Silage – Cost of production (O.S.)

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SILAGE HARVESTING

FORAGE HARVESTERS: COSTS AND LABOUR ORGANISATION, 1956

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SUMMARY

The average cost of harvesting silage on 9 farms using a Silorator forage harvester in the West of Scotland in 1956 was 9/1d per ton of green silage and the average labour requirement was 1.1 man hours per ton. The costs of harvesting by a Gang Mo Loader and by a Wild Thwaites forage harvester on individual farms are shown. A comparison of the costs with those of other methods of harvesting is in favour of the forage harvesters.

Methods of organising the work of the machines are discussed. Using the Silorator with a small team it may be best to hitch the trailer behind the machine, but with a larger team of 3 men or more, a greater daily output may be obtained by running the trailers alongside the machine. The output of the Silorator was about an acre an hour. It may be possible to avoid wasting time in stoppages by careful servicing of the machine before use. Three methods of turning corners in the field are described and it is concluded that the direct turn is the best. Two different methods of arranging the work at the silo are discussed.

The Gang Mo Loader is designed for making silage of high protein content from frequent cuts of short grass. The output was about 3 acres per hour, but on account of the more frequent cutting, the yield per cut was less than that where other machines were used.

Some factors relating to the choice of the best method of silage making for individual farms are considered.

INTRODUCTION

Over the years, increasing interest has been taken in silage making and from time to time new machines have been developed which have made the work of harvesting quicker and easier. Forage harvesters have been in use for many years in America for harvesting both hay and silage and some American machines have been operated in this country.

For the most part, however, the American harvesters have been expensive and have been designed chiefly for large acreages of arable forage crops. It is only recently that cheaper British machines have been put on the market, suitable for smaller acreages and for grass crops. Forage harvesters are, therefore, relatively new mechines on British farms and little information is available about their performance or the cost of operating them. It was therefore decided to obtain such economic information as was available about these machines - the costs of operation, and harvesting - so that comparison could be made with other harvesting methods. At the same time, more detailed time studies were made, which gave an indication of the performance of the machines and some information as to the best methods of organising the work of harvesting with them.

N.B. A word of caution is necessary in the interpretation of the results. The investigation was not specifically designed to test one machine against another under standard operating conditions, but was rather a study of the organisation of silage making on the farm. Furthermore, the small number of farms in the sample limits the validity of the results. The report, therefore, cannot be regarded in any sense, as giving an authoritative comparison of the mechanical efficiency of the machines discussed.

PART I

COST OF HARVESTING

The number of farmers in the West of Scotland known to be using forage harvesters was small but costs have been recorded from 11 farms situated in the counties of Argyll, Stirling, Lanark, Ayr and Kirkcudbright. On nine of these, the make of forage harvester used was the Silorator - a machine which cuts the grass by means of a horizontal rotary cutter, lacerates it, and blows it into a trailer. On one farm, a Gang Mo Loader was used. With this machine, the grass is cut by gang mowers and is delivered to the trailer on an elevator conveyor. The machine is designed for cutting relatively short grass which gives a silage of high protein content. On the remaining farm, a Wild Thwaites forage harvester was in use. This machine picks up the grass from the swath, chops it and blows it into a trailer. All the silage on the farms recorded was of grass, except on farm H where some arable silage was made in addition to grass silage.

The work of harvesting is taken to include cutting, loading, carting, ensiling, and rolling the pit and, in the case of the Wild Thwaites harvester, it includes also some side-raking to give a larger swath for the harvester to pick up. The number of man and tractors and the hours worked were recorded and the costs were calculated from these. The charges made for labour and power were as follows:-

Man	4/0d per hour
Wheeled tractor	3/9d " "
Crawler "	5/9d " "

The charge for labour included an allowance for overtime, perquisites and national insurance.

The costs shown include a charge for depreciation on the machines and for repairs, but no charge is made for interest on the capital invested in the machines. Depreciation was estimated by obtaining the farmer's opinion on the probable life of the machine and the expected number of hours use per annum, from which the total estimated life of the machine in hours was calculated. From this and the cost of the machine - reduced by the scrap or second-hand value, if any - the depreciation was calculated. To cover the average annual cost of repairs, $\frac{1}{4}$ of the depreciation was added to give the operating charge for the machine.

The tonnage of silage produced is based on the recorded number of trailer loads brought in multiplied by an estimate of the average weight of a cartload. On some of the farms one or two trailer loads were weighed and this gave a useful check on the estimated weight. In general, however, the figures for the yields of the crop are subject to possible errors in estimation.

Harvesting Costs on Individual Farms

Table I shows the costs of harvesting on 11 farms. The machine on farm D is included under Silorators but it was in fact a home made machine consisting of a mower cutter bar attached to the lacerating and blowing mechanism - which had been devised before the Silorator harvester was available. On farm L some silage was harvested by baler and some by buckrake and the cost of harvesting by these methods is shown for comparison. The cost of arable silage on farm H is also given separately. The acreage cut per farm is the total acreage of all cuts, treating each cut on a field as if it were a separate field, and the yield per acre represents the average yield of a cut. The yield of silage and the cost per ton is expressed in terms of the green material ensiled and not in terms of mature silage.

TABLE I

SILAGE HARVESTING COSTS

Farm No.	Area Harvested (acres)	Average Yield of green Silage (tons/acre)	Average Cost per acre	Average Cost per ton	Average man-hours per ton
Machine:	Silorator Harvester				
A	86	7.7	£3. 6. 2	8- 7d.	1.1
B	60	7.6	3. 9.10	9-10d.	1.1
C	41	10.6	4. 8. 2	8- 4d.	1.1
D	49	5.1	2. 3. 5	8- 7d.	1.0
E	34	8.8	3. 4. 4	7- 4d.	.93
F	33	10.0	4. 1. 2	8- 1d.	.94
G	41	8.7	3. 1. 4	7- 1d.	1.1
H	14	8.7	6.19. 2	16- 0d.	2.2
J	4	7.5	3. 1. 0	8- 2d.	.73
Average	40.2	8.3	£3.15. 0	9- 1d.	1.1
H - Arable Silage	20	12.9	£8. 5. 9	12-10d.	1.8
Machine:	Gang Mo Loader				
K	170	1.9	-.19. 6	10- 1d.	1.36
Machine:	Wild Thwaites Harvester				
L	149	6.6	£4. 3. 1	11-3d.	1.7

The average cost per ton of harvesting grass silage made by Silorator shows remarkably little variation from farm to farm. If Farm H, where staffing problems made organisation difficult, is excluded, the cost varies from 7/1d. to 9/10d per ton. The labour requirements in terms of man-hours vary round 1 man-hour per ton - from 55 to 66 man-minutes per ton.

On farm K, the average cost per acre of the Gang Mo Loader was 19/6d compared with an average of £3.15/- for the crops harvested by Silorator, but, owing to the lower yield per cut the average cost per ton (10/1d) was slightly higher than that of the Silorator crops. It must, however, be borne in mind that the quality of the Gang Mo silage may be higher. The labour requirement was 1.36 man-hours or 81 man-minutes per ton of silage harvested.

The cost per acre of harvesting by the Wild-Thwaites harvester was £4.3/- and the cost per ton 11/3d. Because of the situation of one of the silos at this farm, rather more labour was used for ensiling than was general on other farms. Making allowance for this, the comparable cost with the other farms in the investigation might be about 10/- per ton of silage.

Comparison with other Methods of Harvesting

An interesting comparison was obtained from Farm L where three different methods of harvesting were carried out, some grass being harvested by buckrake and some by pick-up baler as well as by the Wild-Thwaites harvester.

TABLE II

Machine	Area harvested (acres)	Av.Yield of green silage (tons/acre)	Average Cost per acre	Average Cost per ton	Average man-hours per ton
Wild Thwaites	149	6.6	£4. 3. 1	11- 3d	1.7
Buckrake	50	5.8	3.11. 9	12- 4d	2.6
Baler	50	7.2	6.15. 1	18- 9d	2.6

The cost per ton of silage harvested by baler was about half as much again as the cost for either of the other two methods, representing partly the cost of twine and the cost of the higher investment in machinery. The labour requirement of the buckrake was approximately the same as that of the baler but the buckrake was carrying the grass an average distance of only about 350 yards from the field to the pit, while the average distance carted, when the baler or the harvester were used, was about $\frac{3}{4}$ mile.

A more general comparison of the different methods of silage harvesting can be made with the costs obtained from previous investigations (1) (2). The figures for previous years have been recalculated at 1956 wage rates and the results are shown in Table III.

TABLE III

Method of Harvesting	Average Cost per ton of silage	No.of farms from which figures obtained	Average Labour use. Man-minutes per ton
(1) Silorator	7/- to 10/-	9	67
(2) Buckrake	8/- to 12/-	2	108
(3) Pick-up Baler	15/- to 20/-	14	120
(4) Green crop Loader	15/- to 18/-	3	132

It is interesting to note that the hours of labour taken in the different methods of silage making follow the same order as those shown in a recent publication by the N.A.A.S. on this subject(3) It must be pointed out that the figures for the buckrake and green-crop loader, being based on observations on only a few farms, may not be so representative as those of the other two methods of harvesting.

The silage made by the forage harvesters was either cut into short pieces or lacerated and the quality might, consequently, differ from that of silage made by other methods which did not entail any break-up of the material. The Chemistry Department of the College analysed samples from the eleven farms, but the results fell within the same range as samples taken from farms where the silage was made by other methods.

PART II

ORGANISATION OF THE WORK

Time studies were made of the work of harvesting on five of the farms (A.B.C.D. and K) and from these it is possible to draw some conclusions and make suggestions for the most effective method of operating the machines.

Silorator

Cutting and Loading

One of the chief advantages of the Silorator is that cutting and loading are carried out in one operation, and the loading itself is entirely automatic since the grass is simply blown into the trailer. With all forage harvesters which chop or break up the grass it is important to use trailers with high

(1) West of Scotland Agricultural College. Farm Labour Studies No.4. Baled Silage. A Note on the Organisation and Costs of Harvesting; 1954. November 1954.

(2) Ditto. Farm Labour Studies No.5. Baled Silage, May, 1956. Harvesting Costs and Work Organisation, 1955.

(3) N.A.A.S. Technical Report No.8. Use of Labour and Machinery in Silage Making, July 1956.

sides so that they are capable of holding large loads of loose grass without spilling and without the necessity of having a man on the trailer tramping down the load.

Common Methods of Organisation. There are two methods by which the work of cutting and loading can be organised. The trailer may be attached to the rear of the Silorator so that, while cutting, both are hauled by one tractor, or one tractor may be used to draw the Silorator while the trailer is run alongside hauled by another tractor.

The first method can be very effective where only two men and two tractors are available - one on the tractor drawing the Silorator and trailer and one carting to and from the silo. Two conditions are necessary to enable this to be done. Firstly, the tractor must have plenty of power to haul both the Silorator and the loaded trailer, otherwise too many stoppages may occur where a patch of thick or tough grass has to be negotiated. Under many conditions, a medium powered tractor is needed, although on Farm D, where the organisation was of this type, the diesel model of a light tractor was reasonably satisfactory on level land.

The second condition is that the hitch on the Silorator and trailers should be simple to operate, otherwise, much time may be wasted in changing trailers. On Farm D the drawbar of the trailers was fitted with a riding wheel on a screw jack, which could be easily raised or lowered to facilitate hitching. The whole operation - detaching the full trailer from the Silorator, hitching it to the tractor, unhitching the empty trailer from the tractor and hitching to the Silorator - took on an average, just over 3 minutes. On another farm with a less efficient hitch a time of 7 minutes was recorded for the whole operation.

The second method may be the most effective when more men are available and a high daily output from the machine is desired, because no time is spent hitching and unhitching trailers. If the time saved by avoiding the need for hitching and unhitching is 3 minutes per load, then if 30 loads are brought in, in an 8-hour day, by the first method, the total time saved per day would be an hour and a half, which would be long enough to allow 5 more loads to be harvested during the day. Where the trailer is run alongside the Silorator, no time need be wasted changing tractors, if the changeover takes place at a corner when the machine is out of gear. As the full trailer draws away, the empty one takes up position, ready for the machine to be started again after the corner has been negotiated.

If necessary, harvesting can be carried out with the Silorator by only one man and a tractor, but naturally the output is much less than where more workers are available. Either the machine cuts a load and the tractor hauls both the machine and trailer to the pit without detaching, or, by fitting an easily operated automatic hitch to the Silorator the trailer can be detached by one man and hauled to the pit after it has been filled.

Working Speed. The average speed of the Silorator while working was $2\frac{1}{2}$ miles per hour and it varied from 1.8 to 2.8 m.p.h. Disregarding the time taken by stoppages the throughput of the machines was just about an acre an hour.

Stoppages. On the day the observations were made on the farms observed, the average time taken up by machine stoppages varied from $3\frac{1}{2}$ to 36 minutes per acre cut. These stoppages represent time wasted which could more profitably have been spent in cutting silage. It is therefore important to examine the causes. The two chief causes of stoppages were firstly, the need to service the machine and secondly, the condition of the field and crop, but it may not always be possible entirely to separate these two, because difficult field conditions may make more frequent servicing of the machine necessary.

Sharpening cutter fingers and repairing V belts were the main cuases of machine delay, but it must be stated that, on some farms, neither of these occurred. It is possible that the time wasted on some farms could

be reduced by more attention to the preparation of the machine for work and to the maintenance of an adequate supply of the correct spare parts. A stoppage of the machine for, say, 30 minutes keeps perhaps 3 to 5 men idle or unprofitably employed for that period - a loss of from 1½ to 2½ man hours. In order to prevent such stoppages it would be profitable for the farmer to have one man spending a little time servicing the machine before use - even if it entailed paying some overtime to do so.

In some crops stoppages were caused when the machine encountered a clump of very tough or hard grass, or where the ground was uneven so that the blades came in contact with soil and stones. To some extent, this can be avoided by adjusting the height of the blades. Very often uneven ground is unavoidable, but generally the condition of the land at silage harvest depends on the condition of the seed-bed at the time of sow-out, and steps taken to ensure an even seed-bed may save trouble when the time comes to harvest the silage.

Turning in the Field. On Farm A it was observed that three different methods of turning corners were used during cutting. In the first, the tractor and machine turned directly round into the new direction; in the second, the machine moved out of the row and turned three quarters of a circle finishing up in line with and moving into the new line of cut; while in the third, after the swath had been cut, the machine moved forward, backed away from the corner at right angles and then drew into the new line of cut. The average time taken to turn a corner by these methods is shown below.

TABLE IV

Method	Average time taken per turn(mins)	Number of observations
Direct	.14	4
Circling Round	.36	5
Backing	.43	8

The circling method of turning was quicker than backing, but the direct turn was the quickest of all. On the more acute corners the direct turn presented a difficulty. When the machine had finished cutting one side there was a tendency for a bulge to develop at the corner because the machine did not begin to cut the crop on the next side until it had moved a few yards from the corner. This is the reason for using the other two methods of turning.

It is suggested that the difficulty might be overcome by making two or three cuts across the corner (backing the machine to do so) when the first round is cut, and occasionally afterwards, if a bulge begins to develop. The time spent in making these corner cuts would be small. Comparing the direct method and the circling method using the above figures, if five rounds are made per hour using the latter method in an approximately rectangular field, i.e. 20 corners per hour, the time saved in an 8 hour day by using the direct method would be 35 minutes, which would enable two extra rounds to be made and allow more than enough time for cutting off the corners.

Carting

The speed at which the silage is carted varies with the condition of the road and of the field. On the farms observed, for bringing loads in from the field to a silo at the steading, the average speed was 8 miles per hour and varied from 5.3 to 11.6 m.p.h., while for taking the empty trailers to the field, the average was 7 miles per hour, varying from 4.8 to 10.4 m.p.h. It is surprising to note that in three of the four farms the speed of the empty carts was less than that of the loaded ones. Although too much reliance cannot be placed in the results from only 4 farms, figures from other investigations also show some evidence that tractors with empty trailers travel more slowly than those drawing full ones. It may be that the empty trailer bumps and rattles more on rough going than a full one and thus causes the driver to travel more slowly.

Unloading

The time taken to unload trailers on the farms observed varied from 1½ minutes on Farm B, with a tipping trailer and two men at the pit to nearly 10 minutes on farm D, where the driver was alone.

The number of men required at the silo depends on the method of ensiling. On two of the farms a tractor was used for rolling the pit and another man was present to spread the grass. This enabled the tractor and trailer to unload quickly so that it spent the minimum time at the pit and did not need to delay returning to the field. This method is advantageous when the transport distance between the field and the pit is long, or when the crop is heavy, necessitating many loads to clear the field. By this method, each trailer can bring in the maximum possible quantity of grass per day. Two possible disadvantages are that with two men at the pit, one of them is liable to have some idle time between loads, while the tractor driver may roll the pit more than necessary merely to avoid appearing idle himself.

On Farm D the grass was young and required little rolling, and there were no workers stationed at the pit. The tractor was driven on to the pit and the driver himself tipped the trailer and spread the silage as well as adding molasses and a mineral mixture (obtained from a shed nearby). By careful positioning of the loads in the pit, he was able to spread the silage in less than 5 minutes a load, and the whole operation took only 10 minutes per load.

Time can generally be saved in unloading if the tractor and trailer can move easily on and off the pit. Delay is sometimes caused if the pit is in an awkward position and it is necessary to manoeuvre the tractor to get it on to the pit. Considerable delay may also occur if the pit is not well consolidated so that the tractor tends to bog down in the soft grass.

Gang Mo Loader

Like the Silorator, one of the advantages of this machine is that it cuts and loads the grass in one operation. It differs from most other machines, however, in certain important principles. It is designed to make frequent cuts (4 or 5 cuts per annum are usual) of young grass to produce a high protein silage and for this reason, the treatment given to the land - both stocking and manuring - differs from that normally given for silage making. It is claimed, too, that the frequent cutting encourages the growth of clovers and that consequently less nitrogenous fertiliser need be applied. From the feeding aspect, since more protein is being supplied from the roughage, changes may have to be made in the rations fed to stock, and it may be possible to reduce the quantity of concentrates purchased.

On Farm K, the working team consisted of three men, one on the tractor hauling the machine and a trailer, one man carting and one on the pit spreading grass. The field being cut was on gently sloping land and the yield of grass was over 1½ tons per acre. The speed of the machine while working was about 6 miles per hour. The effective output was over 3 acres cut per hour or 5 tons of grass per hour on the particular field. The average time spent changing trailers was 4½ minutes per load.

At the pit, the carts had to be unloaded from the side and the grass forked off. The tractor could not be hauled over the pit because the young chopped grass required no rolling, and consolidation would have spoilt the silage. The tractor driver and the man at the pit took on an average about 14 minutes to unload a cart. In a situation of this sort, side-tipping carts would no doubt be an advantage.

Choosing the Method of Harvesting Silage

Methods of harvesting silage are related generally to the machines used for carrying out the work. No single system is superior to the others under all, or even most, circumstances, but different methods and different machines suit the varying conditions on different farms. It is, consequently, no easy matter for the farmer to decide which method will be the most suitable for his farm. To do so, all the relevant considerations must be taken into account, and the following are some of the most important factors.

1. The type of silage that is to be made - whether it is to be a large bulk of moderate protein content or a smaller bulk of high protein silage.

2. The skill and ability of the farmer and his staff to give the care necessary for making good silage and for handling the machines.

3. The quantity of silage to be made.

4. The distance which the grass will normally have to be carried from the field to the pit.

5. The number of men and tractors likely to be available for harvesting.

6. The machinery already existing on the farm which could be used for silage harvesting.

7. The cost of new machines and the capital available to buy them.

8. The probable cost per ton of harvesting by the different methods.

Since these factors must always be related to the conditions existing on individual farms, no good purpose would be served by further discussion of them, but it is hoped that some of the information given in this report may be of assistance when the method of making silage has to be decided.

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