside the machine and when the trailer was full, another took its place. Three men with three tractors and trailers were required for this and they drove the turnips to the pits some 150 yards away. They usually spent some time waiting till the previous trailer was filled, but this waiting time would be less if stoppages were reduced.

Machine No. 3 was observed working on 10th February, 1970, in a moderately sloping field under good conditions.

The machine was in its seventh season and was estimated to have harvested about 550 acres to date.

There were three causes of stoppages:

(a) Turnips jammed at the large rotary disc or at the foot of the elevator.

(b) Trash, mainly dead weed stalks, became entangled in the rotating parts. The opportunity was occasionally taken before starting a new drill or while awaiting a trailer at changeover, to clear this.

(c) The tension of the driving belts had to be adjusted and the replacement of the trimmer belt was attempted but a belt of the correct size was not available.

The crop was of purple topped swedes and at this advanced stage of the season there were hardly any shaws and they therefore caused no trouble.

The harvester was drawn by a Massey-Ferguson 35 tractor. Two Massey-Ferguson 135 tractors each with a trailer alternately drove alongside the machine, when one trailer was full the other took its place. The turnips were driven to the steading about $\frac{1}{4}$ mile away.

Although the machine was lifting reasonably well, a number of turnips were left in the field; some overshot the trailer from the top of the elevator and some fell off overfull trailers. However, as young dairy stock were to be put into the field to clean it up, this was not a serious problem.

A further new machine was observed working in good conditions in a slightly sloping field on the afternoon of 29th January, 1970. Apart from the fact that it was working in much shorter drills (90 yards long) in the remaining corner of the turnip field its performance appeared better than any of these in Table IV. Stoppages observed were under 5 minutes per hour and the potential performance was roughly estimated to be just under 2 hours per acre. The crop yield was estimated from trailer loads at 30 tons per acre, the drills were 26 inches wide and the average speed of travel was around 2 to $2\frac{1}{4}$ m.p.h. The land was light and free of stones and at this advanced stage of the season the shaws had virtually withered away and gave no trouble. The crop was green topped swedes and two men with tractors and trailers kept the harvester going but with the short drills involving more frequent turning of the machine, on odd occasions a tractor and trailer had to wait till the preceding one was full.

The farmer co-operators who used complete turnip harvesters whether hired or owned were satisfied with their performance and as long as the roots are not harvested during frosty weather they keep reasonably well. The turnip crop is one which need not be hastily harvested, in south western areas where severe frost is unusual and indeed those who had machines of their own preferred to harvest the roots in batches as required, as in this way they do keep better.

APPENDIX 3

Table V

Range of Contract Charges and Rates of pay for Casual Labour

Operation	Range of Contractors' charges
Dung Spreading	£18 to cart and spread dung on $4\frac{3}{4}$ acre turnip field
Ploughing	£9 for 5 acres to £2.25 per acre using 3 furrow plough
Rotovating	38/- per hour and from £1.35 to £2 per acre
Spreading Fertilisers	30/- per ton or included in fertiliser price
Sowing Turnip Seed (Contractor's) (precision Sower)	30/- per acre by Contractor
Topping and Tailing	£3 - £5 per acre for hire of machine, tractor and operator
Complete Harvester	£8 - £10 per acre for hire of machine, tractor and operator
Hire of Tractor and trailer for carting in crop	£5 per day for Tractor, trailer and Tractorman (Crop harvested by Complete Harvester)
Operation	**Range of Charges for Casual Workers**
Singling	1/9 to 3/- per 100 yds. and 3/- to 5/- per hour
Shawing by hand	1/10 to 3/6 per 100 yds. and 5/- to 7/- per hour
Shawing by gang at rate per acre	£6 to £15 per acre

APPENDIX 4

Table VI

Costs of crop per acre at various stages according to crop treatment

	Crops Shawed by Hand	Mechanically Harvested			Folded by Sheep	
		Topped and Tailed	Complete Harvester by Contractor	Complete Harvester by Farmer	Singled	Not Singled
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
	£					
Cost of crop in ground	18.76	20.80	16.44	14.51	20.17	13.33
Cost of singling and all row crop work	8.81	7.66	9.07	8.48	6.97	3.16
Cost of crop ready to harvest	27.57	28.46	25.51	22.99	27.14	16.49
Rent Charge	5.00	5.00	5.00	5.00	5.00	5.00
Specialised Machinery Charges	1.56	3.77	1.52	3.67	1.03	0.75
Cost of Harvesting and Storage	18.40	11.86	15.96	6.68	-	-
Total cost/acre excl. Overheads	52.53	49.09	47.99	38.34	33.17	22.24
Total cost/ton excl. Overheads (30 ton yield)	1.75	1.64	1.60	1.28	-	-
Total cost/acre Overheads @ £10	62.53	59.09	57.99	48.34	43.17	32.34
Total cost/ton Overheads @ £10 (30 ton yield)	2.08	1.97	1.93	1.61	-	-
Total cost/acre Overheads @ £20	72.53	69.09	67.99	58.34	-	-
Total cost/ton Overheads @ £20 (30 ton yield)	2.42	2.30	2.27	1.94	-	-