Silage
Cost of production

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ECONOMICS OF SILAGE MAKING IN THE EAST OF SCOTLAND, 1952

by

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RECENT PUBLICATIONS

FINANCIAL RESULTS OF EAST OF SCOTLAND FARMS:-

Group	1946-47	1947-48	1948-49	1949-50	1950-51
	No. of farms				
1. Hill sheep farms 2. Stock-rearing farms	52	48	54	52	53
3. Stock-rearing and feeding farms 4. Arable farms 5. Dairy farms	153	143	184	175	178
	205	191	238	227	231

COSTS OF MILK PRODUCTION:- 1945-46, 1946-47, 1947-48, 1948-49, 1949-50, 1950-51.

ECONOMICS OF LIVESTOCK PRODUCTION:-

(a) Winter Fattening of Sheep: 1947-48, 1948-49, 1949-50.
(b) Winter Fattening of Cattle: 1947-48, 1948-49, 1949-50.
(c) Commercial Egg Production: 1949-50, 1950-51, 1951-52.

ENTERPRISE COSTS:- Economics of Silage-making in East of Scotland, 1950, 1951.

DAIRY LABOUR IN THE EAST OF SCOTLAND.

Inquiries regarding the above publications should be addressed to either the Secretary of the College or the Provincial Agricultural Economist

ECONOMICS OF SILAGE MAKING IN THE EAST OF SCOTLAND, 1952

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SUMMARY

(1) The thirty-eight farms included in the survey are all in the area served by the Edinburgh and East of Scotland College of Agriculture. Twelve of the farms were dairy farms where the sale of milk was the main source of income and the remaining twenty-six were cattle rearing or feeding farms producing no milk for sale. Twenty-five farmers made grass silage only, eleven made arable silage only, and two made both grass and arable silage.

(2) Altogether 957 acres of silage were costed in 1952, 775 acres of grass silage and 182 acres of arable silage. The average acreage of grass silage costed was 28.7 per farm, and the average acreage of arable silage costed was 13.9 per farm.

(3) Costs of production are set out in detail. The average costs of production were £2.10.10d. per ton for grass silage and £3. 3. 5d. per ton for arable silage, though there were considerable variations from farm to farm.

(4) The distribution of the costs of making silage under various headings - manuring costs, rent costs, seeds costs, harvesting costs, etc. are set out to show first the comparative differences between the various types of grass silage made, and secondly the comparative difference between grass silage and arable silage.

(5) Of the factors affecting cost of production, yield per acre is the most important, although other factors, notably the harvesting cost per acre and the cost of establishment, also cause variations.

(6) The section on the practical techniques adopted in silage production is of interest, since it provides a picture of the physical background on which the costs of production have been cal:culated. It is split into five sections. The first section deals with the growing of the silage crop and gives information about the seeds mixtures and manurial applications which were used.

(7) The second section deals with the organisation of the work at harvesting 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.

(8) The types of silos - pits, clamps and towers - used by farmers in the survey are described in the next section with notes on costs of construction.

(9) The feeding value of silage is explained in the fourth section with particular reference

(a) to the dairy farmers' requirements.
(b) to the feeding farmers' requirements.

(10) The last section of this part of the report deals with the handling of the silage crop in winter time when it is being utilised, and with the equipment and costs involved.

(11) 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 on which a reasonable choice might be based.

SECTION II. /

SECTION II.

INTRODUCTION

This report is the third in a series based on economic surveys of the silage crop in East and South East Scotland in the years 1950, 1951 and 1952. The growth in the popularity of the crop, pointed out in the two previous reports, continued in 1952 when the estimated total production of grass silage in Scotland reached the record figure of 229,141 tons. Experience of the crop in 1952 has suggested that a further increase in silage pro:duction on Scottish farms in 1953 is more than likely.

The effect of the derationing and decontrol of animal feedingstuffs on the production of silage is yet to be seen, but as many experiments conducted in the last few years have shown that grass silage can to some extent replace concentrated feeding:stuffs, it is to be expected that a further impetus will be given the crop if, as seems to be the general forecast, prices of these animal feedingstuffs do rise. Figures relating to production of silage in Scotland and the cost of bought-in feedingstuffs have been published before, but are again included below to illustrate the expansion of the silage crop in Scotland over the last few years.

TABLE I. SILAGE PRODUCTION IN SCOTLAND

Year	Grass Silage Production in Scotland ≠	Arable Silage Production in Scotland θ	Cost of Bought Concentrates per Ton ≠	
			High Protein Cake - 33% Crude Protein	Medium Protein Cake - 16% Crude Protein
	Tons	Tons	£ s. d.	£ s. d.
1939	Not Known	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	35,054	12. 4. 6	8. 5. -
1949	102,100	42,177	12. 5. -	8. 7. 6
1950	142,758	53,518	24. 2. 6	16. 2. 6
1951	187,293	70,861	32. 5. -	25.15. -
1952	229,141	68,157	36.15. -	30.15. -

It will be seen from the table that apart from differences in the total tonnage produced, that differences in the rates of increase of production of the two types of silage exist. Since 1948 grass silage production has trebled, whereas arable silage production has increased only two-fold.

Various reasons may account for this apparent difference in popularity. For instance, in the case of arable silage the crop occupies the ground for a whole year - unless catch cropping is prac:tised - and there is a considerable risk of unsatisfactory ensilage if the crop is not chopped. In the case of grass silage the yield per acre may be less than with arable silage, but usually good pre:servation is obtained more easily - in most cases without chopping - and in addition the field can be used for grazing both before and after cutting.

Whatever /

≠ 1945 to 1950 figures. "The Production of Grass Silage in Scotland" by A.M.Mackenzie, Farm Economics, Autumn 1950.

θ From Dept. of Agriculture Statistics Branch - "Silage Produced from other sources than Grass".

/ Transactions of the Royal Highland and Agricultural Society of Scotland.

Whatever the reasons weighing the individual farmer's choice of silage crop may be, the fact remains that grass silage production is expanding more rapidly than arable silage production. Emphasis in this report is therefore placed mainly on the grass silage crop.

SECTION III.

Description of the Farms Costed in the Survey

Thirty-eight 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, twenty-five made grass silage only, eleven made arable silage only, and two made both grass and arable silage. Altogether, 957 acres were costed in 1952, 775 acres of grass silage and 182 acres of arable silage. Except in one case, where some grass silage was fed to in-lamb ewes, all the silage was fed to cattle. Twelve of the farms were dairy farms where the sale of milk was the main source of income, and the remaining twenty-six were cattle rearing or feeding farms producing no milk for sale. Most of the farms had acreages of cash crops in addition to the acreage set aside for fodder crop production.

The location of the farms and the size distribution of the acreages of silage costed per farm are given in Table II.

TABLE II. LOCATION OF FARMS : ACREAGES OF SILAGE COSTED : 1952

County	Under 20 acres	20 to 40 acres	Over 40 acres	County Totals
Midlothian	3	1	2	6
East Lothian	1	1	-	2
West Lothian	1	-	1	2
Roxburgh	4	3	1	8
Berwick	2	2	3	7
Fife	-	1	-	1
Perth	1	1	-	2
Angus	6	4	-	10
Totals	18	13	7	38

The farms included in the survey were mostly fairly large as far as scale of silage making was concerned, the average acreage of grass silage costed per farm being 28.7 and the average acreage of arable silage costed per farm being 13.9. The majority of the crops costed, eighteen in number, were under 20 acres in extent and there were thirteen in the 20-40 acre size group. On seven farms more than 40 acres of silage was made.

The distribution of total farm size is illustrated below:-

TABLE III. /

TABLE III. FARM SIZE : SILAGE COSTS INVESTIGATION : 1952

Acreage of Crops and Grass	FARMS MAKING			
	Grass Silage Only		Arable Silage Only	
		%		%
Under 100 acres	1	4	Nil	Nil
100 acres - 200 acres	3	12	1	9.1
200 " - 300 "	3	12	2	18.2
300 " - 400 "	5	20	3	27.2
400 " - 500 "	6	24	1	9.1
500 " - 600 "	4	16	2	18.2
600 " - 700 "	2	8	2	18.2
Over 700 acres	1	4	Nil	Nil
Totals	25	100	11	100
Average Total Acreage per Farm	389		415	

The sizes of the farms concerned are of interest since some idea can be got from them of the numbers of tractors and men likely to be available for silage harvesting. For instance, in the case of the grass silage makers, there was a variation in the number of tractors available from none, in the case of one small hill farm, to six in the case of a large lowground arable farm. In spite of this wide variation, it is of interest to note that the process of ensilage has been accepted equally enthusiastically by both the individual farmers concerned. It would appear from this that mechanisation is not essential for silage making to be a practicable proposition so long as the farmer concerned is silage-minded.

SECTION 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 bases on which these costs were calculated were 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 and include allowances for all perquisites received plus an allowance for holidays with pay and sickness.

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

	Per Hour
Tractor, Wheeled	4/3d.
Tractor, Tracklayer	6/3d.
Horse	1/6d.

(2) /

(2) Overheads

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

(3) Deductions for Grazing and Residual Values of Fertilisers

(a) Grazing : If the field was grazed both before and after cutting for silage, half the cost of growing the grass was charged to grazing and an appropriate deduction of one-half made in the charge to silage. If, as was normally the case, the field was grazed only after the silage cut was taken, then two-thirds of the cost of growing the grass were charged to the silage and a deduction of only one-third was made in respect of the grazing obtained.

(b) Residual Value of Fertilisers : Deductions for residual values of fertilisers were calculated on the basis of the information given in "Advisory Leaflet No. 24 of the Department of Agriculture for Scotland".

TABLE IV. SILAGE AVERAGE COSTS PER ACRE
1952 Crop

	Grass Silage	Arable Silage
	£ s. d.	£ s. d.
Power - Man	2.11. 1	5. 5. 9
Horse	-. 1. 2	-. 1. -
Tractor	2. 1. -	3.14. 2
Rent	1. 6. 3	1.10. 1
Seeds	1. 9. 5	6. 6. 2
Manures - (including residual values of past dressings, the cost of application and all top dressings)	4.15. 5	4. 9.10
Overheads	4. -. -	6. 4. 3
Miscellaneous - (including special equipment depreciation)	-.19. 8	-.17.11
Total	17. 4. -	28. 9. 2
Less - Residual Values	1. 1. 6	Nil
Less - Share to Grazing	2.15. 4	Nil
Net Cost of Silage (up to and including harvesting)	13. 7. 2	28. 9. 2
Number of Records	27	13
Total Acreage	775	181
Average Acreage Costed per Farm	28.7	13.9
Average Yield per Acre	5.6	9.5
Average Cost per Ton	£2.10.10	£3. 3. 5

It will be seen that in the case of grass silage the average cost per acre worked out at £13. 7. 2d., the average yield at 5.6 tons per acre and the average cost per ton at £2.10.10d. The average cost of arable silage was £28. 9. 2d. per acre. The average yield was 9.5 tons per acre and the average cost per ton was £3. 3. 5d.

In /

In 1951 the average cost per acre of grass silage was £11. 6. 8d. and the average cost per ton £2. 4.10d. The corresponding figures for arable silage were £24. -.11d. and £2.14s. The average yield per acre was 5.25 tons in the case of grass silage and 9.25 tons in the case of arable silage. Comparison of the two years would seem to indicate a rise in cost in 1952. However, the sample of farms costed was very different in 1952 from that in 1951 and no real conclusions on the variation in cost between the two years can be made.

There were considerable deviations from the averages in both cost and yield figures in 1952.

(a) Grass Silage

The highest cost per acre was £29.14. 3d. and the lowest £4.14. 7d. The highest cost per ton was £9.15s. - a quite exceptional case - with the next highest being £5. 4. 5d. and the lowest £1. 5. 4d. The factor which was largely responsible for the variation in cost per ton was the yield per acre which was lowest at 1 ton and highest at 10.25 tons.

The relation between costs per ton and yield per acre is illustrated in Table VII. on page 10 of the report, where it is seen that high yields generally result in low costs per ton and low yields in high costs per ton.

(b) Arable Silage

The range in costs per acre here was less than that seen in the case of grass silage due to the greater uniformity in the growing and harvesting methods which were used. The highest cost per acre was £37. 4. 9d. and the lowest £19. 4. 8d. The highest cost per ton was £4.15. 2d. and the lowest £1. 4.10d. Again in yield per acre there was less variation than in the case of grass silage, the highest yield being 10.6 tons per acre and the lowest being 7.0 tons per acre.

It has been possible to group the grass silage costs figures into three categories according to source of grass - those of silage made from one year leys cut either once or twice, those from longer leys cut once in the season and those from permanent grass or long leys on hill farms cut once in the season. The corresponding figures for these three groups show just about as much contrast as do these for grass and arable silage set out in Table VI. To illustrate these variations, Table V. below has been drawn up. However, before referring to this, it may be advisable to point out that the costs structure is somewhat different from that in Table IV. For particulars of this costs structure see Appendix I.

TABLE V. /

TABLE V. CONTRAST IN THE COST OF MAKING SILAGE FROM DIFFERENT KINDS OF GRASSLAND

	One Year Leys			Longer Leys Cut Once	Long* Hill Farm Leys Cut Once
	Cut Once	Cut Twice			
		1st Cut	2nd Cut		
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Establishment Costs					
Power - Man) Horse) Tractor)	-. 8. 8	-. 6.10		-. 7. 9	-. 6. 6
Overheads	-. 7. -	-. 5. 2		-. 6. -	-. 5. -
Seed	3. 7.11	£2. 6. 8		3.19.11	3.15. -
TOTAL	4. 3. 7	2.18. 8		4.13. 8	4. 6. 6
(1) Share to Current Year	4. 3. 7	2.18. 8		1. 8. 3	-.15. 1
Basic Costs					
Rent	2. 1. -	2. 3. 7		2. 1. 2	1.13. 3
Manures (non-nitrogenous manures only)	-. 7.10	4. 6. 5		3.12. 8	-. 8. 5
(2) TOTAL	2. 8.10	6.10. 0		5.13.10	2. 1. 8
TOTAL (1 + 2)	6.12. 5	9. 8. 8		7. 2. 1	2.16. 9
Less Residual Value of Ley	2. 2. -	2. 2. -		-.17. 5	-. 2. 4
NETT ANNUAL COST ..	4.10. 5	7. 6. 8		6. 4. 8	2.14. 5
Less Share to Grazing	1.10. 1	1.19. 5		2.14. 2	-.18. 1
Less Share to -	Nil	2. 5. 3	3. 2. -	Nil	Nil
TOTAL	3. -. 4	3. 2. -	2. 5. 3	3.10. 6	1.16. 4
Top Dressing (nitrogenous manures only) ≠	1.17. 5	2.16. 3	2. 3. 1	1. 6. 7	-. 7.10
(3) Nett Cost of Growing	4.17. 9	5.18. 3	4. 8. 4	4.17. 1	2. 4. 2
Harvesting Costs					
Power - Man	4.12. 2	2. 3. 1	1. 4. 1	2. 7. 1	1.11. 9
Horse	Nil	-. 2.11	-. 1. 8	-. -. 2	-. 6.10
Tractor	3.11. 7	2. 4. 5	-.19. -	1.18. 2	-.10. 6
Overheads	4.15. 5	2.19. 7	1. 9. 3	2.17. 3	1. 5. 7
(4) TOTAL	12.19. 2	7.10. -	3.14. -	7. 2. 8	3.14. 8
(5) Miscellaneous Costs	1. 2. 7	-. 8.11	-. 5. 3	1. 3. 8	-. 4. -
TOTAL COST PER ACRE	18.19. 6	13.17. 2	8. 7. 7	13. 3. 5	6. 2.10
No. of Cases	2	3X	3X	16	3
Average Yield per Acre	7.5 tons	7.1 tons	3.2 tons	5.2 tons	3.0 tons
Average Cost per Ton	£2. 7. 7	£2. -. 7	£2.12. 1	£2.15. 4	£2. 8. 7
Average Acreage Costed per Farm	13.5	24.3	24.3	28.5	18
TOTAL Manures	£2. 5. 3	£7. 2. 8	£6. 9. 6	£4.17. 3	£-.16. 3

* Includes one farm with permanent grass, one with a twelve year ley and one with a four year ley.

≠ In the case of one year leys cut twice for silage there are two different top dressing costs - one for the dressing applied before the first cut and one for the dressing applied before the second cut.

X The same three cases, of course.

From /

From an examination of Table V. it becomes apparent that the final product cost - the cost per ton of silage made - does not vary so very widely being lowest at £2. -. 7d. in the case of silage made from the first cut of a first year ley and highest at £2.15. 4d. in the case of longer leys which are only cut once in the season. When one next looks at the yields per acre the difference between the types of grassland becomes very much more apparent with the tonnages ranging from the lowest of 3 tons per acre in the case of long hill farm leys to the highest of 7.5 tons per acre in the case of one year leys which are cut once for silage. A similar marked degree of contrast will be seen in the costs per acre which vary from £6. 2.10d. to £18.19. 6d. in the cases of the long hill farm ley and the single year ley (cut once for silage) respectively. The factors which lead to this dif:ference in the cost per acre are, on the one hand in the case of the one year leys, those characteristic of intensive production - high manuring cost, higher rent - denoting greater natural fertility - a greater incidence of establishment costs due to the shorter ley and, of course, a higher harvesting cost to cope with the greater yield per acre. On the other hand, in the case of the long hill:farm leys there is practically no manuring cost, rent is lower, a very small incidence of establishment costs due to the length of the ley and a low harvesting cost per acre - all characteristic of an extensive production policy. It is important to note that grass silage production either of the intensive or extensive type costs about the same per ton of made silage, although the costs per acre and yield per acre do vary greatly.

The Distribution of Silage Costs per Acre

After comparing the costs of production of different classes of grassland silage, it is interesting to examine the differences in the distribution of costs under various headings between grass silage and arable silage. These are set out in Table VI. below.

TABLE VI. /

TABLE VI. DISTRIBUTION OF SILAGE COSTS PER ACRE

	Grass Silage		Arable Silage	
	£ s. d.	% of total cost	£ s. d.	% of total cost
Establishment Costs				
Power - Man	-. 3. 1		-.15.10	
Horse	-. -. 1		-. -. 8	
Tractor	-. 4. 2		1. 1. 1	
Overheads	-. 5. 9		1. 5. 7	
Seed	3.10. 2		6. 6. 2	
TOTAL	4.13. 3		9. 9. 4	
(1) Share to Current Year	1.15. -		9. 9. 4	
Basic Costs				
Rent	2. 1. 3		2. 5. 7	
Net Manures* (non-:nitrogenous manures only)	3.10. 5		4.12.11	
(2) TOTAL	5.11. 9		6.18. 6	
TOTAL (1 + 2)	7. 6. 9		16. 7.10	
Less Residual Value of Ley	1. 1. 6		Nil	
NETT ANNUAL COST	6. 5. 3		16. 7.10	
Less Share to Grazing	2.15. 4		Nil	
TOTAL	3. 9.11		16. 7.10	
Top Dressing (nitrogenous manures only) ≠	1.10. 2		-. 2. 8	
(3) Nett Cost of Growing	£5. -. 1	37.5%	£16.10. 6	58.1%
Harvesting Costs				
Power - Man	2. 9. 9		4. 9.11	
Horse	-. 1. 2		-. -. 4	
Tractor	1.19. 2		2.13. 1	
Overheads	2.17. 4		3.17. 5	
(4) TOTAL	7. 7. 5	55.2%	11. -. 9	38.8%
(5) Miscellaneous Costs	-.19. 8	7.3%	-.17.11	3.1%
TOTAL Cost per Acre	13. 7. 2	100%	28. 9. 2	100%

* Includes residual values
≠ These are charged in whole to the one crop

From these figures it is seen that establishment costs in the case of arable silage, being charged to 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 spread over several years. The actual figures for "Share to Current Year" are respectively £9. 9. 4d. and £1.15s.

In the case of arable silage most of the charge for manures is made in respect of non-nitrogenous dressings and residual values, whereas in the case of grass silage considerably more is charged for the cost of top dressing with purely nitrogenous manures.

The nett cost of growing in the case of grass silage was £5.0.1d. and £16.10. 6d. in the case of arable silage. In the latter case not only was the actual amount greater but so also was the proportion which it constitutes of the total costs per acre, the actual figure being 58.1% and that for grass silage being only 37.5%. Harvesting costs amounted to £7. 7. 5d. for grass silage and £11. -. 9d. for arable silage, the proportions of the total costs in these cases being respectively 55.2% and 38.8%

Miscellaneous /

Miscellaneous costs made up 7.3% of the cost of growing grass silage and 3.1% of the cost of growing arable silage.

The importance of knowing the above distribution of costs lies in the fact that proper emphasis can then be put on these factors which make up the total costs in relation to the proportion of total costs which they constitute. For instance, harvesting costs at approximately 55% of the total cost of grass silage are much more important in this case than they are in the case of arable silage, where they constitute only 39% of the total cost. Hence, improvements in harvesting technique will be relatively more important in the case of grass silage than in the case of arable silage.

Factors affecting Costs of Production

(1) 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 Table VII., where the variation in cost per ton with yield per acre in the group of sixteen farms which made silage from three to four year leys in one cut is set out.

TABLE VII. VARIATION OF COSTS WITH YIELDS
GRASS SILAGE, 1952 CROP

Yield per acre	Range in Costs per Ton							Total No. of Costs	Average Cost per Ton
	20s.-30s.	30s. - 40s.	40s. - 50s.	50s. - 60s.	60s. - 70s.	70s. - 80s.	Over 80s.		
Tons	- - - - - N u m b e r		of		C o s t s - - -				£ s. d.
2 - 3							1	1	5. 4. 5
3 - 4					1		1	2	3.13. 8
4 - 5		1	1	2	1	1		6	2.15. 1
5 - 6		1	2	1				4	2. 5. 4
6 - 7		1		1				2	2. 8. 3
7 - 8								Nil	Nil
Over 8	1							1	1. 5. 4
TOTAL	1	3	3	4	2	1	2	16	2.15. 4

This table gives unmistakeable evidence of the economy of high yields in the case of this group of grass silage costs. The position in the other groups of grass silage costs is not so clearly defined because of the small numbers in each group. In arable silage costs the position is the same as with the grass silage group - the highest cost per ton, £4.15. 2d., was obtained with one of the lowest yields per acre - 7.8 tons and the lowest cost per ton, £1. 4.10d., was obtained with the highest yield per acre - 15.5 tons.

(2) Harvesting Costs

In order to consider the importance of harvesting costs, it is advisable to classify the farms costed into two main groups viz. first those which employed mechanical aids such as the green crop loader and buckrake, and secondly, those which 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 where silage harvesting is highly mechanised, there are differences between the farms using different machines. To show these variations, Tables VIII(a). and VIII(b). have been set out, relating respectively to grass silage and arable silage.

TABLE VIII /

TABLE VIII (a). HARVESTING COSTS : GRASS SILAGE
1952 CROP

Harvesting Equipment used	No. of Costs	Yield per Acre	Harvesting Costs	
			Per Acre	Per Ton
		Tons	£ s. d.	£ s. d.
Buckrake	8	5.4	5.11. 1	1. 3. 5
Manual	3	5.5	5.19. 1	1. 1. 7
Green Crop Loader	14	5.5	8.17. 9	1.14. 1

TABLE VIII (b). HARVESTING COSTS : ARABLE SILAGE
1952 CROP

Harvesting Equipment used	No. of Costs	Yield per Acre	Harvesting Costs	
			Per Acre	Per Ton
		Tons	£ s. d.	£ s. d.
Binder	11	9.45	10. 9. 7	1. 4. -
Green Crop Loader	1	10.2	9. 6. 3	-.18. 3

Although Table VIII (a). gives a valid basis of comparison of the two main methods of mechanising the silage harvest - the buckrake and the greencrop loader - Table VIII (b). unfortunately is based on only one green crop loader cost and eleven binder- harvested silage costs, and so is not of much value for comparative purposes. The 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 VIII (a). it would appear that harvesting by buck-:rake is more economic 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 silage has to be carted every day there may be considerable extra expend-:iture (see section on "Utilisation"). Where the silo is sited at the steading such haulage time in winter can be eliminated, but the transport has to be done at harvesting time. In this case the use of the green crop loader along with trailers is probably the more efficient method.

It is interesting to note from Table VIII(a). that silage harvesting using manual labour for loading is as economic as methods using special machinery. However, this statement must be qualified by consideration of Table X(a)., page 16 where it will be seen that this method consumes more man hours per acre than does any other method and so may be quite impracticable where the extra manpower is not available.

(3) The Costs of Establishment

Variations in these occur in the case of grass silage since the "Share to Current Year" of establishment costs depends on the length of the ley. The longer the ley the smaller is the "Share to Current Year". In the case of permanent grass the "Share to Current Year" is nil, and in the case of one year leys it is equal to the whole amount of estab-:lishment costs. In the 1952 costs the highest "Share to Current Year" was £5. 2. 4d. - a one year ley - and the lowest, apart from permanent grass, was 7/6d. - a twelve year ley.

Apart from the effect of "Share to Current Year" the costs of establishment themselves show variation mainly due to different seeds mixture /

mixture costs. The lowest seed mixture cost in the case of grass silage was £1.10s. - a one year ley - and the highest was £4.13s. - a four year ley. In the case of arable silage seeds mixtures the highest cost was £8.12. 2d. and the lowest £3.15s.

(4) 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 to only one-third of the Net Annual Costs 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 first 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. The actual amounts deducted from the Net Annual Cost for grazing varied from £6. 9. 7d. to 13/1d. per acre with an average deduction of £2.15. 4d.

(5) Costs of Manuring*

These varied very considerably according to the particular level of fertility etc. encountered on each farm. Wide differences exist and the highest manuring cost* for grass silage was £6.16.11d. plus a top dressing cost of £2.10. 7d. - a total of £9. 7. 6d. In this case the yield per acre was 9.3 tons. The lowest manuring cost was nothing at all and the yield in this case was 1.85 tons.

Arable silage manuring costs* also varied from the highest of £11. 6s. to the lowest of 5s. per acre. The yields in these two cases were respectively 9 tons and 7.8 tons per acre.

SECTION V.

Practical Techniques Adopted in Silage Production

(a) Growing the Silage Crop

(i) Arable Silage

The arable silage crop is grown in much the same way as is a cereal crop except that it is cut earlier in the year. Since the problem of how to keep the crop standing in the fully ripened stage does not arise, the arable silage crop can be and generally is manured to a greater extent than the normal cereal crop. Most of the seeds mixtures used consisted principally of oats, beans, peas and tares used in varying amounts. On a very fertile border farm the mixture used was 126 lb. oats, 90 lb. beans and 28 lb. peas per acre which worked out at a cost of £4. 6s. per acre. On a not so fertile Angus farm the mixture used was 85 lb. oats, 128 lb. beans, 48 lb. peas and 48 lb. tares (or vetches) per acre costing £7.16. 3d. per acre.

Manurial practice varied quite considerably. Where the arable silage crop was following fairly good grassland or a heavily manured root break, the practice seemed to be to apply no manure of any kind. Where, however, arable silage follows another cereal crop, it is fairly usual practice to apply manure, actual applications varying from 3 cwts. to 6 cwts. of compound fertiliser with the average between 4 cwts. and 5 cwts. per acre. In some cases, grain compound manure is /

* Manuring costs figures stated include residual values of past fertiliser application.

is used, in others potato compound manure is used. Choice of type of compound manure, however, will depend on the particular farm.

Yields where artificial manures are supplied as above, and the land is in good heart, are normally about 10 tons of made silage per acre.

(ii) Grass Silage : Types of Grassland from Which Silage Can be Made

In recent years more and more farmers making silage for the first time have started off by making grass silage rather than arable silage and there has been a distinct drop in the numbers of farmers who have been making arable silage, generally because of difficulty in preser:vation due to overheating. This trouble can be overcome by the use of a cutter blower or by cutting the crop at a younger, greener stage, but either of these tends to make the final product rather more expensive. In strong contrast to the rather narrow limitations of growth and manage:ment which characterise the arable silage crop, is the very flexible management possible with the grass silage crop. At one extreme where the grass is perhaps sown down for one year only, intensively manured and possibly cut more than once a very heavy yield is obtained - up to 10 tons per acre quite commonly - and the picture approximates closely to that presented by the annual arable silage crop with all the advantages of the latter - heavy yield etc. - but without the difficulties inherent in the making of arable silage. At the other extreme we have the permanent pasture of the hill sheep farmer who wants to make some silage for his hill cattle or to help out his sheep feeding in winter time. The grass is not likely to be manured, yields very lightly in comparison with other types of grassland - perhaps only one to two tons per acre - and yet provides a product which is exactly similar to that produced on the low ground farms. Naturally, the extensive type of system involved by this type of grassland demands the use of a different system of harvesting and general management to that of the lowground, heavy yielding grassland. This point is illustrated in Table IX. Between the two extreme types of grassland cut for silage - first, the intensively treated one year ley and, secondly, the extensively treated permanent grass comes the three to four year several purpose ley - used for hay, grazing and silage - which is by far the commonest crop which is cut for silage.

So much for the physical comparison of the various types of grass silage crop. The economic side of the comparison must be treated next. It is true to say that it is technically possible to make silage from all sorts of grassland, but the question which arises is "Is it as economic to make it from one as from the other, technical considerations apart?". That it can be, is illustrated by examples of cost given in Table IX. below. Three farm cases are compared, Case A. being a hill sheep farm where silage was to be made from permanent pasture, Case B. being an ordinary lowground farm, making silage from a ley which is to be down for three or four years, and Case C. being an example of a farm where a one year ley is treated very intensively - almost as an arable crop - and cut twice for silage.

TABLE IX.

Type of Farm	Cost per Acre	Yield per Acre	Cost per Ton
	£ s. d.	Tons	£ s. d.
Case A : Hill Farm	4.14. 7	1.85	2.11. 1
Case B : Low-ground Farm (3-6 year ley)	11. 3. 9	5.2	2. 2. 9
Case C : Low-ground Farm (1 year ley) Two Cuts	28. -. 4	13.2	2. 2. 5

The /

The interest in this table lies in the fact that even though total yields per acre were very different - 13 tons, 5 tons and 2 tons (approximately) - the costs per ton do not vary nearly as widely being £2.11. 1d., £2. 2. 9d., and £2. 2. 5d. The cost per acre is an indication of the degree of intensity of management which is involved in growing the crop, being highest at £28. -. 4d. for two cuts in the case of the heavily manured, heavy yielding one year ley, and lowest at £4. 14. 7d. in the case of the permanent grass which receives no manure and which yields a mere 1.85 tons per acre.

It is of interest at this point to translate the £ s. d. figures denoting intensity of cultural treatment into terms of manures applied, type of seeds mixture used and so on. No great amount of information is available on the seeds mixtures used by farmers co-operating in this year's costs investigation and so no attempt to average their individual practices has been made. For illustration of these practices attention will be drawn to single specific examples which are considered to be typical. In indiv-:idual cases, variation from these would, of course, have to be made according to the nature and state of fertility of the soil. The composition of permanent grass varies so widely from farm to farm according not only to the original seeds mixture sown, but to subsequent manuring and grazing policy that further consideration cannot be given to it here.

The most popular type of ley - the three or four year general purpose type - is commonly cut for silage or hay in the first year and sometimes in its last year, the remaining seasons being reserved for grazing. The types of seeds mixtures vary from farmer to farmer according to indivi-:dual preference, but normally contains Italian and perennial rye grasses along with some cocksfoot and Timothy, plus the red clovers, white clover and possibly some wild white clover. Variation in the constituent grasses and their quantities are made to allow for differing soil conditions. The second type of grass ley - the single year ley - usually consists of Italian rye grass along with red clover.

Manurial practice must march in step with the type of grass ley sown and the way in which it is to be utilised. Usual practice is as follows:-

On permanent grass on hill farms no manure of any kind is normally applied, the periodic dressing of basic slag or lime, once in so many years, being considered quite adequate for the purposes to which the grassland is put. In consequence of this policy, the yield of silage from permanent grass, particularly on hill farms, is very low, being between 1½ and 2 tons per acre. On more fertile lowground farms the figure of yield from per-:manent grass is naturally higher than this figure and when a dressing of, say, 1-2 cwts. of nitro chalk is applied it can normally be expected to reach 5 tons per acre assuming that the ley is otherwise in good order.

On the lowground farm which depends on the three or four year ley for its silage crop manurial practice differs from that of the hill farmer with permanent grass. Normally a dressing of some compound manure is applied early in spring, say, for example, 2-3 cwts. of grain/grass or potato compound manure, and this may be followed by a dressing of 1-2 cwts. nitro chalk a short time prior to cutting. Under such conditions, and with a ley in good order, a yield of 5 tons to 6 tons per acre can be con-:fidently expected. There is, of course, a range of yields which extends below and above the 5 or 6 mark according to the particular conditions involved.

On the most intensively treated grass leys - those sown down for one year only - the manurial treatment must be very generous if a high yield is to be obtained and the soil fertility is not to be depleted. The case of the East Lothian farmer who applies 6 cwts. grain/grass manure in early spring and applies a dressing of 3 cwts. of nitro chalk before each of the two cuts of silage are taken, may be quoted by way of illustration of this policy. Yields in this case were 9.3 tons of silage for the first cut and 3.9 tons of silage for the second cut - a total of 13 tons made silage per acre.

(b) Harvesting the Silage Crop

The date at which harvesting grass silage commenced varied greatly form farm to farm and so, also, did the actual length of the harvesting period. As early as May 8th one farm on very fertile early land had commenced cutting a one year ley for silage. In the following week, that is the week ending May 16th, two other farmers started. In the week ending 23rd May four farmers started and in the week ending 30th May eight farmers started. Thus, by the end of May fifteen farmers had started the harvesting of their silage crop. In the month of June eight others commenced at dates varying fairly uniformly throughout the month. In July three others started on either hill or marginal types of farms. This makes a total of twenty-six; dates for the remaining farms for which the costs of making silage were estimated are not available.

It would then appear that in a growing season such as was experi:enced in 1952 that grass silage would be made mainly in the latter part of May and the first half of June.

The length of the harvesting period varied from five days in the case of a farm making only 4 acres of silage to twenty-six days for a farm making 40 acres with a fairly small staff. The average length of period was fifteen and a half days which is longer than the period of about ten days which is recommended if quality is to be uniform. Where a large quantity of silage has to be made the resources of the farm may be quite inadequate to deal with the operation in anything like the recommended ten days for uniform good quality. In this case a way out of the danger of subsequent lower quality has been found in the one year ley consisting of a mixture of Italian ryegrass and red clover. This type of ley can be cut earlier than the usual three year ley which can then be dealt with in its turn, the total acreage of silage grown being divided between the two types of ley. If required a second cut can then be taken from the one year ley later in the season. In this way the quantity of good silage which can be made on any one farm can be considerably increased.

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

The high degree to which the silage crop has been mechanised was as evident in 1952 as in the earlier surveys of 1950 and 1951. Again the two machines most commonly used are the buckrake and the greencrop loader. Out of the twenty-seven farmers making grass silage only three depended on loading the crop with manual labour alone. Of the remaining twenty-four, fourteen used greencrop loaders, eight used buckrakes and a "Cut-lift" and a "Wilder Steed Loader" were used respectively in each of the last two cases. Not enough data is available on the latter two machines and so they will be excluded from comparisons made later in this section.

The capital cost of the main items of equipment used are £30 - £40 for each buckrake and £130 - £160 approximately for each greencrop loader. These figures, however, vary considerably according to the make of the individual machine. Choice of any particular method depends on a number of factors such as the amount of manual or tractor power available and so on. As a starting-off point in this matter of choice of machine Tables X(a). and (b). have been set out giving general data on each method used, first in the case of grass silage and secondly in the case of arable silage.

TABLE X. /

TABLE X(a). HARVESTING DATA : GRASS SILAGE : 1952 CROP

Harvesting Method Used	No. of Farms	Acreage Costed per Farm	Tonnage Costed per Farm	Yield per Acre	Man Hours	Tractor Hours	Horse Hours
				Tons	- -	Per	Acre - -
Buckrake	8	22.7	143	5.4	11.9	7.1	Nil
Green Crop Loader	14	31.8	166	5.5	19.2	11.0	0.4
Manual	3	22.8	119	5.5	19.9	4.1	5.1

TABLE X(b). HARVESTING DATA : ARABLE SILAGE : 1952 CROP

Harvesting Method Used	No. of Farms	Acreage Costed per Farm	Tonnage Costed per Farm	Yield per Acre	Man Hours	Tractor Hours	Horse Hours
				Tons	- -	Per	Acre - -
Binder or Reaper	11	13.9	126	9.4	29.1	12.4	0.3
Green Crop Loader	1	22	225	10.2	27.1	9.1	Nil

Table X(b). shows that where arable silage is made that the farmers prefer to cut and, in some cases, bind the crop and then to fork it into trailers by hand. The cutting machines used were mainly binders although in one case a side delivery reaper was chosen. In only one case was a greencrop loader used. With such uniformity in practice comparisons cannot be made.

In the case of grass silage, however, as is shown by Table X(a). manual handling i.e. loading the grass onto trailers or carts by hand was uncommon - only three farmers out of the twenty-five included using this method. The remainder used either the buckrake or the greencrop loader methods and with the figures available it is possible to compare to a certain extent the relative efficiencies of these two methods.

Considering firstly their effect on manual labour requirements. From Table X(a). it will be seen that the average man hours per acre used in manual handling, greencrop loading and buckraking are respectively 19.9, 19.2 and 11.9. From these figures it would appear that the buckrake is by far the most efficient method for conserving man hours and that there is not much to choose in this respect between the greencrop loader and manual handling. However, two rather exceptional cases occur among the greencrop loader farms in which the respective amounts of man hours used were far above the average amount per acre at 50.9 and 37.9. If these two are excluded a rather different figure is presented by the remaining twelve. The three figures are then 19.9 for manual loading, 14.9 for greencrop loading and 11.88 for buckraking - all figures in man hours per acre. The position presented then is that for economy in manual labour the buckrake should be chosen with the greencrop loader as second choice. The manual labour method is relatively inefficient in this respect.

The second consideration which the farmer would have to think of in this choice of mechanisation of his silage crop is the number of tractors which would be available in relation to the amount of silage which has to be made. Obviously the hill farmer with no tractor and perhaps only one horse has no choice in the matter - he must load his silage crop manually and so must keep the acreage of silage grown down to that amount which he can harvest with his available supply of labour in the proper length of time. The farmer with one tractor can only think in terms of either one buckrake or one greencrop loader as alternatives to manual handling and again has to relate the acreage of silage to be grown to his available labour and power. In this case, if maximum acreage of silage is the aim then he would probably choose the greencrop loader which can cope with more /

more silage per working hour than can the buckrake. In both the above cases the likelihood is that all the available resources are taken up in the task of harvesting the silage crop. However, at the other extreme, is the primarily arable farmer with four or five tractors and ten or eleven men who wishes to grow a matter of thirty or forty acres of grass silage. The task is well within his resources and will probably absorb only part of his available tractor and manual power.

The average sizes of teams involved in the 1952 investigation were:-

(a) Grass silage, using buckrakes .... 3.5 men and 2.4 tractors

(b) " " " greencroploaders 5.85 " " 3 "

A third consideration must be taken into account before final choice of method is made and that is the siting of the silo relative to field and steading. Given the silage pit in the field the buckrake is probably the more efficient method since the time occupied in transport between picking up the load in the field and emptying at the silo is small. Where the transport time is necessarily longer - as when the silo is at the steading and fairly distant from the field - the buckrake is at a dis-:advantage since the loads which it can carry are much smaller than those carried on trailers loaded in the field by greencrop loaders. This would result in a higher transport cost per ton of silage. Thus in these cir-:cumstances - always depending on the actual distance to be covered - the greencrop loader would probably be the more efficient. Again, with the silo in the field the greencrop loader is less efficient than the buckrake because of the wastage in time hitching and unhitching and the extra difficulty of unloading the trailer and spreading the load on the silo due to its greater size.

Field Organisation

Some examples of field organisation at harvest time follow to illustrate the various practices adopted by the farmers in this investi-:gation. Two main types of organisation will be dealt with: first, that where buckrakes were used and, secondly, that where greencrop loaders were used.

I. With Buckrakes:

The average output from each buckrake measured in terms of made silage on the eight farms where the grass silage was harvested by buck-:rakes was 1.12 tons per buckrake per hour.

Example 1. One Buckrake : Farm with One Tractor : Pit Silo

This is the case of one farm with 170 acres arable land, 100 acres permanent grass and 500 acres hill grazing on which the total farm staff was two men. Only one tractor was available on the farm for silage making. The acreage made was 9½ acres grass and 2 acres arable silage. The latter was harvested by binder and so this section is confined to the harvesting of the 9½ acres of grass by buckrake. The total tonnage of grass silage made was 60 and the number of buckrake hours was 50 so that output per buckrake hour is 1.2 tons. Output per man hour was 0.45 tons.

One man cut enough grass for one or two days and spent the rest of the day buckraking. The second man was at the pit to help in unloading and spreading. About an hour was spent each day in rolling the pit with the tractor.

Note: In this case the operation of silage harvesting required the use of all available labour and power on the farm.

Team : 2 Men : 1 Tractor : 1 Buckrake : 1 Mower.

Example /

Example 2. Three Buckrakes : Farm with Four Tractors : Pit Silo

This farm consisted of 600 acres of good land of which 420 acres were under arable cultivation. The total acreage of grass silage which was to be harvested was 50 and for this purpose three buckrakes were used. Such a set up, requiring the use of four men, two boys and four tractors, was well within the capacity of the available labour and power on the farm which amounted to eight men, two boys and six tractors. The tonnage of silage made was 500 and the total number of buckrake hours was 435 so that output per buckrake hour amounted in this case to 1.15 tons. Output per man hour in this case was 0.65 tons.

One man with tractor cut enough for the day's working and then went to the pit to help spread and consolidate the silage. The second, third and fourth men were buckraking the whole day and the two boys were spreading and consolidating at the pit.

Team : 4 Men : 2 Boys : 4 Tractors : 3 Buckrakes : 1 Mower.

Intermediate between the two examples given are the farmers who use two buckrakes and from two to four men. An important point to notice is that the use of the buckrake as a harvesting method was equally popular with the small grower of 10 acres and the large grower with 50 acres of silage.

II. With Greencrop Loaders:

The average output from each green crop loader measured in terms of made silage on the fourteen farms which used these machines was 2.14 tons per greencrop loader hour. The information obtained during this survey suggests that the greencrop loader is not popular with the grower of only 10 acres or under but is used on the larger farms growing 20 acres or over. Such farms usually carry not less than two tractors and so the three examples given below are, first, one with two tractors available and, secondly, two with three tractors available.

Example 3. One Greencrop Loader : Farm with Two Tractors : Pit Silo

This farm was an upland farm of 400 acres of which 230 acres were arable and 170 acres were rough grazing. The acreage of grass silage grown was 70 with an average yield of 4.5 tons per acre. The labour force available was two men, two boys and two tractors. The system of working was to have one man cutting enough for the day and then helping the boy spreading and rolling at the pit. The second man and boy circulated with a tractor and trailer picking up the grass, transporting it to the pit and helping to unload. When the farmer was available in addition an extra trailer was added to the team since the fields were quite distant from the pit at the steading. In this case all the available labour was in use.

The tonnage of silage made was 315 and the number of hours worked by the loader was 200 hours so that output per loader hour was 1.57 tons. Output per man hour was 0.36 tons.

Team : 2 Men : 2 Boys : 2 Tractors : 1 Greencrop Loader : 1 Trailer : 1 Mower

Example 4(a). One Greencrop Loader : Farm with Three Tractors : Pit Silo

This dairy farm extended to 300 acres - all of which were under arable cultivation. The total number of men on the farm was five and the total number of tractors was three. In the silage harvesting operation all the available tractors and men were used. 29 acres of grass silage were made yielding 4.3 tons per acre - 125 tons in all. The greencrop loader was working approximately 60 hours so that output per loader hour was 2 tons (approx.). Output per man hour was 0.33 tons.

The /

The system was to have one man with tractor cutting the crop then going to help out at the pit with the spreading and consolidating. Two of the men were driving the tractors engaged in loading and trans-:porting the grass, assisted in the field by a third man. The fifth man was at the pit most of his time.

Team : 5 Men : 3 Tractors : 1 Greencrop Loader : 2 Trailers
1 Mower.

Example 4(b). One Greencrop Loader : Farm with Four Tractors : Tower Silo

This arable farm extended to 350 acres and had at the steading a tower silo which had been constructed in 1925 and used, up to the war, for making arable or mashlum silage. However, after the war, it was decided that it suited the farm better to fill the tower with grass silage. The acreage cut was 30 and total tonnage made was 160. The greencrop loader worked for 63 hours so that output per loader hour was 2.54 tons. Output per man hour was 0.4 tons.

The harvesting was organised as follows. The first man cut the grass and helped with the loading in the field. He had a tractor with him the whole time which was only used for cutting. The second and third men were tractor drivers engaged with two tractors and trailers in loading, transporting and unloading at the tower silo. The fourth man fed the cutter blower and the fifth man assisted by a woman consol-:idated the silage inside the tower. Occasionally, the farmer assisted at the tower as well. The fourth tractor was required to drive the cutter blower. As the farm normally had only 4 men and 3 tractors an extra man and tractor were required and were obtained on contract.

The use of the tower in this case necessitated an extra tractor for driving the cutter blower and at least one extra man for feeding the cutter blower.

So much for the greencrop loader - the size of team varied from one to four tractors and from three to eight men. The most common arrangement was to have three trailers (when available) and five men. Only in those cases where tower silos were used was the number increased normally to four tractors and six or seven men.

(c) The Silage Pit or Tower

In the survey, twenty-five of the twenty-eight farmers making grass silage used pit or clamp silos and the remaining three used tower silos. Of the thirteen farmers making arable silage six used tower silos and the remainder used either pits or clamps. All of the towers used had been built about 1925 and originally were all used for mashlum silage. This practice was carried on by six of the nine farmers who had tower silos on their farms but the remaining three had decided to use their towers for grass silage. The figures stress the popularity of the pit silo particularly among the grass silage makers. Many of these farmers have only started making silage in recent years and their choice between pit or tower silos has been more or less automatic in view of the very expensive nature of the latter compared with the former. One tower silo erected in 1948 cost £800 and an additional £200 for a cutter blower. With a silage capacity of 200 tons this tower and equipment works out at £5 per ton capacity. The cost of an earthen pit dug by farm labour was worked out in the 1950 silage costs report* at 3/1d. per ton capacity with sides unlined. A bull-dozed pit of the same type worked out at 2s. per ton capacity and a pit with sides lined with bricks at 10s. per ton capacity.

Thus, /

* "Economics of Silage in the East of Scotland, 1950" by A.B.K. Tracey.

Thus, a farmer with 200 tons of silage can either -

(a) construct a tower silo at a cost of £1000
(b) " " lined pit at a cost of £100
(c) " an unlined pit at a cost of £32
(d) use a clamp silo in which case there is practically no capital involved etc.

In addition to their relative capital costs there are several other factors which must be taken into account when comparisons are made between the pit and the tower silos. For as little wastage as possible the tower silo is far and away the better type of the two. For ease in feeding in winter time it is also the better, as it is usually sited at the steading. However, at harvesting time, a bigger team both of men and tractors is likely to be required since it takes at least one extra man to feed the cutter blower and one extra tractor to drive the cutter blower. With the pit silo, wastage is not necessarily unavoid-:able but the risks are definitely greater and considerable wastage does occasionally occur. Particularly when sited in the field and used in conjunction with buckrakes the pit makes possible a very labour-saving and economic system of harvesting; however, when it is sited at the steading and a greencrop loader used its advantage in this respect is not quite so apparent. In addition to the low initial cost of the pit must be added the cost of fairly regular maintenance of the earthen silo walls which does not occur with more permanent structures. It might be said that the life of an earthen pit is five years, that of a lined pit ten or fifteen years and that of a 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 with a tower silo. The reverse process - that of uncovering - also has to be done in winter time. Costs of covering pits are not readily available, and those that are vary considerably. However, below are three fairly typical examples:-

<u>Pit No. 1</u> - 55' long and 15' broad

Covered with 6" earth .. .. 17 man hours
8 woman hours
9 boy hours
Total Cost/ .. .. .. £4. -. 6d. for 12 acres of silage

<u>Pit No. 2</u> - 89' long and 21' broad

Covered with special waterproof paper and straw bales
45 man hours cost .. .. £6.15. -
Cost of paper .. .. £15. -. -
Total Cost/ .. .. .. £21.15s. for 28 acres of silage

<u>Pit No. 3</u> - 25' long and 17' broad

Covered with dung and straw .. 37 man hours
17 horse hours
Total Cost/ .. .. £6.16. 6d.

Once the type of silo has been decided upon it is very important to consider the siting of the silo in relation both to summer harvesting work and winter utilisation. For winter feeding it is obviously desirable to have the silo placed as near the steading as possible since much time can be wasted in winter through having to transport silage from pits at some distance from the steading. Information on the time used up in this process is given in the section on utilisation on page 22. For ease in harvesting, however, the best place for the pit is in the silage field but the final choice must be a compromise between this consideration and that of winter feeding mentioned above. If stock are to be out-:wintered, feeding time can be very much reduced by having the silo in the field as the stock and, for ease in harvesting, the silage crop should if possible be taken from an adjacent field.

(d) /

/ excluding overheads

(d) Feeding Value of Silage

In dealing with the feeding value of silage, it is necessary to consider the special needs of the two types of farm most interested in it, viz. the dairy farm and the stock rearing and feeding farm.

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 are not so highly productive. The advantage of good quality silage as a fodder for dairy cows lies in the fact that it can act to a certain extent as a concentrate saver, which roots and hay cannot do. Concentrates are very expensive to buy and the national aim is to reduce the consumption of these imported feedingstuffs by pro:ducing more home-grown high quality feed. That this can be done economically is well illustrated by work done at the Hannah Dairy Research Institute.*

The average percentages crude protein in grass and arable silage (1950 figures) are stated below and give some idea of the relative feeding values of the two types of silage -

Grass Silage ..... 13.1% crude protein in dry matter
Arable Silage ..... 10.8% " " " " "

As far as the dairy farmer with highly productive cows is concerned it would seem from these figures that grass silage should be his choice. This view is confirmed when the practices of the dairy farmers taking part in the survey is examined. Of the fifteen dairy farmers, twelve made grass silage only, two made both arable and grass silage and only one depended on arable silage alone for his stock.

Typical rations containing grass silage fed to dairy stock - cows, in-calf heifers and bulling heifers - on a dairy farm growing no roots at all are given in Table XI. below.

TABLE XI. RATIONS FED TO DAIRY STOCK

Stock Type	Daily Rations	Comments
Dairy Cow	50 lb. grass silage 15 " draff 3 " beet pulp	This provides 11.8 lb. starch equivalent and 1.65 lb. protein equivalent - enough for mainten:ance and 2 gallons of milk. For each additional gallon, a mixture of oats and beans was fed at the rate of 4 lb. to the gallon.
In-Calf Heifer	30 lb. grass silage 15 " straw (oat)	To raise the protein quantity, some cake is added when necessary near calving time.
Heifer Stirk	20 lb. silage 8 " good hay	A little cake will be fed if re:quired. 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, 2½ tons for each two year old heifer and 1½ tons for each one year old heifer for an estimated winter feeding period of, say, 180 days. These quantities would be reduced if sugar beet tops or kale were available in the first half of winter for direct feeding and silage was depended on to provide for only the second half of winter.
For /

* "Self-sufficiency on the Dairy Farm" by W. Holmes, Scottish Journal of Agriculture, Autumn 1952.

For a herd of thirty milking cows, ten two-year old heifers, ten one-:year old heifers and ten under-one-year olds, 32 acres of rotational grass cut once for silage and yielding 5 tons to the acre would be required.

The above example is perhaps of an extreme type of case, where roots and hay are replaced entirely by silage in the feeding of the dairy herd - except for the very young calves. More usually some roots are fed along with the 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 choosing the type of silage to use on this type of farm it must be remembered that the animals are not in the same 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. The following is an example of such a ration:-

Ration 1.	Fattening Animal (10 - 11 cwts.)	40 lb. arable silage
		40 lb. swedes
		12 lb. oat straw
		3 lb. cake

For an 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 per head instead of $6\frac{3}{4}$ tons of roots as would formerly have been fed with a daily ration of roots alone. The acreages involved would be 0.3 acres of arable silage and 0.14 acres roots per head compared with about 0.34 acres roots with an "all roots" ration. Thus with the mixed ration there is a bigger acreage involved in the growing of fodder and so less would be available for cash cropping. The degree to which this occurs, along with the other roots versus silage factors discussed elsewhere in this report, would probably decide whether or not arable silage could replace roots as a fodder crop.

Ration 2.	Breeding 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 therefore be cor-:respondingly less.

Having outlined the feeding value of the product, consideration is next given to the problems involved in handling the silage during the winter utilisation period.

(e) Notes on Silage Handling during Utilisation

These notes are based on a survey carried out during the winter of 1951-52 when fifteen farms were visited to find out what methods of silage handling were in use. Twelve of these fifteen farms had pit silos - five permanent pits and seven ordinary earth-sided pits. Tower silos were used on only three of the farms. Since methods varied widely it was not possible to arrive at strict averages in every case and figures given below can be taken as being typical rather than as being average.

I. /

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

I. The Time Involved in Silage Handling

Throughout these notes the standard for comparison will be "per 100 animals fed" assuming that each animal receives 25 lb. as its daily ration of silage.

TABLE XII. THE TIME INVOLVED IN SILAGE HANDLING : COMPARISON OF PIT AND TOWER SILOS

	Per 100 animals fed	
	Pit Silo[(a)]	Tower Silo
Time to remove seal : Every 7 days	$1\frac{1}{2}$ hours	Nil
Time to remove and load Silage (2,500 lb.)	25 - 30 mins.	15-20 mins.
Time to transport to steading (return journey by hand barrow)	4 mins./100 yds./load	Nil
Time to feed at steading	40 - 45 mins.	40-45 mins.

(a) It is assumed that the pit is 15' wide and $4\frac{1}{2}$' deep and that 6' of seal is removed each week.

Table XII. gives an outline of the differences between pit and tower silos when silage is being fed. The most important difference between them is the extra time taken up for transport in the case of the pit silo. Other differences also exist and these are discussed more fully below.

Considering first a pit within 50 yards of the steading, transport time would be 2 minutes for the return journey so that ten trips would have to be made taking approximately 20 minutes if a normal hand barrow is used holding 250 lb. of silage. This time will increase as the silage cutting face recedes still farther away. This compares with a transport time of <u>nil</u> in the case of a tower silo. Of course, time in transport would be reduced by using a larger barrow, for instance if one of 500 lb. capacity were used, transport time would be cut to 10 minutes - although the extra weight makes it more difficult for one man to handle and the provision of a good hard road is all the more essential. In addition to the transport time involved there is, in the case of most pits, the extra time involved in removing the seal to be taken into account. This is largely dependent on the type of material used for covering. For a pit 15' wide the time to remove 6' of earth of about 4" to 6" deep works out at 90 square feet in $1\frac{1}{2}$ hours for 1 man.

Considering now a pit situated at some distance from the steading, it is obvious in this case that a heavier form of transport is required, the one generally chosen being either the horse and cart or the tractor and trailer. A horse and cart can transport 10-12 cwt. silage and a tractor and trailer twice that amount, so that in the latter case less time is taken in transport. This saving is partly compensated for by the fact that a horse cart tips very much more quickly than does a tractor trailer and so less time would be taken at the steading by the former. Putting the stages of the process in tabular form:-

TABLE XIII. /

TABLE XIII. COMPARISON OF HORSE AND CART WITH TRACTOR AND TRAILER FOR SILAGE TRANSPORT

Type of Transport	Average loading time (for 2,500 lb. silage)	Time of Return Journey where distance to pit is:-							Dumping time (2,500 lb. silage)
		100 yds	200 yds	300 yds	400 yds	500 yds	600 yds	700 yds	
	- - - - - - - - - - M i n u t e s - - - - - - - - - -								
Horse/Cart/Man	26	$5\frac{1}{2}$	11	$16\frac{1}{2}$	22	$27\frac{1}{2}$	33	$38\frac{1}{2}$	2
Tractor/Trailer/Man	25-30	$1\frac{3}{8}$	$2\frac{3}{4}$	$4\frac{1}{8}$	$5\frac{1}{2}$	$6\frac{7}{8}$	$8\frac{1}{4}$	$9\frac{7}{8}$	5

(Notes on Table XIII.:- Average Speeds assumed - Horse and Cart $2\frac{1}{2}$ m.p.h., Tractor and Trailer 5 m.p.h. Dumping time in both cases is for tipping only. This would be considerably increased if loads had to be forked off.)

From Table XIII. it is possible to consider the ways in which labour time can be saved in transport time from pit silo to steading. Two examples will serve to illustrate this point.

Case No. 1 - 300 yards away from steading

Total horse and cart time is $44\frac{1}{2}$ mins.) Difference of
Total tractor and trailer time is $35\frac{1}{8}$ ") $9\frac{3}{8}$ mins.

Case No. 2 - 700 yards away from steading

Total horse and cart time is $66\frac{1}{2}$ mins.) Difference of
Total tractor and trailer time is $40\frac{7}{8}$ ") $25\frac{5}{8}$ mins.

In Case No. 1 the saving in time by using a tractor and trailer instead of a horse and cart is only 10 minutes (approx.) whereas in Case No. 2 the saving is going on for half an hour. Thus it can be stated that little substantial saving in time will be effected by the substitution of a tractor and trailer for a horse and cart where distances are less than 700 yards.

Considering lastly the sequence of events involved in silage utilisation from a tower silo. The only times spent are first, that taken to remove the silage and, secondly, that taken to feed it to the stock. No time is involved in removing the seal (except for the top layer removed at the initial opening of the tower), and no time is involved in transport to the steading. Time taken to remove an equivalent quantity of silage here is slightly less than it is in the case of a pit silo mainly because the material is chopped and very easily forked out. The time of feeding is much the same. The total saving in time effected by using a tower instead of a pit silo is thus a considerable argument in its favour - an argument which is further strengthened by the fact that no outside labour is normally necessary to supplement that of the cattleman.

II. The Cost Involved in Silage Handling

It has already been stated that with a tower silo it is normal for the cattleman to fork the silage from the tower and feed it himself to his beasts. In this way one man completes the whole operation. However, where pit silos are used the cattleman in some cases will not, and in most other cases cannot, cope with the extra transport time involved and the outside staff have to be charged with the responsibility of the additional carting. Time thus spent by the outside staff must be taken into consideration in arriving at any estimate of the cost of silage utilisation and charged to the stock expense bill in addition to the cattleman's wages.

Cost /

Cost Involved in Silage Utilisation from Tower Silos:-

Here the cost is the appropriate share of the cattleman's wage proportionate to his time involved on the job. From Table XII. this time is 15 to 20 minutes for removing silage from the tower and a further 40 to 45 minutes to feed it. Feeding silage at the rate of 2,500 lb. per day therefore involves a total cost of £18.18s. for a season of 18 weeks.

No extra cost is incurred since the outside staff are not involved at all. The cost of utilisation from pit silos generally includes a certain extra amount for the outside staff's part in the process.

Cost Involved in Silage Utilisation from Pits:-

In addition to the approximate cost of the cattleman handling a ton of silage, the cost of the outside staff's part in the job needs to be added and the following estimates give some idea of the total costs involved

(Notes:- Feeding period is considered to be 18 weeks and the number of stock is assumed to be 100 consuming 2,500 lb. weight of silage per day. The pit silo is 15' broad, $4\frac{1}{2}$' deep and a "cut-in" of 6' provides 8 tons of silage - enough for 7 days' feeding.)

1. Removing Seal: 6' x 15' (4"-6" earth): 1 man: $1\frac{1}{2}$ hours. This is a cost of 4/6d.* per week or £4. 1s.* over the whole season.

2. Cutting and Loading the Silage:

   2 cart loads per day) takes approximately
   1 tractor load per day) 25 minutes per day

   Total time involved for each week is approximately 3 hours. The cost of a horse, cart and man is taken as 4/6d.* per hour and for a tractor, trailer and man as 7/3d.* per hour.

	Total Cost/Week	Total Cost/Season
Horse/Cart/Man	£-.13. 6	£12. 3. -
Tractor/Trailer/Man	£1. 1. 9	£19.11. -

3. Transport and Dumping of Silage:

   This depends on the distance travelled and, of course, is greatest in the case of those pits at a considerable distance from the steading. Taking a pit 400 yards away as an example:-

	Transport time/day	Transport time/week	Cost/ Week	Cost/ Season
Horse/Cart/Man	24 mins.	$2\frac{3}{4}$ hours	12/4	£11. 2. -
Tractor/Trailer/Man	$10\frac{1}{2}$ "	$1\frac{1}{4}$ "	9/1	£8. 3. 8

4. Total Costs involved in 1, 2, 3 above

	Removing Seal	Cutting & Loading	Transporting & Dumping	TOTAL
Horse/Cart/Man	£4. 1. -	£12. 5. -	£11. 2. -	£27. 6. -
Tractor/Trailer/Man	£4. 1. -	£19.11. -	£ 8. 3. 8	£31.15. 8

The /

* No overheads are included in the charges made.

The total tonnage involved is 145 so that the total extra cost per ton where the pit is 400 yards from the steading is 3/9d. per ton where a horse and cart is used, and 4/4d. per ton where a tractor trailer is used. For every 100 yards distance more or less than the 400 yards involved in this example add or deduct $4\frac{1}{4}$d. and $1\frac{3}{4}$d. per ton respectively in the cases of the horse and cart and the tractor and trailer.

III. Special Handling Equipment

Cutting Tools. Many different types were used, the most popular three being the modified hay knife, the "Battle Axe" - which con:sists of a plough disc welded on to a steel tubular handle and used in the way which its name implies and, lastly, a special heart-shaped silage knife. Each tool has its own particular good and bad points - the hay knife is generally already on the farm but it is rather weak for cutting silage: the "Battle Axe" is cheap to make but takes too much energy to use, the special silage knife is the most efficient and requires little effort to use but costs more than the others.

Transporting Equipment. There is much variety here parti:cularly in the design of barrows and "super barrows", designed to carry up to 5 cwts. Each farmer has his own ideas about these and has his own peculiar problems to solve so that no general rules about choice can be laid down. Obviously extra expense on highly specialised barrows can only be justified by a proportionate saving in time and increase in efficiency. Where good runways and hard floors are used there is, however, probably little to gain by choosing an expensive rather than an ordinary barrow unless, of course, the new type barrow has a much greater capacity.

IV. Estimation of Silage Yield

Estimations of yields in this survey have been based on an average density figure for all types of silage of 45 lb. weight per cubic foot. Alternatively, this can be expressed as 50 cubic feet per ton of silage. Procedure in estimating the quantity of silage in the silo is first to obtain the dimensions of the silo and, secondly, to calculate the volume of silage in cubic feet. The tonnage can then be calculated by dividing the volume of the silage by 50.

V. Conclusions on Silage Handling

In ending these notes on aspects of silage handling the impor:tance of siting the silo properly and of making the fullest possible use of the cattleman in handling the silage must again be stressed. With tower silos he can usually handle the silage without the extra expenditure incurred through using the outside staff. However, the initial costs of this type of silo are high - about £1,000 for a 200-250 ton silo - which usually decides choice in favour of the pit silo. Even where a pit silo is used the cattleman can be independent of outside assistance if siting is at the steading and proper runways are provided for his barrow. However, it is on those farms where for one reason or another the pits are sited well away from the stock that the use of the outside staff is essential - often at a time during the season of short days when there is usually more than enough for them to do already. Assuming that this last statement - that of the difficulty of fitting silage carting in with other jobs - is ruled out, the extra cost still remains to be considered and so, for economic working, it is essential to plan the siting of the silo so that it fits in both with summer harvesting and winter utilisation of the silage.

SECTION VI.

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 technique and so on. Brief references are made to these below.

1. Type of Animal to which Silage is fed

Arable silage is fed mainly to feeding and rearing animals from which very high production is not demanded, This is shown by the fact that ten out of the thirteen farmers whose arable silage was costed, were on feeding or rearing farms. The remaining three were dairy farms, but only one of these depended on arable silage alone, the other two grew both arable and grass silage. Of the fifteen dairy farmers, twelve made grass silage only, two made both arable and grass silage and only one made arable silage alone. The reasons for this are probably two-fold.

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

(2) 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 summer time 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 utili:sation present a considerable problem. It can certainly not be used for grazing unless extra stock are bought and so is normally conserved for winter use.

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 in fattening on the grass those animals which were not finished in the courts, but which 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 crops. To him, the poorer protein quality of the former will not matter as the demands for protein made by the rearing and fattening animal are considerably less than those made by the dairy cow. The important factor to him is the Starch Equivalent and in arable 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%* and for medium grass silage of 7.9%*.

2. Comparative Costs of Production

Choice may also be influenced by a comparison of costs of pro:duction since it can be said that arable silage at an average cost of £3. 3. 5d. per ton is 12/7d. dearer per ton than is grass silage at £2.10.10d., but again it must be stressed that when relative costs are considered/

* Figures from Watson and More "Agriculture"

considered the quality of the silage, based on feeding value, 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 will probably be in favour of grass silage production; the rearing or 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. In addition to considering direct costs such as the above, one must also remember to take into account indirect costs which are apt to rise in substituting one crop for another. For instance, if grass silage is compared with arable silage on the basis of yield of nutrients per acre, it is seen that arable silage can produce considerably more nutrients per acre than grass silage. In this way, a smaller acreage will supply specific stock requirements than would be in the case of grass silage and less acreage taken up by fodder crops and more consequently left for cash crop production.

3. Problems of Management and Techniques

In addition to these 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 fairly technical reason for preferring either grass or arable silage may be the time of cutting the crop. Grass silage is cut mainly at the end of May or in June, whereas arable silage is cut mainly at the end of July and the beginning of August. If farm labour is tied up on other crops in May but is available in July, it may be advantageous to produce arable rather than grass silage.

In the 1952 survey it was noted that arable silage does not lend itself well to harvesting by buckrake or greencrop loaders as does grass silage. This fact that arable silage harvesting is not so easily mechanised, is possibly another argument in favour of grass silage.

ACKNOWLEDGMENT

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APPENDIX

(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 grass silage the ley concerned may be down for several years and only part of the total establishment costs are charged to the current year. This is the "Share to Current Year" and is calculated thus:-

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

In the case of the arable silage costs which appear in Table VI. the total establishment costs are charged to the current year.

(2) Basic Costs

These are made up of items charged solely to the current year and necessary for the production of the crop and include rent, residual value 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 of "Top Dressing" referring to application of nitrogenous manures only which were applied in the current year.

(4) Harvesting Costs

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

(5) Miscellaneous Costs

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