Silage Cost of production

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R E P O R T

on

ECONOMICS OF SILAGE MAKING IN THE EAST OF SCOTLAND, 1951

by

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ECONOMICS OF SILAGE MAKING IN THE EAST OF SCOTLAND 1951

C O N T E N T S

I. SUMMARY

1. This report on the economics of silage in 1951 opens with an introduction illustrating the growth of silage making in Scotland in recent years - a useful background for the work of silage costing. Included also are some short notes on how, on some farms, silage could be the solution to the problem of obtaining greater food pro-:duction.

2. The 25 farms included in the survey are all in the area served by the Edinburgh and East of Scotland College of Agriculture. Eighteen of these are arable/stock farms where no milk is produced for sale: the remaining 7 are dairy farms. Nineteen farmers made grass silage only, 4 made arable silage only and 2 made both arable and grass silage.

3. Altogether 693 acres of silage were costed in 1951, 574 acres of grass silage and 119 acres of arable silage. The average acreage of grass silage costed was 27.36 and the average acreage of arable silage costed was 19.75.

4. Costs of production are set out in detail. The average costs were £2. 4.10d. per ton for grass silage (single cut) and £2.14s. per ton for arable silage, though there were considerable variations from farm to farm.

5. Of the factors affecting cost of production yield is the most important. With yields of over 5 tons per acre, average costs per ton are £1.18. 9d.; with yields of less than 5 tons per acre, average costs per ton are £2.12.10d.

6. Harvesting costs vary considerably from farm to farm, particularly where different methods of mechanising the process have been adopted.

7. A later section of the report deals with work organ-:isation at harvest time, and contains information on team sizes (labour and equipment) required with the two main mechanical methods of harvesting - by buckrake and by green-:crop loader, with notes on output per hour. It also refers to the types of silos used by the farmers in the survey and also states the relative costs of the different types. The importance of siting the silo properly is also stressed.

8. The feeding value of silage is explained with par-:ticular reference

   (a) to the dairy farmer's requirements,
   (b) to the feeding farmer's requirements,

   a short comparison of roots and silage being added.

9. The choice of silage crop "Arable or Grass?" is a question now being asked by many farmers. The report tries to answer this by stating some of the principles upon which a reasonable choice might be based.

10. Inquiries have been made during the past winter on the utilisation of silage and it is hoped to deal with this in a later report, now in preparation.

II. INTRODUCTION

In the last decade every report on grassland and grass conservation seems to have begun by illustrating the need for increased stock food production and stressing the important part that grass can play in this connection. While this report is no exception to the rule in that the importance of increased pro-:duction, especially from grassland, is fully realised, it is felt that any further statement here of the general position of feeding stuffs supply can add very little of value to what has already been well said elsewhere and to what is now, in any case, widely realised as fact by the farming community.

Discussion in this report will therefore be confined to the particular problems which arise on the farms where silage is grown or is being proposed as a possible crop. Such questions as cost of production, the type of equipment necessary and the utili-:sation value of silage will be discussed in the appropriate sections and it is hoped that by giving at least a partial answer to some of these, this report on the 1951 crop - the second of a series - may be of some assistance to farmers in planning their drive for increased production with the aid of silage.

Although the figures included here are taken from an investigation confined to the East and South East of Scotland, it is of interest to note from Table I. below how silage production in the whole of Scotland has risen in the last few years. Since silage can be regarded as an alternative food for a proportion of bought-in feeding stuffs, the prices of High Protein Cake (33% Crude Protein) and Medium Protein Cake (16% Crude Protein) are also given for comparison.

TABLE I.

Year	Grass Silage Production in Scotland	Cost of Bought Concentrates per Ton	
		High Protein Cake 33% Crude Protein	Medium Protein Cake 16% Crude Protein
	Tons	£ s. d.	£ s. d.
1939	Not Known	8.12. 6	5. 7. 6
1945	30,200	11. 7. 6	8. 5. -
1947	48,700	11.19. 6	8. 5. -
1948	73,300	12. 4. 6	8. 5. -
1949	102,100	12. 5. -	8. 7. 6
1950	142,758	24. 2. 6	16. 2. 6
1951	187,293	35.17. 6	28. 7. 6

(The figures relating to Silage Production in Scotland 1940-50 are taken from A.M. MacKenzie's article in "Farm Economics", Autumn, 1950)

Very little reduction in the tonnage of roots produced has taken place over the same period but hay tonnage has gone down by 75,000 tons or approximately 10% of total production. With grass silage production in 1951 of 187,293 tons, this means a considerable total increase in the quantity of stock food produced. In addition to grass silage 70,861 tons of arable silage were produced in 1951.

When the question of increased production on the farm is raised, it is natural to see what can be done to increase the acreage of such crops as roots and hay, long established in the farmer's favour and usually well managed; but in most cases it is impossible to increase the production of winter stock food from these, since in /

in growing even the present acreage, the resources of farm power and labour are often already strained to the utmost. Farmers, struggling against the bad haymaking weather, often year after year, cannot risk increased expenditure and labour on a bigger acreage of hay which will make harvesting in good condition more fraught with risk than ever. In addition root growers, faced with harvesting potatoes, sugar beet and, perhaps, the last part of the grain harvest at the time when fodder root lifting should be going on, will be averse to growing still more roots. If increased pro-:duction of roots and hay is impracticable or inadvisable, grass is the best alternative.

This crop has in the past been very much neglected, but, by the application of new techniques, production per acre can now be very considerably increased. Before the introduction of silage and grass drying, hay was the only method of conserving for winter feed that part of the Spring flush of grass which was in excess of grazing requirements at the time. Unfortunately a large acreage was apt to mature all at once with the result that, in our weather conditions, only part of it could be saved in good condition before the weather broke, causing much of the remainder to be of poor final quality. By contrast, the policy of making part of the excess grass into silage before the grass matures and then making the remainder into hay has not only led to good silage and better hay - since less hay has to be put up in the short period of good weather - but also to a considerable smoothing out of labour peaks. In this way, it might well be said that the silage and hay crops are com-:plementary to one another.

If part of the root break is replaced by silage, the labour normally available for hoeing the roots would be diverted to silage making. At root harvesting time this in turn saves a considerable amount of labour when it is perhaps most needed - i.e. in the short days of October, November and December for the tasks of potato and sugar beet lifting (or for delayed grain harvest operations). Going back to summer, the altered sequence of farm operations could now be Silage - Root Thinning (reduced) and Hay Making (reduced) - Silage (second cut). In this way the good quality of the several crops is more assured, so leading to an increased production of nutrients per acre. The practical solution to the problem of increased production may well lie in the more widespread adoption of silage making, either as an addition to or a partial substitute for part of the present acreage of roots and hay.

III. DESCRIPTION OF THE FARMS COSTED IN THE SURVEY

Twenty-five farmers in the College area comprising the eleven counties of East and South East Scotland co-operated with the staff of the Economics Department by furnishing them with complete records of the operations involved in growing and harvesting their silage crops. Of these farmers, nineteen made grass silage only, four made arable silage only and two made both arable and grass silage. Altogether 693 acres were costed in 1951, 574 acres of grass silage and 119 acres of arable silage.

The silage was fed entirely to cattle, since the feeding of silage to sheep has as yet not gained very much popularity with sheep farmers. Seven of the farms were dairy farms where the sale of milk was the main source of income, and eighteen were cattle rearing or feeding farms where no milk was produced for sale. Most of the farms had acreages of cash crops in addition to the acreage set aside for fodder crop production.

The distribution of the farms over the College area, and the acreage of silage costed per farm are illustrated in Table II.

TABLE II. /

TABLE II.

County	Under 20 Acres	20 - 40 Acres	40 - 60 Acres	County Totals
Midlothian	1	1	1	3
East Lothian	-	2	1	3
West Lothian	-	1	-	1
Roxburgh	1	-	-	1
Berwick	-	2	1	3
Perth	1	6	-	7
Fife	1	1	-	2
Angus	2	2	1	5
TOTALS	6	15	4	25

The farms included in the survey were all fairly large as far as scale of silage making operations was concerned, none of the silage crops costed being below 10 acres in extent. The average acreage of grass silage costed was 27.36 acres per farm and that of arable silage 19.75 acres per farm. The majority of the crops, 13 in number, costed were between 20 and 30 acres. It is unfortunate that figures representative of the smaller types of farm and of smaller acreages per farm were not available this year, but it is hoped to correct this in future surveys.

IV. COSTS OF PRODUCTION

In the following tables, average costs of production per acre are set out, including, in the case of grass silage, a share of the cost of establishment of the grass ley.

The basis of these costs was as follows:-

1. Labour and Power

(a) Manual labour charges were based on the actual rates of wages paid to the workers concerned on each particular farm.

(b) Tractor and horse labour charges were made in all cases in accordance with the following basic rates:-

	Per Hour
Tractor, wheeled	4/3d.
Tractor, track-layer	6/3d.
Horse	1/6d.

2. Overheads

These were charged in accordance with the rates agreed upon by the Scottish Conference of Agricultural Economists.

3. Deduction for Grazing and Residual Values

In the case of deductions for grazing, the practice adopted here was slightly different from the 1950 report. If a field was grazed before and after cutting for silage, half the cost of growing the grass was charged to silage. If only grazed after-:wards, two-thirds of the cost of growing the grass was charged to the silage.

Residual values for grassland were based on the length of time for which the ley had been down, the annual deduction being greatest in the case of the first year and decreasing in the later years of the ley.

Residual /

Residual values in respect of fertilisers applied were based on the tables given in Advisory Leaflet No. 11 of the Department of Agriculture for Scotland.

TABLE III. SILAGE - AVERAGE COSTS PER ACRE, 1951 CROP

	Grass Silage	Arable Silage
	£ s. d.	£ s. d.
Power :		
Man	1.19. 1	3.13.10
Horse	-. 2. 2	-. 5. 4
Tractor	1.14.10	2.17.10
Rent	1. 9. 1	1.12. 6
Seeds	1. 8. 2	5. 7. 2
Manures : (including residual values, cost of application and top dressings	4.12. 4	3.11. 9
Overheads	3. 4. 8	4.17. -
Miscellaneous : (including special equipment depreciation)	-.17.11	1.15. 6
	15. 8. 3	24. -.11
Less : Residual Values	1. -. 7	Nil
Less : Share to Grazing	3. 1. -	Nil
NET COST OF SILAGE (up to and including harvesting)	£11. 6. 8	£24. -.11
Number of Records	21	6
Total Acreage	574	119
Average Acreage costed per farm	27.36	19.75
Average Yield per Acre	5.25 tons	9.25 tons
Average Cost per Ton	£2. 4.10	£2.14. -

It will be seen that in the case of grass silage the average cost per acre worked out at £11. 6. 8d., the average yield at 5¼ tons per acre and the average cost per ton at £2. 4.10d. As to arable silage the average cost per acre was £24. -.11d., the average yield was 9¼ tons and the average cost per ton £2.14s.

In 1950 the average cost per acre of grass silage was £10. 5. 1d. and the average cost per ton was £2. 2. 6d. The average yield was 4.86 tons per acre. The corresponding figures for arable silage were £24. 3. 1d. average cost per acre, £2.16. 7d. average cost per ton and a yield per acre of 8.7 tons.

There was a considerable deviation from the average in both cost and yield figures.

(a) Grass Silage

The highest cost per acre was £16. 9. 2d. and the lowest £5. 6.10d. /

£5. 6.10d. The highest cost per ton was £3. 7. 6d. and the lowest was £1. 7. 6d. The factor which was largely responsible for the range in the cost per ton of silage was the yield per acre. Yields varied from 2.4 tons to 8.9 tons per acre.

(b) Arable Silage

The range in costs per acre here was much less than it was in the case of grass silage, the highest cost per acre being £26.10. 2d. and the lowest £21. 8.10d. The highest cost per ton was £3.13. 8d. and the lowest was £1.17. 2d. Variations in yield, like variations in costs per acre, were less than in the case of grass silage, the highest being 13 tons per acre and the lowest 7 tons.

Cost of Second Cut Grass Silage

In 1950, nine cost records of second cut grass silage were available and a reasonable sample was thus obtained. In 1951, however, only two such costs were obtained and so the average figure derived from such a small sample must be treated with reserve. The average figures for 1951 second cut silage were as shown in Column "A". To put the second cut figures into perspective the corresponding figures for the first cuts of silage on the two farms are shown in Column "B".

	"A" (second cut) (2 cases)	"B" (first cut) (2 cases)
Cost per Acre	£10. 1. 4	£10.16.11
Cost per Ton	£ 2. 1.11	£ 2. 1. 2
Yield per Acre	4.8 tons	6.25 tons
Total Acreage costed	43.5 acres	43.5 acres
Average Acreage costed	21.75 "	21.75 "

It will be seen that there is very little difference in cost per ton of first and second cut silage.

Distribution of Costs per Acre

Not only does the total cost per acre of grass silage differ markedly from that of arable silage - the latter being fully double the former - but the percentage composition of total costs shows wide contrasts.

To illustrate this difference Table IV. has been drawn up but, before referring to this, it may be advisable to point out that the costs structure is different from that in Table III. and comprises the following items:-

1. Establishment Costs

These are the costs of labour, power and seed used in the sowing down of the crop, plus appropriate overheads. In the case of arable silage, which is a one-year crop, the total establishment costs are charged to the current year. In the case of grass silage the ley concerned may be down for several years and only part of the total establishment costs can be charged to the current year. This is the "Share to Current Year" and is calculated thus -

$$\text{Share to Current Year} = \frac{\text{Total Establishment Costs}}{\text{Length of Ley (in years)}}$$

2. Basic Costs

These are made up of items chargeable solely to the current /

current year and necessary for the production of the crop and include rent, residual values of manures applied in previous years, the appropriate share of manures applied in the current year (excepting nitrogenous manures : see "Top Dressing") and overheads charged where applicable.

3. Top Dressing

The amount of this is shown as a separate item, the item Top Dressing referring to applications of purely nitrogenous manure made in the current year.

4. Harvesting Costs

The items included in harvesting costs are solely those of the labour and power used plus the appropriate overheads.

5. Miscellaneous Costs

Under this heading are included the depreciation of equip-:ment or capital structures used solely in connection with the silage crop (e.g. crop loaders, silage pits, etc.), and miscellaneous items of cost such as molasses, binder twine, repairs to pits etc.

TABLE IV. DISTRIBUTION OF SILAGE COSTS PER ACRE

	Grass Silage		Arable Silage	
	£ s. d.	% of total cost	£ s. d.	% of total cost
1. Establishment Costs:				
Labour - Man	-. 3. 1		-.11.10	
Horse	-. -.10		-. 3.10	
Tractor	-. 2. 1		-.14. 4	
Overheads	-. 3. 3		1. -. 9	
Seed	3.18. 9		5. 7. 2	
TOTAL	£4. 8. -		£7.17.11	
Share to Current Year	£1.11. 6	13.9%	£7.17.11	32.8%
2. Basic Costs:				
Rent (incl. rental overheads)	2. 4. 4		2. 8. 1	
Manures	3.16. -		3.15.11	
TOTAL	£6. -. 4	53.1%	£6. 4. -	25.8%
3. Top Dressing:	-.19. 7	8.6%	Nil	Nil
4. Harvesting Costs:				
Labour - Man	1.18. -		3. 2. 1	
Horse	-. 1.11		-. 1. 6	
Tractor	1.14. 1		2. 3. 6	
Overheads	2. 4.11		2.16. 5	
TOTAL	£5.18.11	52.5%	£8. 3. 6	34%
5. Miscellaneous Costs:	-.17.11	7.9%	1.15. 6	7.4%
TOTAL	£15. 8. 3	136%	£24. -.11	100%
Less:				
Residual Value	1. -. 7	9.1%	Nil	Nil
Share to Grazing	3. 1. -	26.9%	Nil	Nil
TOTAL	£11. 6. 8	100%	£24. -.11	100%

From /

From Table IV. it is seen that in the case of arable silage establishment costs, being charged for one year only, form a considerably larger proportion of the total costs per acre than they do in the case of grass silage where costs of establishment are generally spread over several years. The actual percentages are respectively 32.8% and 13.9% of total costs.

The basic costs, rent and manures, form only 25.8% of the total costs of growing arable silage but 53.1% of the cost of growing grass silage to which must be added a further 8.6% spent on top dressing with nitrogenous manures, these two items thus making up 61.7% of the cost of growing grass silage compared with 25.8% in the case of arable silage. However, against part of this 61.7% could be offset the 36% deductions for grazing and the residual values of the grassland.

Harvesting costs again do not make up as large a pro-:portion of the total cost of growing arable silage as they do in the growing cost of grass silage, the respective figures being 34% and 52.5%.

These percentage figures are important in that emphasis can be put on the factors which constitute the major part of the total costs. For instance, harvesting costs at 52.5% of total costs are relatively much more important in the case of grass silage than they are in the case of arable silage where the percentage is 34%. Hence, improvements in harvesting technique resulting in lower costs will be relatively more important in the case of grass silage than in the case of arable silage.

V. FACTORS AFFECTING COSTS OF PRODUCTION

(i) Yield per acre

Other factors being equal, the most important factor influencing the cost per ton of grass silage is the yield per acre, as is seen from a study of Table V.

TABLE V. VARIATION OF COSTS WITH YIELDS - GRASS SILAGE, 1951 CROP

Yields per acre	Range of Costs per Ton					Total Number of Costs	Average Cost per Ton
	20/- to 30/-	30/- to 40/-	40/- to 50/-	50/- to 60/-	60/- to 70/-		
Tons	Number of Costs						£ s. d.
2 - 3			1	1		2	2.10. 2
3 - 4	1			1		2	2. 1. 4
4 - 5				3	2	5	2.18. 6
5 - 6		3	2			5	2. 1. 4
6 - 7		1				1	1.12. 4
7 - 8	1	1	3			5	1.17. 9
Over 8		1				1	1.17.11
TOTAL	2	6	6	5	2	21	£2. 4.10

Because /

Because of the manifest imperfections of the above table due to the smallness of the sample of farms studied - unlike last year # it does not show the same even gradation from high costs per ton where yields are low to low costs per ton where yields are high - it still gives unmistakable evidence of the economy of high yields. Actually, the nine crops costed with yields below 5 tons per acre showed an average cost of £2.12.10d. per ton; the eleven crops costed with yields above 5 tons per acre, had an average cost of £1.18. 9d. per ton i.e. 14/1d. per ton cheaper.

In the case of arable silage also, the position is much the same. Here the highest cost per ton, £3.13. 8d., was obtained with a yield of 7 tons per acre, and the lowest cost per ton, £1.17. 2d., was obtained with the highest yield per acre in our sample - 13 tons per acre.

(ii) Harvesting Costs

In order to consider harvesting costs, it is advisable to classify the farms costed into two main groups viz. first those which, on the one hand, employed mechanical aids such as greencrop loaders, buckrakes etc., and, secondly, those which, on the other hand, relied on manual labour unaided by such special machinery.

Between these groups there is considerable variation in cost; and also, with the group of farms whose silage harvesting is highly mechanised, there are differences between the farms using different machines. To show these variations, Tables VI(a). and VI(b). have been set out, relating respectively to grass silage and arable silage.

TABLE VI(a). HARVESTING COSTS : GRASS SILAGE, 1951 CROP

Harvesting Equipment Used	No. of Costs	Yield	Harvesting Costs/Acre	Harvesting Costs/Ton
		tons/acre		
Buckrake	7	5.5	£6. -. 2	£1. 1.10
Green Crop Loader	12	5.84	£7. 2. 7	£1. 4. 5
Manual	1	2.4	£3. 9. -	£1. 8. 9

TABLE VI(b). HARVESTING COSTS : ARABLE SILAGE, 1951 CROP

Harvesting Equipment Used	No. of Costs	Yield	Harvesting Costs/Acre	Harvesting Costs/Ton
		tons/acre		
Binder	4	9.37	£8. 6. 6	£-.17. 9
Green Crop Loader	1	9	£11. 7. 2	£1. 5. 3
Buckrake	1	9	£8. -. 2	£-.17. 9

Although Table VI(a). gives a valid basis of comparison of the two main methods of mechanising the silage harvest - the buckrake and the green crop loader - Table VI(b)., unfortunately, is based on too small a number of records to be of much value. The harvesting /

See earlier Report "Economics of Silage Making in the East of Scotland, 1950"

harvesting costs in both tables are made up of labour and power costs with appropriate overheads, the cost of depreciation of the equipment used, and the cost of binder twine in the cases where binders were used. From Table VI(a). it would appear that harvesting by buckrake is more economical than harvesting by green crop loader, but to complete the comparison it is necessary to consider the siting of the pit. Where the pit is in the field, and the distances covered in transport - as distinct from loading - are small, then undoubtedly the buckrake is the more efficient machine. But in winter time when the silage has to be carted to the steading every day there is considerable extra expenditure. By siting the silo at the steading this extra expenditure can be eliminated but this may give rise to a good deal of haulage between the field and the steading at harvest time. In this case the silage must be transported in as large loads as possible and in such circumstances the green crop loader may well prove to be the more efficient machine.

(iii) Costs of Establishment

As was pointed out in the 1950 report, there are wide variations in the "Share to Current Year" charges for grass silage according to the length of the ley. The longer the ley, the less is the cost per ton - so long as other factors, such as the yield and vigour of the ley, remain the same.

The highest "Share to Current Year" in 1951 was £3.5.3d. per acre - in this case a one-year ley. The lowest was 13/3d. for a six-year ley. The difference between these two is con-:siderable - amounting to £2.12s. per acre or more than 10s. per ton when spread over a 5-ton per acre yield.

(iv) Deductions for Grazing and Residual Values

Since, in our costs, allowances for the above items vary according to the treatment of the grass, variations in grassland management can cause quite considerable differences in the cost of silage. In the case of arable silage no deductions for grazing were made, and residual values were calculated on manurial applications alone. In the case of grass silage deductions for grazing varied, sometimes amounting to as much as two-thirds, sometimes only $\frac{1}{3}$, according to the intensity of the grazing. Besides deductions for manurial application, a deduction for the residual value of the grassland is made amounting to £2.2s. per acre for 1st-year grass and gradually increasing by annual increments as the grass becomes older up to about the eighth year when the residual value - on ploughing up - is reckoned to be £3.2s. per acre.

The actual amounts deducted for grazing varied from £8.10s. to £1.-.3d. with an average deduction of £3.1s. per acre.

(v) Costs of Manuring

These varied very considerably according to the particular conditions of fertility etc. encountered in each farm. Such wide differences exist that it is worth while to note that the highest manuring cost for grass silage was £8.14.9d. per acre plus £2. 9.11d. per acre for nitrogenous top dressing - a total of £11. 4. 8d. per acre. The yield in this case was 8.9 tons of grass silage per acre. The lowest manuring cost was £1.16. 4d. per acre and no top dressing was applied here. The yield in this case was 3.9 tons per acre. Average figures for manurial applic-:ations to grass silage were £3.16s. plus 19/7d. for top dressing.

In the case of arable silage the highest manurial cost was £8.12. 4d. per acre and the lowest was nothing at all. The average cost was £3.15.11d. per acre.

VI. ORGANISATION AND EQUIPMENT REQUIRED FOR SILAGE HARVESTING

This section of the report will be dealt with in two sections, the first dealing with field equipment and organisation, the second with the silo itself.

Field Equipment and Organisation

Field Equipment

One of the most striking features of silage making which the surveys of 1950 and 1951 have brought out is the degree to which the process of harvesting has been mechanised. Two machines, the buckrake and the green crop loader have been adopted very generally. This year, out of the twenty-one farmers whose grass silage was costed, seven harvested their silage with buck-:rakes, thirteen used green crop loaders and only the sole remaining farmer relied on manual labour alone for harvesting. The capital costs of these items of equipment are respectively £30 - £40 for each buckrake and £130 - £160 approximately for each green crop loader. These figures, however, do vary according to the make of the individual machine.

As far as field working is concerned Tables VII(a). and VII(b). give harvesting data according to the different machines employed.

TABLE VII(a). HARVESTING DATA : GRASS SILAGE, 1951 CROP

Harvesting Method Used	No. of Farms	Acreage per Farm	Tonnage per Farm	Yield per Acre	Man Hours	Tractor Hours	Horse Hours
				tons	- - - Per Acre - - -		
Buckrake	7	30.5	160	5.5	14.22	8.45	0.63
Green Crop Loader	12	25.7	147	5.84	16.8	8.38	1.1
Manual	1	18.5	45	2.4	13.1	-	8.6

TABLE VII(b). HARVESTING DATA : ARABLE SILAGE, 1951 CROP

Harvesting Method Used	No. of Farms	Acreage per Farm	Tonnage per Farm	Yield per Acre	Man Hours	Tractor Hours	Horse Hours
				tons	- - - Per Acre - - -		
Binder	4	21.37	187.5	9.37	26.3	8.1	1.5
Buckrake	1	20	180	9	18.0	12.0	-
Green Crop Loader	1	13	117	9	29.8	15.9	-

In Table VII(a). the comparison is in effect limited to the buckrake and green crop loader. Perhaps the main point of this table is that it shows that the buckrake and the green crop loader have been adopted equally readily on farms making silage on a fairly big scale - 30.5 acres per farm where buckrakes are employed and 25.7 acres for farms favouring green crop loaders. The average yield per acre of silage harvested is very similar in both cases. As to draft power, the buckrake seems to be somewhat more economical of man hours per acre than the green crop loader.

Regarding power requirements for each of the main methods it is interesting to note how the ratio of man hours to tractor hours /

hours varies. For binders the ratio is 3:1, for green crop loaders 2:1 and for buckrakes $1\frac{1}{2}$:1, these figures indicating the degree to which mechanisation of the process has occurred. However, rather than basing his choice of method on the degree to which silage harvesting can be mechanised, the farmer would probably consider the following two factors as being more important.

Firstly, the siting of the silo and the distance of the silage field from the silo, and secondly, the total size of team required.

Given the silage pit in the field, the buckrake is pro-:bably the most efficient machine since the time occupied in trans-:port between picking up and unloading is very small. On the other hand if the silage pit or tower is at the steading, then the use of a buckrake would result in a high ratio of transport time to loading and unloading time which would, in turn, put up the cost of harvesting per ton of silage. With the use of a green crop loader, the transport time might not be reduced in total, but the transport time per ton of silage transported would be very much less, since bigger loads would be carried in the trailers than could be carried on the buckrakes. The use of a green crop loader when the silage pit is in the field will not be so successful as the use of a buckrake would be in these circumstances, since there would be a considerable wastage of time hitching and unhitching the loader. In addition the load itself being larger and more compacted would be more difficult to spread at the pit.

The team size involved at harvest time is the second factor which could influence choice. The average sizes of teams for grass silage with the two main methods were:-

With Buckrakes	5.85 men 4.00 tractors
" Green Crop Loaders	5.4 men 2.6 tractors 0.2 horses

These figures obviously provide a basis for choice on the number of tractors required. Where buckrakes were used, the average number of tractors was 4; where green crop loaders were used, it was 2.6 tractors. On the farm where a fairly large acreage of silage is grown, but where the number of tractors is limited, the choice would probably fall upon the green crop loader. This choice would be further justified if, as is pointed out above, the silo was some distance from the field. If, however, the larger number of tractors was available then the choice might well be the buckrake, particularly if the silo was in or near the field in which the silage crop was grown.

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Field Organisation

Some examples of field organisation at harvest time follow, first, those based on buckrakes, second, those based on green crop loaders.

1. With buckrakes -

The average output of silage moved per hour per buckrake was 0.96 tons. Two sizes of teams were used on the seven farms where buckrakes were used: (a) With one Buckrake
(b) With three Buckrakes.

(a) /

(a) One buckrake : Two tractor farm

On this farm the total acreage of silage cut was 16. The team consisted of one man with tractor and buckrake and one man at the pit, who, for one or two hours earlier in the day would have been cutting enough silage to keep the buckrake working for the remainder of the day. The amount of silage moved by the buckrake was 1.45 tons per hour.

Team : 2 men, 2 tractors, 1 buckrake, 1 mower.

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(b)i. Three buckrakes : Four tractor farm : Example I.

The first example here consisted of three farms where the silage was all cut by the same team working on one farm after the other. In this case the average amount of silage moved per hour was 0.95 tons per buckrake. The team consisted of one man and tractor cutting enough each day to keep the three buckrakes going and then spending the remainder of the day rolling and helping gen-:erally at the pit. The second man horse-raked the grass and also helped at the pit. The third man was permanently at the pit and three men with tractors and buckrakes brought the silage to the pit.

Team : 6 men, 4 tractors, 3 buckrakes, 1 mower, 1 horse and horse-rake.

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(b)ii. Three buckrakes : Four tractor farm : Example II.

This is an example of a farm where three buckrakes were used in the team and operated on the one farm only. The amount of silage moved per buckrake per hour here was 0.8 tons. The three tractors and buckrakes brought the silage to the pit where it was handled by a permanent team of one man and two women. The fifth man cut in the early part of the day and helped out at the pit later.

Team : 5 men, 2 women, 4 tractors, 3 buckrakes, 1 mower.

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2. With Green Crop Loaders

The output from green crop loaders, on average, was 2.45 tons per hour, considerably in excess of the average figure of 0.96 tons of silage shifted per hour with a buckrake.

(a) Two tractor farm

The team here consisted of the first man and tractor cutting enough silage for the day and then going to the pit to help there. The second man and tractor with trailer were engaged in loading with the help of the third man, and the fourth man was permanently at the pit. Output per hour was 1.5 tons - but the length of haul here was about 1 mile.

Team : 4 men, 2 tractors, 1 trailer, 1 green crop loader, 1 mower

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(b) /

(b) Three tractor farm

The team here was so arranged that the silage was cut by one man and one pair of horses. One man helped in the field with the loading, two men and two tractors and trailers were engaged in collecting and transport. One man was permanently engaged at the pit spreading and the final man spent his time with a tractor rolling the silage in the pit. Output 2.5 tons per hour.

Team : 6 men, 3 tractors, 1 pair of horses, 1 green crop loader, 2 trailers, 1 horse mower.

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The Silage Pit or Tower

In the survey, five farmers had tower silos and the remaining twenty used pit silos. This certainly stresses the popularity of the pit for making silage particularly since four of the five towers were built about 1925 and only one has been built since the war, in 1948. The reason for this popularity probably lies in the low initial cost incurred in the construction of pit silos compared with the cost of tower silos. The tower silo built in 1948 cost £800 plus £200 for a cutter blower. The necessity for a cutter blower with a tower silo is quite a big disadvantage for, in addition to its initial cost and high rate of depreciation it normally needs one of the farm tractors to drive it - reducing the field team accordingly and also making necessary at least one additional man to feed the machine and to look after the driving tractor. With a silage capacity of 200 tons this tower silo equipment works out at a cost of £5 per ton capacity. In last year's report the cost of a silage pit dug by farm labour in spare time worked out at 3/1d. per ton capacity - with sides unlined. With a bulldozer working the cost of a similar pit worked out at 2/- per ton capacity. When the sides of the pit were lined with brick the cost worked out at 10/- per ton capacity.

So, taking a farmer with 200 tons of silage crop to ensile from 40 acres, he can -

(a) construct a tower silo at a cost of £1,000

(b) " " lined pit silo at a cost of £100

(c) " " unlined pit silo at a cost of £32

However, to the low initial cost of the unlined pit must be added the cost of fairly regular maintenance of the silo walls etc. which does not occur with more permanent structures. It might be said that the life of an earthen pit is about five years, that of a lined pit perhaps 10 - 15 years, and that of a silage tower for a considerably longer period. A disadvantage of the pit is the cost of covering the silage once it has been ensiled. This does not need to be done so carefully in a silage tower. Costs of covering pits are not readily available, and those that are vary considerably. However, below are three fairly typical examples.

Pit No. 1. 55' long x 15' broad.

Covered with 6" earth .. 17 man hours
8 women hours
9 boy hours

Total Cost - £3.11. 7d. for 12 acres of silage.

Pit No. 2; 89' long x 21' broad.

Covered with special waterproof paper and straw bales .. 45 hours
Cost of paper .. £20
Total Cost £25.16. 1d. for 28 acres of silage.

Pit No. 3 75' long x 17' broad

Covered with dung and straw .. 37 man hours
17 horse hours
Total Cost .. £9.16. 3d. for 28 acres of silage
(No charge is made here for dung or straw)

Once the type of silo is decided upon it is very important to consider the site in relation to both winter feeding and to harvesting in summer.

For winter feeding it is obviously desirable to have the silo placed as near the steading as possible as much time can be wasted in winter through having to cart silage from pits sited in the silage fields at some distance from the steading. No detailed information on time wasted in this way is yet available but it is hoped that a winter silage utilisation survey being carried on at the moment may give us more data on the subject.

For ease in harvesting, however, the best place for the pit to be is in the field, but this may clash with the winter programme as mentioned above, and, therefore, the decision as to siting may have to be a compromise. As an example of how such a compromise can be struck, take the case of the farm where stock are outwintered. If the field in which the stock are to be outwintered contains the silage pit, then feeding time in winter can be very much reduced and, for ease in harvesting, the silage crop can be grown either in the same or an adjacent field.

VII. FEEDING VALUE OF SILAGE

In dealing with the feeding value of silage, we may with advantage consider the special needs of two types of farm most interested in it, viz. dairy farms and stock rearing and feeding farms.

On the Dairy Farm

The object of growing silage on the dairy farm is to feed most of it to highly productive animals - the dairy cows - the rest of it going to young stock which cannot be regarded as highly productive animals. The advantage of silage over other home-grown foodstuffs is that it is more highly concentrated, particularly in protein, which is perhaps the nutrient in shortest and most expensive supply on the dairy farm.

In 1950, the average % crude protein in silage was -

Grass Silage 13.1%

Arable Silage 10.8%

This means that as far as the dairy farmer is concerned, grass silage is better for his cows than is arable silage. Out of the seven dairy farmers taking part in the 1951 survey, only one made arable silage, the remaining six making grass silage.

We may cite as typical examples the rations containing silage fed to dairy stock - cows, in-calf heifers and bulling heifers - on a dairy farm growing no roots at all.

Stock /

Stock	Daily Rations	Comments
Dairy Cow	50 lb. grass silage 15 lb. draff 3 lb. beet pulp	This provides 11.8 lb. starch equivalent and 1.65 lb. protein equivalent - enough for maintenance and 2 gallons of milk. For each additional gallon, a mixture of beans and oats is fed at the rate of 4 lb. to the gallon.
In-calf Heifer (2 yrs. old)	30 lb. silage 15 lb. straw (oat)	To raise the protein quantity, some cake is added when necessary near to calving time.
Heifer Stirk (1 yr. old)	20 lb. silage 8 lb. good hay	A little cake will be fed if required. With medium quality silage this should not be necessary.

With a rationing plan arranged as above, the farmer with a self-contained herd will have to budget for 4 tons of silage for each cow, $2\frac{1}{2}$ tons for each two year old heifer and $1\frac{1}{2}$ tons for each 1 year old heifer for the winter feeding period of 180 days. For a herd of 30 milking cows, 10 two year old heifers, 10 one year old heifers and 10 under one year olds, the acreage of grassland cut once for silage with a yield of 5 tons per acre would be 32. With grassland cut twice for silage the acreage required at a yield of 9 tons per acre would be 18. To provide the same amount of energy as the 160 tons of grass silage, about 275 tons of swedes costing £550 would have to be grown - assuming an acreage cost of £40 and a 20 tons per acre yield. The cost of 360 tons of grass silage at the average cost figures would be £360.

(The starch equivalent values assumed here are 12 for grass silage and 7 for swedes).

To provide the same amount of protein equivalent about 450 tons of swedes would have to be grown at a cost of £900. (The protein equivalent values assumed here are 2.0 for grass silage and 0.7 for swedes).

The above example of a farm rationing plan is perhaps an extreme case, where roots and hay were replaced almost entirely by silage (some hay was fed to the younger stock) and is not sufficiently representative of general practice. More usually some roots are fed along with silage, the latter thus forming only a part of the daily ration. In such cases, the estimate given for the acreage of silage required would therefore have to be correspondingly reduced.

On the Rearing and Feeding Farm

When making the choice of silage to use on farms of this type it should be remembered that the animals are not in the same "high production category" as are dairy cows. Therefore, in spite of its slightly higher cost, arable silage is often chosen in preference to grass silage for the feeding of such animals because of its higher yield per acre. Roots are seldom replaced entirely by silage in the feeding of fattening animals, and a daily ration is fed which includes both roots and silage. As an example take the following:-

Ration 1. /

Ration 1. Fattening Animal (10-11 cwts.) : 40 lb. Arable silage
40 lb. Swedes
12 lb. Oat straw
3 lb. Cake

For the average winter feeding period of 150 days* this ration will amount in total to $2\frac{3}{4}$ tons of silage and $2\frac{3}{4}$ tons of roots instead of $6\frac{3}{4}$ tons of roots as would formerly have been fed at the daily rate of 100 lb. The cost would work out about £13.10s. for the roots ration at £2. per ton, and £12.18. 6d. for the mixed ration assuming arable silage to cost £2.14s. a ton. The acreage that would be involved would be about 0.3 acres of arable silage and 0.14 acres roots per head, compared with an acreage of about 0.34 acres roots with an "all-roots" ration. Thus with the mixed ration there is a bigger acreage involved in growing fodder and less is available for cash cropping. The degree to which this occurs in particular cases along with the other silage versus roots factors duscussed elsewhere in this report would probably decide whether arable silage would be adopted or not, as a fodder crop.

Ration 2. Rearing Cow : 25 lb. Silage
45 lb. Swedes
10 lb. Hay
plus oat straw to fill up.

This is an example of a ration fed which does not contain as much silage in proportion to roots as does Ration 1 in this section. The acreage of silage necessary to supply this would be correspondingly less.

VIII. CHOICE OF SILAGE CROP

In deciding which type of silage should be used, grass or arable, a variety of considerations will influence the farmer's choice : the type of animal to which the silage is to be fed, comparative costs of production, problems of management and tech-:nique, and so on. Brief reference is made to these below.

1. Type of Animal to which Silage is Fed

Arable silage is fed mainly to feeding and rearing animals of which very high production is not demanded. This is shown by the fact that five out of the six farmers whose arable silage was costed were people with feeding or rearing farms - a ratio of 5 : 1. Out of seven dairy farmers concerned, six made grass silage and only one made arable silage - a ratio of 6 : 1. The reasons for this are probably twofold.

(i) Grass silage is, as a rule, of high protein content than is arable silage - a fact of importance when high-:producing dairy cows have to be fed as much as possible on home-grown foods.

(ii) The dairy farmer, more than any other stock farmer, has his numbers of stock more or less constant throughout the year. This means that he requires more grazing in the summertime than, say, fat stock farmers who practise the system of buying in stores in the autumn. With this big acreage of grass, the May/June flush of grass and its proper utilisation present a considerable problem. It can /

* "Economics of Livestock Production - Winter Fattening of Cattle, 1949-50" by J.A. Maclennan, B.Sc.

can certainly not be used for grazing unless extra stock is bought, so it is normally conserved for winter use. As pointed out in the introduction (Section II.), conservation of some of this as silage is probably the most practicable course to take to obtain full production per acre.

The beef producer or cattle rearing farmer, on the other hand, very often wants to keep his acreage of grassland and fodder crops to a minimum so that he can grow as much cash crop as possible. In addition he very often carries more stock in Autumn and Spring than he does in Summer and can do with very much less grazing in July and August than can the dairy farmer. His flush of grass in Spring is probably used up already in fattening on the grass those animals which were not finished in the courts, and thus these are graded before the summer shortage of grass occurs. Even with this relative shortage of grass enough is usually available for the reduced numbers of breeding and young stock now remaining.

For wintering his stock this type of farmer may prefer arable to grass silage since the former will give him about double the quantity of fodder per acre, compared with the latter, and so save a considerable acreage for cash crop. To him, the poorer protein quality of the former will not matter as the demands for protein of the rearing and fattening animal are considerably less than those of the dairy cow. The important nutrient factor is Starch Equivalent, and in mashlum silage the average figure for Starch Equivalent is 12.8% (Vetches and Oats mixture) compared with an average Starch Equivalent for short grass silage of 12.0% and for medium grass silage of 7.9%/

2. Comparative costs of production

Choice may also be influenced by a comparison of costs of production since it can be said that arable silage at the average cost of £2.14s. per ton is 9/2d. dearer per ton than is grass silage at £2. 4.10d. per ton, but again it must be stressed that when relative costs are considered, the quality of the silage, based on chemical analysis, must also be taken into account. For instance, the dairy farmer will be comparing silage samples on the basis of protein equivalent for which the cost per unit of feeding value figures will probably be in favour of grass silage production; and the rearing and fattening stock farmer will be making his comparison on the basis rather of starch equivalent, and in this case, the figures will probably be in favour of arable silage production in spite of the higher cost of production per ton.

3. Problems of management and technique

In addition to these more general reasons for choice stated above, there are many problems of technique which may influence the farmer's decision. The crop rotation itself may be a matter of importance. For instance, a one-year ley where the herbage is cut twice for silage will probably be a better cleaning crop than one year of arable silage. The annual weeds will be kept down with a year under grass, and the perennials will be considerably weakened by the double cutting. However, the fact that spraying can be applied to arable silage to keep down weeds may outweigh this advantage of grass silage although the additional cost of the spraying must be borne in mind.

Another purely technical reason for prefering either grass or arable silage may be the time of cutting of the crop. Grass silage is cut mainly at the end of May and in June, whereas arable silage is cut mainly at the end of July and the beginning of August. Arable /

/ Figures from Watson & More "Agriculture".

Arable silage in the current year has given rather unsatisfactory results in its preservation due to a considerable amount of over-:heating. This factor is inducing quite a few farmers who have been disappointed in this way to take up grass silage, where good preservation does not seem to be so difficult to attain.

Another reason which is put forward in support of arable silage on the feeding farm is the fact that if the grassland on the farm is used for grazing only, without any cut of silage being taken off it, and is left down, say, for 2 years, the indirect value of that grassland in increasing the fertility of the farm more than makes up for any direct loss incurred through not cutting. Stocking must, of course, be heavy to keep such young grass under control, particularly if heavy artificial manuring is practised.

While the function of this report is to stress mainly the economic considerations involved in silage making, it is important from the farm management standpoint to recognise how such practical conditions as those outlined above can affect the farmer's choice of silage crop.

Of equal importance to the farmer is the problem of the utilisation of silage for winter feeding. This has been the subject of investigation during the past winter, and it is hoped that this will be dealt with in a later report, now in preparation.

ACKNOWLEDGMENTS

Grateful acknowledgment is made to the farmers whose co-operation with the Economics Department staff in the keeping of the necessary field records made this report possible. Thanks are also extended to the county advisers who, by making suggestions regarding the content of the report, have been of great assistance to us. It is confidently hoped that the same consideration will be extended to us in the survey of grass conservation costs to be undertaken in 1952.
