University of Reading
Department of
Agricultural Economics & Management

GRASS CONSERVATION: 1980

Susan M. Burns
with M.R. Lewis & J. Rendell

Economic Report No. 82

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CONTENTS

FOREWORD

AGRICULTURAL ENTERPRISE STUDIES IN ENGLAND AND WALES

University departments of Agricultural Economics in England and Wales have for many years undertaken economic studies of crop and livestock enterprises, receiving financial and technical support from the Ministry of Agriculture, Fisheries and Food.

The departments in different regions of the country conduct joint studies of those enterprises in which they have a particular interest. This community of interest is recognised by issuing enterprise studies reports prepared and published by individual departments in a common series entitled "Agricultural Enterprise Studies in England and Wales".

Titles of recent publications in this series and the addresses of the University departments are given at the end of the report.

PREFACE AND ACKNOWLEDGEMENTS

The results presented in this report summarise data on hay and silage crops for 1980 collected as part of the National Investigation into the Economics of Milk Production, which is financed jointly by the Milk Marketing Board of England and Wales and the Ministry of Agriculture, Fisheries and Food. The field work was carried out by Askham Bryan College of Agriculture and the Universities of Aberystwyth, Cambridge, Exeter, London (Wye College), Manchester, Newcastle, Nottingham and co-ordinated by Reading.

This Department is indebted: to all co-operating farmers who provided the basic information without whose help the study and this report would not have been possible; to colleagues at the afore-mentioned Universities and College who were responsible for collecting the data and forwarding it to us; and finally to Mr. Colin Dibb, Regional Agronomist, S.E. Region of ADAS for his valuable comments on Section 1.

Within this Department the fieldwork was carried out by Mrs. S. M. Burns, Mrs. E. I. Harland, Miss F. Wilks and Messrs. M. R. Lewis, A. K. Martin, R. L. Vaughan and J. Wright. Mrs. Burns supervised the study and was responsible for Section 1 of the report. Mr. Lewis compiled Section 2 and Section 3 was produced jointly by Mrs. Burns and Mr. J. Rendell. The report was typed by Mrs. C. Card.

SUMMARY

This report summarises the results of a joint study carried out by the Departments of Agricultural Economics at the seven Universities and one College of Agriculture mentioned in the Preface, in conjunction with the National Investigation into the Economics of Milk Production 1980-81. The main aim of the study was to provide economic data on hay and silage harvesting for the 1980 season, as well as a limited amount of physical information on such topics as tractor and labour usage, storage and feeding methods, physical yields and areas mown.

The sample was selected using information supplied by co-operators in the Milk Production Survey regarding their intended methods of harvesting and the quantities of hay and silage to be harvested in 1980. Because of insufficient numbers of co-operators using certain harvesting methods the final sample included only three different silage and two different hay harvesting methods. In total 107 hay and 108 silage crops were surveyed.

Average costs for conserving one tonne of hay in 1980 ranged from £32.66 to £40.36 depending on method of making and quantity made. Silage costs also varied with type of harvesting and quantity harvested, ranging from £9.56 to £11.33 per tonne.

Weather conditions for conservation were not very favourable in 1980, with a late spring and early summer of near drought conditions. The consequently retarded growth of grass led to silage cuts taken in May being below average yield, although the quality was good. The mid-summer tended to be cool and unsettled with periods of very heavy rainfall ensuring plentiful supplies of grass but making silage and hay harvesting extremely difficult and protracted. Later in the summer the weather stabilised and satisfactory late silage cuts were able to be taken during August and September.

SECTION 1 : GRASS AND ITS CONSERVATION

I GRASS IN THE U.K.

The total agricultural area in the U.K. in 1980 was 19 million hectares of which 71% (13.5 million hectares) was grass. The importance of grass to U.K. agriculture stems from its ability to provide a relatively cheap source of feed for ruminant livestock, both as a grazed crop and as conserved fodder to be fed during the winter period. In 1980 13.4 million cattle and calves, and 31.4 million sheep and lambs (MAFF) used the grasslands in this country to varying extents, for their own maintenance and also for the production of meat, milk and wool for human consumption and use. In 1980 ruminant livestock products, consisting of sales of wool, fat cattle and calves, sheep and lambs, and milk and milk products, together accounted for 43% of gross agricultural output in the U.K.

Grassland occurs in all areas of the U.K. as it provides a satisfactory use of land in the hill and mountain regions where soils are poor, as well as in lowland areas with rich, fertile soils. The ability of certain grasses to grow in the difficult hill and mountain environment emphasises the importance of grass to economically unfavourable areas where, because of high altitude with the associated high rainfall, low temperatures and shorter growing season, thin, acid soils, and difficult rocky terrain with steep gradients, virtually no alternative crops can be grown.

Table 1 indicates the proportions of the three major classes of grassland in the U.K. These are:

1) grassland less than 5 years of age, often forming part of an arable rotation and providing all the advantages of a break crop;

2) grassland over 5 years of age;

3) rough grazing ie grazing land of low productivity frequently supporting low output and income hill sheep farming.

As Table 1 shows between 1966 and 1980 the proportions of total grass taken up by both temporary grass and rough grazings have fallen slightly. At the same time the area of permanent grass increased because of improvements in grassland management involving fertiliser application, reseeding and weed control.

Table 1 Grassland less than 5 years of age, grassland over 5 years of age, and rough grazings as percentages of total grassland; UK 1966 - 80

	Year				% change in area 1966-80
	1966 %	1970 %	1975 %	1980 %	
Grassland under 5 years	17.4	16.5	15.5	14.8	- 22.0
Grassland 5 years and over	33.7	35.4	36.9	38.3	+ 4.0
Rough grazings	48.9	48.1	47.6	46.9	- 12.2
TOTAL GRASSLAND	100.0	100.0	100.0	100.0	- 8.5

Source: MAFF

Where temperature and light are non-limiting, water is the critical factor restricting grass growth. Coupled with the natural geography of certain areas this results in large regional variations in the proportion of grass grown, as illustrated by Tables 2 and 3.

Table 2 Regional percentages of grassland less than 5 years of age, grassland over 5 years of age, and rough grazings: England and Wales 1980

MAFF Region*	Grassland under 5 years	 5 years and over	Rough grazings	All grassland
Eastern	4.8	4.0	2.6	3.9
South East	14.5	9.2	3.3	9.2
East Midlands	8.0	7.9	3.8	7.2
West Midlands	14.5	12.9	2.7	11.4
South West	26.2	22.8	9.4	21.1
Northern	12.6	13.5	34.1	17.0
Yorks./Lancs.	5.7	8.9	12.0	8.8
Wales	13.7	20.8	32.1	21.4
TOTAL ENGLAND AND WALES	100.0	100.0	100.0	100.0

* See Map 1 page 7

Source: MAFF

Table 3 Grassland less than 5 years of age, grassland over 5 years of age, and rough grazings as percentages of each region's total agricultural area: England and Wales 1980

MAFF Region	Grassland under 5 years	 5 years and over	Rough grazings	All grassland as % of total agricultural area
Wales	11.0	55.5	23.8	90.3
Northern	10.5	37.7	26.3	74.5
South West	16.9	49.0	5.3	71.2
West Midlands	15.0	44.3	2.6	61.9
Yorks./Lancs.	6.7	34.8	13.0	54.5
South East	13.7	29.2	2.9	45.8
East Midlands	7.7	25.3	3.4	36.4
Eastern	3.8	10.8	2.0	16.6
TOTAL ENGLAND AND WALES	10.9	36.4	10.1	57.4

Source: MAFF

It is evident that the largest concentrations of all types of grassland are found in the wetter western side of the country, with Wales, the North, the South West and the West Midlands each having over 60% of their area down to grass. In addition, over two thirds of the total rough grazings in England and Wales are to be found in Wales and the North where hill land limits alternatives. The western areas, containing the largest concentration of dairy herds, tend to be too wet for arable crops with restricted cultivation and difficult harvesting.

Moving east across the country grass plays a lesser role in the farming picture and the more easterly regions are typically arable in farm type.

Table 4 Ruminant livestock numbers by region: England and Wales 1980

	Cattle and calves		Sheep and lambs	
MAFF Region	1000 head	% of total	1000 head	% of total
Eastern	484.5	5.1	315.3	1.4
South East	958.3	10.1	1513.4	6.7
East Midlands	793.4	8.4	1334.5	5.9
West Midlands	1365.6	14.5	2219.6	9.9
South West	2338.8	24.8	3109.8	13.8
Northern	1290.8	13.7	4395.0	19.6
Yorks./Lancs.	824.2	8.7	1666.9	7.4
Wales	1392.9	14.7	7946.7	35.3
TOTAL ENGLAND AND WALES	9448.5	100.0	22501.2	100.0

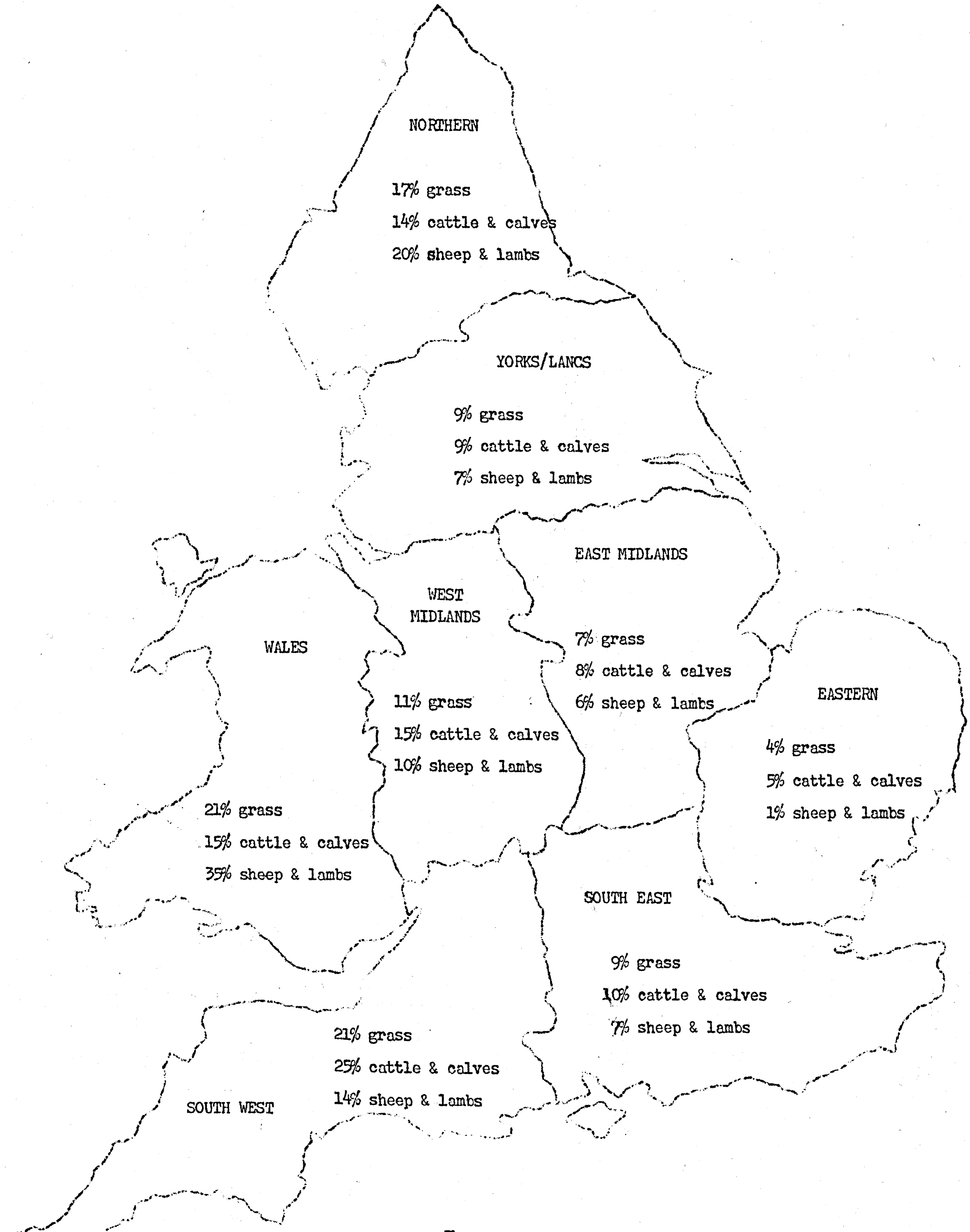
Source: MAFF

Ruminant livestock concentrations are also related to the amount of grass available with the largest numbers to be found in the western regions, as shown in Table 4. The full relationship between grassland area and livestock numbers is illustrated in Map 1.

The supply of grass in the U.K. fluctuates considerably even during the growing season mainly due to the incidence of rain or drought. Livestock farmers have therefore to meet their summer grazing needs in all conditions as well as make sufficient conserved fodder to carry their animals through the winter period (in association with other feeds). Because most farmers fear a shortage of grass under very dry conditions it is often felt that British grassland tends to be understocked and hence its potential is rarely exploited to the full.

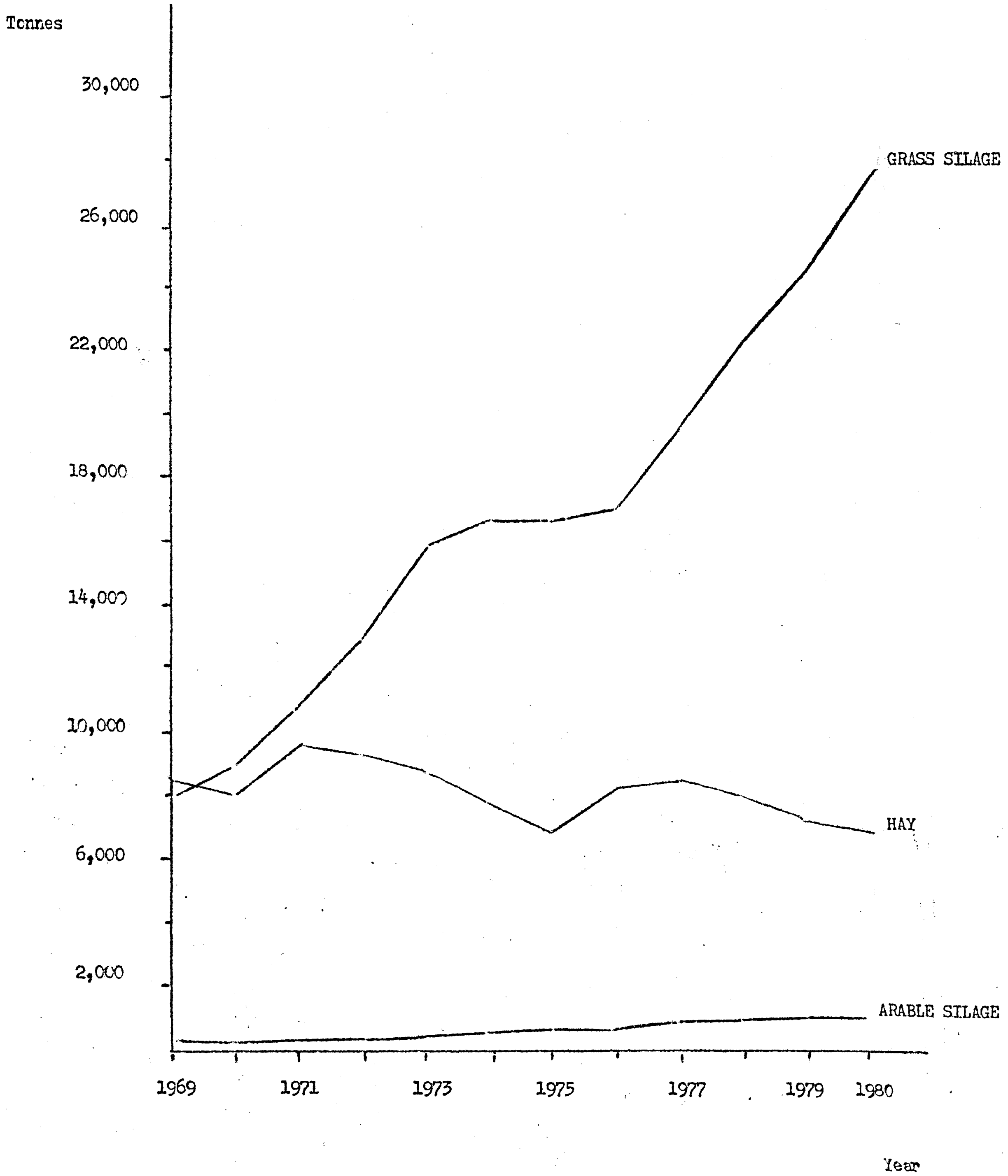
MAP 1

Area of Grassland, and Sheep and Cattle Numbers as percentage of total in England and Wales, by MAFF Region - 1980



GRAPH I

Quantities of Hay and Silage - U.K. 1969 - 1980 inclusive



Source: MAFF

II CONSERVATION

The aim of grass conservation is to preserve as much as possible of the feed value and bulk of the 'live' crop by preventing deterioration during harvesting, storing and feeding. Two main types of conserved fodder are made in the U.K. today - hay and silage. Both can provide a relatively cheap fodder of reasonable to good quality which, in association with concentrate feeds and forage crops, can maintain ruminant livestock in their productive state throughout the six/seven month winter period. Most conservation is carried out during the early summer months when grass growth and quality are at their peak and in excess of the grazing animal's requirements.

The area of grass intended only for mowing in England and Wales has fallen slightly since the late 1960s by 2.7% and in 1980 amounted to 1.7 million hectares. Of this 57% was cut for hay and 42% for silage, the remaining 1% being used for artificially dried grass.

The quantity of hay made between the late 1960s and the late 1970s in the U.K. remained reasonably stable at around 8 or 9 million tonnes, reaching a final peak of 8.6 million tonnes in 1977. (Graph 1) However the years 1978-1980 inclusive have seen less hay made with an estimated 6.9 million tonnes made in 1980. Silage, on the other hand, has increased substantially since the mid 1960s before which U.K. farmers had difficulty in making a good quality crop. Nearly 8 million tonnes of grass silage were harvested in 1969 but by 1980 this figure had more than trebled to an estimated 27.7 million tonnes in the U.K. The proportion of the total grassland area cut for hay and for silage during this period have each changed accordingly, hay falling and silage increasing. At the same time research into the technology of silage making has increased the use of silage on livestock farms, especially those carrying dairy herds. Silage of a good enough quality to provide not only the maintenance of the animals but also to contribute towards production requirements can now be made consistently.

The choice between making hay and making silage is governed by a number of factors, as follows:

1) the type of product required - a roughage or a more concentrated food stuff, in turn governed by the types and number of livestock to be fed;
2) the amount of labour involved in the making;
3) the amount of nutrients likely to be lost in the making;
4) the capital cost of the equipment required;
5) labour and equipment availability;
6) ease of integration of conservation with grazing;
7) the need to achieve maximum yields through optimum fertilizer use.

Each of the processes is now considered in turn.

II (i) HAY

Hay is the traditional conserved fodder crop in the United Kingdom and, despite the increase in the popularity of silage, it is still the major forage fed on many livestock farms, particularly those with beef cattle and sheep enterprises. Most farmers making silage also make hay.

The advantages of hay and hay-making are varied:

1) it is easy to transport and handle during the winter months for feeding to livestock, whether they be in or out-wintered;

2) some of the machinery required is not specific to hay-making i.e. tedders and balers can be used for straw;

3) hay is a saleable product and can be a valuable cash crop on all farms but especially in an arable system where grass is grown only as a break crop;

4) related to point 3), in times of shortage hay can be bought in by livestock farms;

5) small amounts of grass can more easily be conserved as hay.

The disadvantages of hay are few, but are important:

1) as a crop it is extremely weather dependent, which affects the quality of the crop made;

2) given the variable quality due to its vulnerability to weather, quality is also dependent on good management;

3) it is a relatively expensive crop to make and to buy in.

To elaborate on these points, when the grass is cut, its moisture content is high at around 80%. This level has to be reduced to 20-25% by drying the crop in the field before the crop can be baled, and further reduced to 18% before the bales can be stacked for long-term storage. This assumes that no artificial means of drying is used. If barn hay drying is employed the hay may be baled at 30-40% moisture content and then dried artificially.

Where hay is a major crop the increased nutritive value and reduction in dry matter losses will probably offset the extra power costs associated with these techniques. However, only a very small proportion of hay is barn dried and the amount is not increasing.

Stacking field hay or ceasing to blow air through barn-dried hay before sufficient moisture has been extracted leads to heating. This seriously reduces nutritive value as well as creating a fire risk. Moulds grow on damp hay creating a hazard of Farmer's Lung to workers and ill-health in livestock. Because of the amount of moisture which has to be lost between mowing and baling a minimum of four days of warm, dry weather is required to reduce the moisture level sufficiently. Hence, hay-making's main disadvantage - its dependence on good weather. In an unsettled summer in the U.K. hay can prove a very difficult crop to make. Warm, breezy conditions of low humidity are more ideally suited to drying the crop in the swath than brilliantly sunny days with very little air movement. Thus, the major objective in hay-making is to remove the moisture as quickly as possible in order to minimise the time the crop is left to dry in the field.

Initial water loss, down to 65% moisture content occurs quite quickly and easily through the stomata of the plants which stay open for a period after mowing. As the crop becomes drier, so it becomes more difficult to remove further moisture and hence the process takes longer. This is due to the closure of the stomata after which any water loss must take place through the cuticle of the plants. Use of a crimper, roller crusher, flail attachment or some other sort of conditioner which crushes or acts as an abrasive to the stems immediately after mowing, allows the internal moisture to pass out more easily resulting in a quicker drying process, shorter time in the swath and shorter period of weather dependence. As the leaves of the plants dry more quickly than the stems any process which permits quicker drying of the stems is of valuable assistance. An early tedding operation also assists the rate of initial drying of the crop.

Because of these various factors the quality of hay made in the U.K. is extremely variable and although weather plays a large part in the ability to make a good quality product, the level of management as one would expect, is of great consequence.

An important point to remember here is that it is impossible for the resulting crop to be better than the grass from which it is made. Hay quality depends on the botanical composition of the sward and on the stage of growth of the grass at cutting. The former affects the nutrient value, digestibility and earliness of maturity of the crop. Stage of growth is the most important consideration with regard to quality of the ensuing hay crop. When grass is at a young, leafy stage of growth at pre-ear-emergence, it has a high feed value in terms of protein and sugar content, but produces lower yields than when the grass is more mature. At the other end of the scale, when the ears have emerged, yields are higher but quality has started to decline due to increased fibre in the plants. Farmers have, therefore, to reach a satisfactory compromise of a reasonable yield of the crop at as good a quality as possible and there is a high premium in this respect on their managerial judgement. The situation is further complicated by the grazing of hay fields in spring, particularly by ewes and lambs, leading to variation in shutting up dates. Further losses in quality arise from continued respiration after cutting, leaching, and leaf shatter due to mechanical treatment of the crop. Rain falling on a partially dried crop washes out valuable nutrients, and if the crop has been conditioned to assist drying, then unfortunately nutrients are more readily lost from the stems. When the crop has been subjected to additional wetting further mechanical treatment in the form of tedding/turning has to take place to redry the crop. Mechanical losses, giving increased dry matter losses, rise with the number of turning treatments required, thus lowering the quantity and quality of the end product.

Additives for use on hay crops can help to prevent the development of mould on high moisture crops. However there are two major problems: one is ensuring even distribution of additives in the bale, and the second is providing an adequate concentration of additives to cope with the varying moisture content.

II (ii) SILAGE

As previously mentioned the popularity of silage as a form of grass conservation to be fed during the winter months has increased dramatically since the 1960s.

Improved technology has resulted in the ability to produce good silage of better quality, in most years. The improved standard of the fodder means generally that it can contribute nutrients for both the maintenance and production from high output ruminant animals.

The other advantages of silage are:

1) unlike hay-making it does not require perfect weather conditions; direct cut materials can be ensiled satisfactorily and wilting generally takes less than one day; it suits the British climate and especially the wetter western areas where a large number of dairy herds are to be found;
2) grassland management as a whole is easier when silage is made - excess grass growth is used when it is at its peak;
3) aftermath recovery of the sward is quicker and soiled swards are cleaned;
4) a high level of mechanisation is involved and therefore the entire operation is speedy and relatively easy to carry out by farmer or contractor;
5) silage making suits intensive livestock systems;
6) it allows the optimal use of fertiliser for high grass yields which are more easily conserved as silage than hay;
7) labour for feeding the livestock in the winter is reduced by being able to use either a mechanised feeding system or a self feeding system;
8) it is relatively cheap to make.

Disadvantages are:

1) a high capital investment in machinery is required;
2) silage is not a saleable product; generally speaking it cannot be bought in or sold as a cash crop;
3) wet silage gives problems of disposal of effluent and low DM intake by the animals;
4) wastage can be high if small amounts only are made at one time, although baled silage can overcome this difficulty;
5) it is heavier and more difficult to handle than hay;
6) it is difficult to use as a feed for outwintered cattle or sheep.

The aim of making silage is to produce a product as near as possible in quality to the grass crop from which it was made. After the crop is mowed, carted to the silo and ensiled, the sugars in the plants are fermented to lactic and acetic acids by lactobacilli bacteria present on the surface of grasses in abundance. These bacteria are micro-aerophilic and thus an environment low in oxygen concentration must be created for their active operation in the silo. The acid fermentation is equivalent to a 'pickling' of the grass crop and prevents spoiling, at the same time producing a silage of agreeable flavour to ruminant livestock. Sufficient sugars must be present for ensilage to produce enough acid to form a stable product. However, if the environment of the ensiled crop is insufficiently acid clostridial bacteria, present in faeces and soil, will be activated and result in the breakdown of proteins, giving a further rise in pH and a butyric fermentation. This is a highly undesirable substance leading to rotting and decomposition of the silage, and eventually rendering the crop unsuitable for livestock consumption.

Stage of growth at cutting is an exceedingly important factor in silage making. A high quality product is obtained by cutting the crop at full leaf stage with flower heads just starting to appear. However, as D value starts to fall with increasing maturity dry matter (DM) yield is still increasing, so the optimum is a compromise between yield and quality.

Dry sunny weather stimulates photosynthesis and hence improves sugar concentration in the plants. Cutting during these conditions will improve sugar concentration as will mowing the crop later rather than earlier in the day for the same reason.

Before ensilage the cut crop can be wilted, ideally to 25-30% DM in the swath for crops which will be ensiled in a clamp or pit. For tower silage, however, the crop must be wilted to 40% DM. The advantages of wilting are that:

1) it reduces the moisture content of the crop and thus eliminates/reduces the problem of valuable nutrients being lost in the form of effluent and minimises the risk of pollution of water courses;

2) there is a reduced weight to be carted from field to silo and thus the material is easier to handle;

3) the sugars in the plant sap become more concentrated.

However, the longer the wilting process the higher the dry matter losses from continued respiration and the greater the risk from adverse weather.

An increased level of chopping of the cut grass by the forage harvester results in:

1) better fermentation due to release of juices from stems;

2) grass being more densely packed in trailers and thus more is carried at any one time;

3) quicker wilting of the plants which reduces DM losses;

4) greater consolidation in the silo, which lessens the initial heating of the crop;

5) more efficient use of additives;

6) a shorter chopped silage which is more suitable for self feeding.

Additives are now widely used if it is suspected that the sugar concentration of the crop will be insufficient to provide a satisfactory fermentation and hence not enough acid will be produced. These can be applied to the crop either as it is collected from the field or when it is in the silo. They are in the form of sugars, acids and acid salts, sterilants, bacteria, and enzymes. Sugars promote good fermentation and are safe in use. However, they have to be applied in large quantities which can cause problems. Acids and acid salts provide a rapid acidification and inhibit microbial action, but acids tend to be corrosive and unpleasant to use. Acid salts are safer to handle than acids alone and are efficient in use. Sterilants inhibit fermentation and are generally used with acids. Bacteria and enzymes are claimed to speed up natural fermentation and are safe to use.

When the crop is ensiled air must be excluded from the silage clamp by adequate consolidation and sealing. Temporary surface sealing of the silo is often carried out overnight and a permanent seal put on as quickly as possible after the filling of the silo is complete. These measures reduce heating and dry matter losses and should eliminate surface wastage from air and rain penetration. When feeding of the silage starts, air gains access to the clamp. This is of little consequence with well-preserved compact material managed to maintain a tight face. With drier material only loosely consolidated, aerobic deterioration can be a source of loss unless the face can be removed at a sufficiently fast rate.

Thus, whilst not perhaps presenting the farmer with the same managerial challenge as hay, silage-making of good quality is certainly not without its difficulties and, as with hay, timeliness in the use of resources can be critical and have important ultimate economic consequences.

In the remainder of this report the comparative economics of these two fundamentally different methods of grassland conservation, and some of the variations within the two methods are fully explained.

SECTION 2 : HAY 1980

I INTRODUCTION

The hay-making section of this survey covered 107 farms with production per farm ranging from 5 tonnes up to 320 tonnes of hay in the 1980 season. According to the MAFF classification three-quarters of the farms were 'specialist dairy' producers and one-quarter were 'mainly dairy' producers. Thus they were all predominantly livestock farms with some 94% keeping young cattle up to two years old and 90% keeping dairy in-calf heifers. Only 31% kept other cattle of over two years old and 12% beef cows. Approximately one-third of the sample had at least some sheep on the holding. The average size of dairy herd was 70 cows ranging from the smallest herd of 12 cows up to the largest of 238.

The 107 holdings in the survey covered land amounting to 8,173 hectares of which 66% was owner-occupied and 34% rented. Obviously the majority of this area was down to grassland (72%) with one-half of the total being recorded as permanent grassland, that is, sown in 1975 or earlier. Arable land occupied 20% of the land area, the rest being rough grazing, roads and woodland. A small proportion of the grassland was let (1%) but this was more than compensated for by the much larger area of grass keep taken (475 hectares). The total adjusted grassland area for all farms was 6420 hectares equivalent.

From the recruiting survey data the sample was split into two groups based on the method of making, a small baler being used in all cases:

1) traditional methods;

2) quick methods; i.e. those which accelerated the process to some extent by the use of mower conditioners, crimpers, additives or artificial drying.

The traditionally made crops were subdivided into three size categories according to tonnage produced, in order to determine the effect of size on costs of production. Insufficient numbers in the sample of 'quick' hay crops prevented a similar analysis for this group. Details of the number of farms, average size of output, and total tonnage of each group are presented in Table 5.

Table 5 Hay-making methods

	Traditional crops by size group				Quick crops	All hay crops
	0-49 t	50-99 t	100+ t	All crops		
Number of crops	36	33	21	90	17	107
Average farm size - ha	57.4	79.4	106.5	76.9	73.6	76.4
Average size of crop - t	28.2	71.3	148.0	71.9	78.1	72.9
Total tonnage made	1014	2352	3107	6473	1328	7801
% of total output	13.0	36.3	48.0	83.0	17.0	100.0

II COSTS OF PRODUCTION

Table 6 presents the costs of production, subdivided into harvest and non-harvest costs. The harvest costs consist of labour, tractor and machinery costs, and sundry costs, the latter being almost entirely composed of twine for traditional crops and a combination of twine and additives for the quick crops. Non-harvest costs comprise a share of ley establishment, fertilisers, sprays, rent and costs of labour and machinery for cultivations and FYM spreading.

Table 6 Costs of production by method of making

	Traditional crops by size group								Quick crops	
	0-49t		50-99t		100+t		All crops			
Number of crops	36		33		21		90		17	
Average crop size - t	28.2		71.3		148.0		71.9		78.1	
	£ per t	%	£ per t	%	£ per t	%	£ per t	%	£ per t	%
HARVEST COSTS										
Labour	5.21	13.3	4.99	13.5	4.43	13.5	4.75	13.5	4.47	11.1
Tractor and machinery	13.66	34.8	11.99	32.6	9.76	29.9	11.18	31.8	14.73	36.5
Sundries	1.31	3.3	1.15	3.1	1.01	3.1	1.11	1.1	1.52	3.7
TOTAL HARVEST COSTS	20.18	51.4	18.13	49.2	15.20	46.5	17.04	48.4	20.72	51.3
Share of non-harvest costs	19.06	48.6	18.71	50.8	17.46	53.5	18.17	51.6	19.64	48.7
TOTAL CONSERVATION COSTS	39.24	100.0	36.84	100.0	32.66	100.0	35.21	100.0	40.36	100.0

For traditionally made crops the results in the table show a clear trend of decreasing cost of production with increasing size of output, ranging from £39.2 for farms producing less than 50 tonnes to £32.7 for farms producing over 100 tonnes. This trend applies to both the harvest and non-harvest share of costs but is more pronounced in the former. The average cost of producing one tonne of hay traditionally in this survey was £35.2, 48% of which was attributable to harvest costs and 52% to non-harvest costs.

The hay crops made by using some form of accelerated technique were more expensive to harvest than traditionally made crops, with an average cost per tonne of £40.36, 51% resulting from harvesting costs and 49% from non-harvest costs. Machinery was the major contributor here, accounting for 37% of total conservation costs. Labour, due to a higher level of machinery input, accounted for a slightly smaller proportion of the total costs than with traditionally made crops.

The average costs shown mask a considerable variation in range of costs incurred on particular farms. This range for each group is shown in Table 7.

Table 7 Range of costs of production by method of making

	Traditional crops by size group			Quick crops
	0-49t	50-99t	100+t	
	£ per tonne			
Range of total costs	21.7 - 80.5	21.7 - 61.7	19.7 - 49.5	26.0 - 66.7

There are two points to make concerning these figures. Firstly, the most efficient farms in each group were all producing at, or about, the same cost per tonne of hay produced with a slight cost advantage shown by the farms in the largest size group of traditionally made crops. Secondly, whilst the range in costs of production between farms was due to a number of factors, the very high costs experienced by the three farms shown above as producing at £80.5, £61.7 and £66.7 per tonne respectively were due to particularly high depreciation charges on equipment but not tractors. This may have been due to recent heavy capital expenditure by these particular farms or else they may have made a much smaller tonnage of hay than was normally the case.

The labour component of harvesting costs consisted of labour contributed by permanent male staff, youths and girls, and casual labour. For the traditional crops approximately 30% of the farms in the two smaller size categories employed some casual labour though this amounted to only 12% of the total labour bill. Only three of the farms producing over 100 tonnes employed casual labour, equivalent to 46% of the total wages bill. No casual labour was employed for any of the quick hay crops. The tractor and machinery costs identified previously have been split into their constituent parts of tractor, contract, depreciation and repairs, and sundry costs in Table 8. This table shows that for traditional crops, the decline in costs with increasing size of production is particularly noticeable with regards to the cost of depreciation and repairs. It also confirms the point made on page 18 concerning the relative incidence of contracting between the different size groups.

Table 8 Machinery costs by method of making

COST ELEMENT	Traditional crops by size group								Quick crops	
	0-49t		50-99t		100+t		All crops			
	£ per t	%	£ per t	%	£ per t	%	£ per t	%	£ per t	%
Tractor	5.48	40.1	5.27	43.9	5.26	53.9	5.30	47.4	5.88	39.9
Depreciation and repairs	6.89	50.4	5.39	45.0	4.12	42.2	5.02	44.9	7.54	51.2
Contract charges	1.26	9.2	1.27	10.6	0.38	3.9	0.84	7.5	0.84	5.7
Other costs	0.02	0.1	0.05	0.4	-	-	0.02	0.2	0.47	3.2
TOTAL MACHINERY COSTS	13.66	100.0	11.99	100.0	9.76	100.0	11.18	100.0	14.73	100.0

For hay crops made using accelerated techniques depreciation and repairs accounted for over half the machinery costs. This compares with 45% for the average of all traditionally made crops. The reverse situation occurs with regard to the cost of tractors, with lower costs for the quick crops due to a smaller tractor usage in terms of hours.

An attempt was made to compare the costs incurred on those farms employing contractors with those farms undertaking all the work with their own labour and machinery. This was done by comparing the harvest costs per tonne between the two groups for the two smaller sized categories of traditional crops, there being an insufficient number using contractors in the largest size group and for the quick hay group. Table 9 shows that the results are inconclusive with contracting farms having relatively higher costs in the 0-49 tonnes category and relatively lower costs in the 50-99 tonnes category.

Table 9 Average costs for contract and non-contract farms

	Traditional crops by size group			
	0-49t		50-99t	
	Contract	Non-contract	Contract	Non-contract
	£ per tonne			
Total harvest costs	21.9	19.3	16.7	18.6

Even if a particular group has apparently shown an economic advantage one would hesitate before concluding that this would generally be the case. This is partly because the numbers involved are relatively small and partly because in particular instances a farmer may have employed a contractor to carry out a very small part of the total operation and this will obviously affect the results as shown above. Moreover, the decision as to whether or not to employ a contractor is not solely an economic one because other factors such as availability of skilled labour, timeliness of operation, other farm commitments etc. have to be taken into account.

III LABOUR AND TRACTOR REQUIREMENTS

Table 10 shows the total labour and tractor hours on a per tonne basis for each of the four groups. The distribution of hours between the different hay-making operations is shown and these have been identified as: mowing; turning, tedding and rowing-up; baling; stacking and transporting. Those farms employing contractors have been omitted from these calculations in order to give as accurate a picture as possible of the time actually involved in each of these operations. Labour and tractor hours differ only for stacking and carting in all four groups.

Table 10 Labour and tractor usage by hay-making method

	Traditional crops by size group								Quick crops	
	0-49t		50-99t		100+t		All crops			
LABOUR HOURS	Hrs per t	%	Hrs per t	%	Hrs per t	%	Hrs per t	%	Hrs per t	%
Mowing	0.25	10.2	0.29	11.4	0.23	10.4	0.25	10.6	0.16	8.1
Turning etc	0.61	25.2	0.63	24.7	0.51	23.2	0.56	23.8	0.45	22.6
Baling	0.26	10.6	0.30	11.7	0.23	10.4	0.26	11.1	0.17	8.5
Stacking and carting	1.31	54.0	1.33	52.2	1.23	56.9	1.28	54.5	1.21	60.8
TOTAL LABOUR HOURS	2.42	100.0	2.55	100.0	2.20	100.0	2.35	100.0	1.99	100.0
TRACTOR HOURS										
Mowing	0.25	13.1	0.29	14.3	0.23	12.6	0.25	13.1	0.16	9.8
Turning etc	0.61	31.9	0.63	31.0	0.51	28.0	0.56	29.5	0.45	27.4
Baling	0.26	13.6	0.30	14.8	0.23	12.6	0.26	13.7	0.17	10.4
Stacking and carting	0.79	41.4	0.81	39.9	0.85	46.8	0.83	43.7	0.86	52.4
TOTAL TRACTOR HOURS	1.91	100.0	2.03	100.0	1.82	100.0	1.90	100.0	1.64	100.0

The table shows that for traditional methods an average of 2.35 labour hours were expended in making one tonne of hay compared to 1.90 tractor hours. Mowing and baling each accounted for about 11% of labour, turning, tedding and rowing-up 24% and the rest was taken up with the very heavy demands of stacking and transporting. The figure of 0.56 hours per tonne for turning and associated activities may not be a true reflection of the labour and tractor demands of this part of hay-making in a 'normal' year. This is because in 1980 there was a considerable amount of wet weather experienced during hay-making and, as a consequence, many farmers had to turn, ted and generally 'work' the hay much more than usual. In comparing the labour and tractor hours for the different size categories it is surprising to note that the most 'inefficient' of the three categories is the middle size rather than the smallest size. The reasons for the difference between the groups are not obvious but one suspects that the greater efficiency of the largest size category is due to the use of bigger tractors and machines. Also, the fact that this group uses relatively more tractor hours in stacking and carting the hay indicates that this whole operation is generally more mechanised for these farms. With regards to the twenty farms not completely dependent on their own labour and machinery resources 85% employed a contractor to undertake the baling and 40% to carry out the mowing operation.

Hay made by accelerated techniques used fewer labour and tractor hours than traditionally harvested crops: 1.99 labour hours and 1.64 tractor hours per tonne. Mowing and baling each consumed approximately 8% of total labour hours with turning and tedding accounting for a further 23%. The rest of the labour hours were taken up with transporting and stacking the crop.

As for the largest size group of traditionally made hay, over half of all tractor time was spent transporting the crop and similarly this suggests a high degree of mechanisation for this operation.

During a wet summer such as 1980 the advantages of accelerated techniques of making hay should be fully felt by enabling a good quality crop to be harvested despite the weather conditions. In fact less time was involved in turning and tedding operations for the quick crops than for the traditional crops and this suggests the crop was able to dry more quickly and be stored sooner, thus reducing the level of weather dependence of these crops.

IV CAPITAL INVESTMENT

The survey data was analysed in order to ascertain the distribution and extent of investment in the different types of machinery used in hay making. The figures shown for each size category represent the total investment in each type of machine divided by the total tonnage of hay for which that item was used. Those farms employing contractors have been omitted and therefore the results relate to the actual level of investment for farmers owning their own machines.

Table 11 Investment[1] in machinery by method of making

MACHINE CATEGORY	Traditional crops by size group								Quick crops	
	0-49t		50-99t		100+t		All crops			
	£ per t	%	£ per t	%	£ per t	%	£ per t	%	£ per t	%
Mower	6.45	15.1	6.01	18.2	4.04	19.2	5.10	18.0	4.63	15.2
Turner, tedder etc	11.37	26.6	6.50	19.6	4.10	19.5	6.10	21.6	6.35	20.8
Baler	13.06	30.6	13.06	39.4	7.73	36.8	10.15	35.9	11.70	38.3
Other equipment	11.86	27.7	7.54	22.8	5.16	24.5	6.91	24.5	13.93* 7.84	45.7
TOTAL INVESTMENT	42.74	100.0	33.11	100.0	21.03	100.0	28.26	100.0	30.52**	100.0

1 written down replacement values

* investment in equipment used in barn hay-drying

** barn hay-drying investment excluded from the total

Within the category labelled 'other' is included trailers, elevators and sledges with the investment per tonne being fairly evenly divided between trailers and carriers on the one hand and elevators and sledges on the other. This table confirms the point made previously relating to machinery depreciation that there is a very discernable decrease in investment per tonne with increase in size of output.

V PHYSICAL YIELDS

The survey covered the production of some 7801 tonnes of hay from 1442 hectares. Most farmers took only one cut of hay but 19 farms (18%) took a second cut though often on a very small scale. Table 12 shows the average yields obtained from first and second cuts, the former being sub-divided into those which were not grazed after 1st April and those which were grazed after 1st April and the latter between those taking a second cut after hay and those taking a second cut after silage.

Table 12 Hay yields

	1st cut		2nd cut	
	Not grazed after 1st April	Grazed after 1st April	Taken after hay	Taken after silage
Yield - tonnes per hectare	5.9	5.4	3.3	4.0
Area cut as % of total	59.6	31.0	1.8	7.6

Table 12 shows that nearly 60% of the hay area was grassland which had not been grazed afrer 1st April with the resulting yields of hay harvested higher than from all other areas. Thirty one per cent of the total area was taken for a first cut and grazed after 1st April but the ensuing average yield was lower than crops taken from grass which had been shut-up earlier in the season. Approximately 10% of the total area was cut a second time, the majority following a silage crop. Yields from the second cut were predictably substantially lower than those from the first cut, with crops taken after silage heavier than those taken after a first hay crop.

VI STORAGE AND FEEDING METHODS

Information was also collected concerning the storage and feeding of hay. The bulk of the hay was stored in Dutch Barns used for hay and straw only (72% of farms). Twenty one percent of farms stored hay on top of silage in a Dutch Barn type of building, 15% of farms used lean-to type buildings for hay storage that were used for this purpose only and 22% reported using 'other' types of buildings not identified or classified. Surprisingly only four farms reported that they stored any hay outside. Some farms used more than one type of building which is why the sum of the percentages is over 100. Table 13 shows the age distribution of these buildings according to size group with those farms producing most hay having a relatively higher proportion of younger buildings.

Table 13 Age of storage by method of making

AGE OF BUILDING - YEARS	Traditional crops by size group								Quick crops		All farms	
	0-49t		50-99t		100+t		All crops					
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0 - 9	5	12.5	9	19.1	8	23.5	22	18.2	4	21.1	26	18.6
10 - 19	9	22.1	15	31.9	12	35.3	36	29.7	5	26.3	41	29.3
20 - 29	7	17.5	8	17.0	7	20.6	22	18.2	4	21.1	26	18.6
30+	19	47.5	15	31.9	7	20.6	41	33.9	6	31.5	47	33.5
TOTAL BUILDINGS	40	100.0	47	100.0	34	100.0	121	100.0	19	100.0	140	100.0

The storage capacity of these buildings is given in Table 14 and relates to a total of 131 buildings and not 140 as in Table 13 because of a lack of information relating to some of them. Obviously one would expect a strong positive correlation between size of building and size of output and this is shown to be the case.

Table 14   Storage capacities by method of making

CAPACITY OF BUILDING - TONNES	Traditional crops by size group								Quick crops		All farms	
	0-49t		50-99t		100+t		All crops					
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0 - 49	13	35.1	19	42.2	4	13.3	36	32.1	3	15.8	39	29.8
50 - 99	15	40.5	13	28.9	8	26.7	36	32.1	6	31.6	42	32.0
100+	9	24.3	13	28.9	18	60.0	40	35.7	10	52.6	50	38.2
TOTAL BUILDINGS	47	100.0	45	100.0	30	100.0	112	100.0	19	100.0	131	100.0

The farmers in the survey were asked whether the hay was stored close to the livestock being fed or whether it had to be transported any distance to them. Two-thirds reported that they were feeding hay close to the point of storage and one-half reported that they were carting hay to livestock. Ninety-two percent of farms were feeding hay to young stock or dairy followers but only 75% reported feeding hay to dairy cows, this latter figure being due to the fact that quite a number of the farms in the smaller size categories were not feeding any hay to cows. In contrast, all of the farms in the over 100 tonnes category and all but one of the farms making hay using accelerated techniques were feeding at least some hay to cows. Surprisingly only 10% of farms were reported to be feeding any hay to sheep despite the fact that one-third of the farms in the survey had at least some sheep on the farm. (This low percentage may be partly due to fieldworker error in collecting and/or recording the information.)

SECTION 3 : SILAGE 1980

I INTRODUCTION

The silage-making section of this survey included 106 farms with production per farm ranging from 50 to 2725 tonnes of silage in the 1980 season. Seventy five percent of the co-operating farms were 'specialist dairy' in type and 20% were 'mainly dairy' according to the MAFF classification. Half the remaining 5% were 'mixed' farms and the rest 'very small' farms.

In addition to dairy cows 86% of the farms kept in-calf dairy heifers, and 94% kept young cattle of less than two years of age. Other cattle of more than two years old were to be found on 35% of holdings and sheep on 15%. Only 5% of co-operators kept beef cows.

The total area of the 106 farms in the survey amounted to 12,076 hectares, 69% of which was owner-occupied and 31% rented. Sixty four percent of the total area was taken up by grassland and 30% by arable land, the remainder being rough grazing, roads and woodland. Permanent grass, sown in 1975 or earlier, accounted for 60% of all grassland and temporary grass 40%.

From the recruiting survey data the sample was sub-divided into three silage-making methods:

1) use of a double chop forage harvester;
2) use of a precision chop forage harvester;
3) use of a forage wagon.

All silage crops were wilted prior to ensilage and stored in either clamps or pits. Sufficient numbers of co-operators produced silage by use of a precision chop forage harvester to enable the results for this group to be broken down into three size categories. Details of the number of crops surveyed, the average size of output and the total tonnage made by each method are presented in Table 15.

Table 15 Silage-making methods

	Double chop	Precision chop by size group				Forage wagon	All silage crops
		0-299t	300-599t	600+t	All crops		
Number of crops	17	14	14	53	81	10	108*
Average farm size - ha	79.4	39.2	62.9	167.0	126.9	52.4	113.9
Average size of crop - t	522.5	202.1	433.6	1070.2	810.1	535.8	739.4
Total tonnage made	8883	2829	6071	56719	65619	5358	79860
% of total output	11.1	3.6	7.6	71.0	82.2	6.7	100.0

* 2 co-operators used 2 methods of making silage.

II COSTS OF PRODUCTION

Table 16 presents costs of production, broken down into harvest and non-harvest costs, for all three silage-making methods. Harvest costs comprise labour, tractor and machinery, additives and clamp covering materials. Non-harvest costs consist of a share of ley establishment, sprays, fertilisers, rent and costs of labour and machinery for cultivations and FYM spreading.

Table 16 Costs of production by harvesting method

			Precision chop by size group									
	Double chop		0-299t		300-599t		600+t		All crops		Forage wagon	
Number of crops	17		14		14		53		81		10	
Average crop size - t	523		202		434		1070		810		536	
	£ per t	%	£ per t	%	£ per t	%	£ per t	%	£ per t	%	£ per t	%
HARVEST COSTS												
Labour	1.13	10.5	0.89	7.8	0.84	7.6	1.02	9.5	1.00	9.2	0.90	9.4
Tractor & machinery	3.29	30.6	4.46	39.4	4.08	36.7	3.18	29.5	3.31	30.6	3.42	35.8
Additives	0.12	1.2	0.27	2.4	0.36	3.3	0.34	3.1	0.34	3.1	0.09	0.9
Clamp covering material	0.15	1.4	0.19	1.7	0.09	0.8	0.13	1.2	0.13	1.2	0.12	1.3
TOTAL HARVEST COSTS	4.69	43.7	5.81	51.3	5.37	48.4	4.67	43.3	4.78	44.1	4.53	47.4
Share of Non-Harvest Costs	6.05	56.3	5.52	48.7	5.71	51.6	6.12	56.7	6.06	55.9	5.03	52.6
TOTAL CONSERVATION COSTS	10.74	100.0	11.33	100.0	11.08	100.0	10.79	100.0	10.84	100.0	9.56	100.0
Average of top 25%	13.31	-	14.56	-	14.08	-	14.00	-	14.28	-	n.a.	-
Average of lowest 25%	6.95	-	8.48	-	8.90	-	7.79	-	7.98	-	n.a.	-
No. of crops a) treated with additives	9		8		9		41		58		1	
b) as % of total	53		57		64		77		72		10	

n.a. not available

For all methods of making silage harvest costs accounted for between 43 and 51% of total conservation costs, the rest being attributable to a share of non-harvest costs. Use of a forage wagon proved to be the cheapest silage-making method in this survey - £9.56 per tonne, with little difference in cost between the double chop and the overall precision chop methods: £10.74 and £10.84 per tonne respectively. Such differences as exist are far outweighed by differencesbetween individual farms; the top quarter of farms (upper quartile in terms of cost per tonne) average nearly double the cost of the lower quartile.

Within the precision chop sample the results show that costs of conservation fall with increasing size of crop harvested, from £11.33 to £10.79 per tonne. For all silage-making methods tractor and machinery costs are the largest item in the harvest costs, contributing between 30 and 39% to the total conservation costs. Labour costs per tonne of silage were lowest for precision chop crops of 300-599 tonnes, and highest for crops harvested using a double chop harvester. Additives were applied to some crops in all groups, although only one of the ten forage wagon crops was treated in this way. In the precision chop group frequency of additive use increased with size of crop made with an overall average of 72% of crops.

Table 17 Machinery costs by method of harvesting

	Double chop		Precision chop by size group								Forage wagon	
COST ELEMENT			0-299t		300-599t		600+t		All crops			
	£per t	%	£per t	%	£per t	%	£per t	%	£per t	%	£per t	%
Tractor	1.69	51.4	1.27	28.4	1.26	30.9	1.62	50.9	1.57	47.4	1.29	37.7
Depreciation & repairs	0.97	29.5	1.10	24.7	1.52	37.2	1.04	32.7	1.08	32.6	2.11	61.7
Contract	0.63	19.1	2.09	46.9	1.30	31.9	0.52	16.4	0.66	20.0	0.02	0.6
TOTAL MACHINERY COSTS	3.29	100.0	4.46	100.0	4.08	100.0	3.18	100.0	3.31	100.0	3.42	100.0
No. of crops												
a) on which a contractor was employed	5		11		9		16		36		1	
b) as % of total	29		79		64		30		44		10	

The machinery costs presented previously have been broken down into their constituents of tractor, depreciation and repairs, and contract in Table 17. The level of use of contractors in the different groups affects other costs in this section. The incidence of contractor use was very low in the forage wagon group with only one farmer not depending entirely on his own resources for harvesting his silage. This would be expected as forage wagons tend to be used on smaller farms with lower labour availability.

For the double chop crops and for the precision chop crops over 600 tonnes, use of contractors was relatively low, 29-30% of both groups. The other two groups of precision chop crops showed employment of contractors to be quite high - 79% of those farmers making crops of less than 299 tonnes silage, and 64% of farmers harvesting crops of between 300 and 599 tonnes. The extent to which farmers relied on outside assistance varied a great deal within the sample, however, from a very small part of the silage-making process to the entire operation. The greater the part played by contractors in the whole process the lower were the depreciation and repair costs, as in the smallest group of precision chop crops where they accounted for only 25% of all machinery costs. The middle sized precision chop group, however, although relying to a large extent on contractors, had the highest depreciation and repair costs for all crops made by this method. This suggests that the farmers in this group used a combination of own equipment and contractor's machinery and labour for harvesting their crops. The labour costs for this group, shown previously, are lower than for other groups which would tend to substantiate this point.

Harvesting is more frequently done by contractors than is any other operation, and indeed for 'double chop' production 29% of farmers employed a contractor and for 'precision chop' 41% did so. For the individual size groups this means that 71% in the 0-299 tonne group, 64% in the 300-599 tonne group and 26% in the over 600 tonne group used a contractor for some part of their harvesting operation.

III LABOUR AND TRACTOR REQUIREMENTS

Table 18 presents total labour and tractor hours on a per tonne basis for each of the three groups. The distribution of hours between the different operations is shown and these have been identified as mowing, turning, harvesting, carting and work at the clamp. Those farms employing contractors have been omitted from these calculations in order to give as accurate a picture as possible.

Silage-making with a forage wagon emerged as the most economical method in terms of labour and tractor usage: 0.41 and 0.40 hours per tonne respectively. At the other extreme was the smallest size group of precision chop crops which consumed an average 0.68 labour and 0.64 tractor hours per tonne of silage made.

Turning was the least demanding operation and the one least frequently undertaken. Harvesting, carting and clamp work (buckraking, rolling and covering) each accounted for between 20 and 30% of all labour and tractor time, varying with the method of harvesting. The only operation where labour requirements exceeded those of tractors was work at the clamp, due to covering and sealing of the silo.

Table 18 Labour and tractor usage by method of harvesting

	Double chop		Precision chop by size group								Forage wagon	
			0-299t		300-599t		600+t		All crops			
LABOUR HOURS	Hrs per t	%	Hrs per t	%	Hrs per t	%	Hrs per t	%	Hrs per t	%	Hrs per t	%
Mowing	0.10	15.4	0.10	14.7	0.06	10.9	0.07	12.5	0.07	12.5	0.08	19.5
Turning	0.05	7.7	0.05	7.3	0.04	7.2	0.05	8.9	0.04	7.1	0.02	4.9
Harvesting	0.15	23.1	0.17	25.0	0.15	27.3	0.13	23.2	0.13	23.2	0.15	36.6
Carting	0.21	32.3	0.15	22.1	0.15	27.3	0.18	32.2	0.18	32.2		
Clamp work	0.14	21.5	0.21	30.9	0.15	27.3	0.13	23.2	0.14	25.0	0.16	39.0
TOTAL LABOUR HOURS	0.65	100.0	0.68	100.0	0.55	100.0	0.56	100.0	0.56	100.0	0.41	100.0
TRACTOR HOURS												
Mowing	0.10	15.6	0.10	15.6	0.06	11.8	0.07	12.7	0.07	13.0	0.08	20.0
Turning	0.05	7.8	0.05	7.8	0.04	7.8	0.05	9.1	0.04	7.4	0.02	5.0
Harvesting	0.15	23.5	0.17	26.6	0.15	29.4	0.13	23.7	0.13	24.1	0.15	37.5
Carting	0.21	32.8	0.15	23.4	0.13	25.5	0.18	32.7	0.18	33.3		
Clamp work	0.13	20.3	0.17	26.6	0.13	25.5	0.12	21.8	0.12	22.2	0.15	37.5
TOTAL TRACTOR HOURS	0.64	100.0	0.64	100.0	0.51	100.0	0.55	100.0	0.54	100.0	0.40	100.0

IV CAPITAL INVESTMENT

The information supplied regarding farmers' investment in machinery was analysed to determine the extent of investment in different types of machinery used for the silage-making operation. The results are presented in Table 19 and represent the total investment for each type of machine divided by the total tonnage of silage on which that item was used. Those operations carried out by contractors were omitted in order to arrive at the actual level of investment for farmers owning their own machines.

Table 19 Investment[1] in machinery by method of harvesting

			Precision chop by size group									
MACHINE CATEGORY	Double chop		0-299t		300-599t		600+t		All crops		Forage wagon	
	£ per t	%	£ per t	%	£ per t	%	£ per t	%	£ per t	%	£ per t	%
Mower	0.79	13.9	2.42	11.0	1.25	11.4	0.91	15.8	1.00	15.8	1.11	12.0
Turner etc	0.59	10.4	1.05	4.8	1.05	9.5	0.42	7.3	0.50	7.9	0.79	8.6
Harvester	1.90	33.4	15.93	72.5	5.97	54.2	2.52	43.9	2.79	44.1	6.93	75.2
Trailers	2.14	37.7	1.90	8.6	1.98	18.0	1.72	29.9	1.78	28.1		
Buckrake	0.26	4.6	0.67	3.1	0.76	6.9	0.18	3.1	0.26	4.1	0.39	4.2
TOTAL INVESTMENT	5.68	100.0	21.97	100.0	11.01	100.0	5.75	100.0	6.33	100.0	9.22	100.0

1 - written down replacement values

All size groups for precision chop silage production are associated with a higher level of investment than the double chop group, and a low throughput of the former is markedly more expensive in terms of investment than is a higher level of throughput. However, the investment in a harvester in the smallest size group is the average of only two holdings and may be untypically high.

For double chop silage production, trailers incur the major investment with the harvester only slightly less: 38 and 33% respectively. The situation is reversed for precision chop production, the harvester itself being the most expensive item of machinery.

Investment in equipment for farmers using a forage wagon to harvest their silage crops was on average £9.22 per tonne which compares favourably with the 300-599 tonne group of precision chop crops. The forage wagon itself, taking the place of both the harvester and the trailers, was the most expensive piece of machinery and was responsible for 75% of total investment.

V (i) PHYSICAL YIELDS

The 79,860 tonnes of silage covered by this survey were harvested from a total area of 5502 hectares, with an average of just over two cuts. Eighteen percent of farmers took only one cut of silage, 82% mowed the grass twice and a further 27% resorted to three silage cuts. Over half the total mowing area was cut once, with less than 10% of this area having been grazed after 1st April prior to mowing. There is some indication that yields from these grazed fields are lower than from the rest of the area which was not grazed before mowing. The second and third silage cuts covered 35% and 11% of the total mowing area respectively. Yields from the second and subsequent cuts are on average appreciably lower than from the first cut, as would be expected. There is little difference in yields between double chop, precision chop and forage wagon silage, but for both first and second cuts there is a consistent increase in yield per hectare with increasing throughput.

Table 20 Areas of grass mown and silage yields

	Double chop		Precision chop by size group								Forage wagon	
			0-299t		300-599t		600+t		All crops			
	Avg ha mown	Yield t per ha	Avg ha mown	Yield t per ha	Avg ha mown	Yield t per ha	Avg ha mown	Yield t per ha	Avg ha mown	Yield t per ha	Avg ha mown	Yield t per ha
First cut												
a) not grazed after 1st April	19.16	16.37	9.02	14.53	15.17	15.77	35.16	16.43	27.19	16.26	20.15	15.62
b) grazed after 1st April	2.05	15.64	1.24	13.62	2.85	15.53	2.36	21.04	2.28	20.16	12.14	17.72*
Second cut	12.54	9.20	5.30	9.65	8.53	12.80	26.88	13.13	19.85	13.02	15.31	14.19
Subsequent cuts	6.70	9.25	0.56	6.19	1.10	12.47	8.82	9.82	6.06	9.84	5.37	10.80
Total yield divided by first cut area	-	24.7	-	19.75	-	23.3	-	28.4	-	27.36	-	26.17
	%		%		%		%		%		%	
Area of second cut as percent of area of first cut	59.1		51.6		47.4		71.5		67.4		63.6	
Area of subsequent cuts as percent of area of first cut	24.7		19.8		23.3		28.4		27.4		8.7	

* Two crops only.

V (ii) CHANGES IN QUANTITIES OF SILAGE HARVESTED

Co-operators were asked to provide information regarding the quantities of silage they had harvested since 1976 and the results are provided in Table 21.

In this particular sample there has been an increase of 22 in the number of silage makers over this five year period, only one of whom harvested the crop for the first time in 1980. Farmers using forage wagons had all made silage since 1976, although as with all the sample this does not necessarily imply the same method of harvesting the crop was used for the entire period.

Table 21 Changes in quantities of silage made between 1976 and 1980

METHOD OF HARVESTING	Co-operators who made silage in 1976		Co-operators who made silage for the first time in:				Co-operators who made silage in 1980	
	Nos	Quantity - t	1977	1978	1979	1980	Nos	Quantity - t
Double chop**	11	6090	-	2	2	1	16	8803
Precision chop								
0-299t***	9	1890	2	-	3	-	14	3059
300-599t	9	2715	-	4	1	-	14	6071
600+t	46	38199	4	1	2	-	53	56719
All precision chop	64	42804	6	5	6	-	81	65849
Forage wagon*	9	4425	-	-	-	-	9	5208
TOTAL ALL METHODS	84	53319	6	7	8	1	106	79860

* One farmer used two methods, included in P.C. 0-299t, excluded from Forage wagon

** One farmer used two methods, included in P.C. 0-299t, excluded from D.C.

Table 22 Changes in quantities of silage made between 1976 and 1980 by an identical sample of 84 co-operators

METHOD OF HARVESTING	Quantities made - tonnes		% change	Number of co-operators
	1976	1980		
Double chop	6090	7831	+ 28.6	11
Precision chop				
0-299t	1890	1842	- 2.6	9
300-599t	2715	3948	+ 45.4	9
600+t	38199	50407	+ 32.0	46
All precision chop	42804	56197	+ 31.3	64
Forage wagon	4425	5208	+ 17.7	9
TOTAL ALL METHODS	53319	69236	+ 29.9	84

Table 22 shows the change in the total quantity of silage made by the original 84 co-operators between 1976 and 1980. Overall the total quantity harvested rose by nearly 30%, with only one group producing less silage in total than in 1976. This was as a result of a number of farmers each reducing the quantity made by a small amount. The remaining groups harvested between 18 and 45% more silage than 5 years previously, although there was of course large variation within each group.

VI STORAGE AND FEEDING METHODS

(a) Storage

Information on storage methods for silage crops in this survey was analysed according to harvesting method and the results are presented in Table 23.

Table 23 Silage storage by method of harvesting

METHOD OF STORAGE	Double chop		Precision chop by size group								Forage wagon	
			0-299t		300-599t		600+t		All crops			
	Capacity - tonnes	%	Capacity - tonnes	%	Capacity - tonnes	%	Capacity - tonnes	%	Capacity - tonnes	%	Capacity - tonnes	%
Field clamp away from buildings	-	-	380	9.7	-	-	1645	2.6	2025	2.8	-	-
Clamp near a building	2300	29.4	780	19.8	2250	35.2	29065	46.7	32095	44.2	750	13.5
Clamp within a building	3230	31.5	2328	59.3	3650	57.0	28856	46.3	34834	47.9	3745	67.5
Pit near buildings	4730	46.1	440	11.2	500	7.8	2590	4.2	3530	4.9	1050	19.0
Outside stack	-	-	-	-	-	-	150	0.2	150	0.2	-	-
TOTAL CAPACITY	10260	100.0	3928	100.0	6400	100.0	62306	100.0	72634	100.0	5545	100.0
Subsidiary capacity as % of total capacity	3.1		7.9		1.6		10.7		9.8		6.3	

For the entire sample the form of storage with the largest capacity was a 'clamp within a building' (47% of total capacity), with a 'clamp near a building' able to accommodate another 40% of total capacity. However, the methods of storage used varied with method of harvesting. Whereas a 'pit near buildings' was the most important method for storing double chop silage, a 'clamp within a building' was the most popular method of storage for all precision chop crops. Moreover a pit was used hardly at all. A 'clamp near a building' was also frequently used for the precision chop crops and on the farms with the highest throughput storage capacity for this method just exceeded that of a 'clamp within a building'. 'Field clamps' and 'outside stacks' found little favour.

On some farms more than one method of storing silage was adopted, and on average the subsidiary storage methods accounted for between 3 and 10% of total capacity. They represent the whole of the 'outside stack' capacity and form a large proportion of the 'field clamp' capacity.

(b) Feeding Methods

Farmers were asked what methods they used for feeding silage to their dairy cows and the data is presented in Table 24.

Table 24 Feeding methods by harvesting methods

METHOD OF FEEDING	Double chop		Precision chop by size group 0-299t		300-599t		600+t		All crops		Forage wagon	
	% of no. of records	% of cow nos.	% of no. of records	% of cow nos.	% of no. of records	% of cow nos.	% of no. of records	% of cow nos.	% of no. of records	% of cow nos.	% of no. of records	% of cow nos.
Hand fed at storage point	6.2	4.4	7.1	3.3	-	-	-	-	-	-	5.6	4.4
Hand fed, cut and carted	37.6	24.0	21.5	17.7	35.7	34.0	24.5	26.8	25.9	27.0	16.7	13.6
Self fed	50.0	44.0	64.3	70.5	57.2	55.0	49.1	45.2	53.1	48.2	72.2	76.1
Semi-automatic	-	-	-	-	7.1	11.0	7.5	7.7	6.2	7.5	-	-
Mixer wagon	-	-	-	-	-	-	12.3	12.9	8.0	10.5	5.5	5.9
Forage box	6.2	27.6	7.1	8.5	-	-	6.6	7.4	5.6	6.0	-	-
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Self-feeding of silage by the dairy herd was the most commonly adopted method, irrespective of how the silage was harvested, and throughput. However, there is evidence that as throughput increases the importance of self-feeding declines relative to other methods.

Hand feeding of silage away from the storage point was the second most important method over the entire sample, although hand feeding at the storage point was rarely practised, and was restricted to annual throughputs of less than 300 tonnes. Semi-automatic feeding or the use of mixer wagons was only found when total silage made exceeded 300 tonnes.

SECTION 4 : CONCLUSION

A summary of the main points of information arising out of this survey is presented in Tables 25 and 26.

Table 25 Hay crops: Summary by method of making

	Traditional crops by size group				Quick crops
	0-49t	50-99t	100+t	All crops	
Number of crops	36	33	21	90	17
Average crop size - tonnes	28.2	71.3	148.0	71.9	78.1
% of total output - tonnes	13.0	36.3	48.0	83.0	17.0
Total costs of production - £ per tonne	39.24	36.84	32.66	35.21	40.36
Machinery investment (i) - £ per tonne	42.74	33.11	21.03	28.26	30.52(ii)
Total labour hours - per tonne	2.42	2.55	2.20	2.35	1.99
Total tractor hours - per tonne	1.91	2.03	1.82	1.90	1.64

(i) written down replacement values
(ii) excludes barn hay drying investment

Traditionally made hay accounted for 83% of all hay included in the survey the remainder being harvested using some form of accelerated drying technique. The crops made by the latter methods were more expensive in terms of costs of production than the average of all traditionally harvested crops - £40.36 and £35.21 per tonne respectively. When the traditional crops were broken down into three size groups a variation of nearly £7 per tonne was evident, the smallest size group being the most costly. Machinery investment per tonne for quick crops (excluding barn hay drying investment) was comparable with the traditional group. For the few farms using barn hay drying an additional £13.93 per tonne was incurred in investment in machinery.

Hay crops harvested using some form of accelerated drying technique were less extravagent in their use of labour and tractor resources in 1980 than crops made in the traditional manner, which, because of the wet summer, were subjected to more turning and tedding operations than is usual.

Table 26 Silage crops: Summary by method of harvesting

	Double chop	Precision chop by size group 0-299t	300-599t	600+t	All crops	Forage wagon
Number of crops	17	14	14	53	81	10
Average crop size - tonnes	522.5	202.1	433.6	1070.2	810.1	535.8
% of total output - tonnes	11.1	3.6	7.6	71.0	82.2	6.7
Total costs of production - £ per tonne	10.74	11.33	11.08	10.79	10.84	9.56
Machinery investment (i) - £ per tonne	5.68	21.97(ii)	11.01	5.75	6.33	9.22
Total labour hours - per tonne	0.65	0.68	0.55	0.56	0.56	0.41
Total tractor hours - per tonne	0.64	0.64	0.51	0.55	0.54	0.40

(i) written down replacement values
(ii) see text page 27 for clarification

Of the three silage making methods covered by the survey, use of a precision chop forage harvester, due to its even chopping ability and high output potential, was by far the most popular, with 82% of all silage harvested in this way. A forage wagon was the cheapest method in terms of costs of production of making silage although a higher level of investment in machinery was required than for any other method: £9.22 per tonne. Use of a double chop forage harvester required the least investment in machinery by co-operators in this survey.

Because of its suitability for a small farm/labour force situation one would expect that the forage wagon would be the least extravagent in terms of labour and tractor usage and this was shown to be the case. The double chop forage harvester and the smallest size group of precision chop forage harvester, however, consumed the most labour and tractor hours per tonne of silage harvested.

These comparisons between the two approaches to conservation and the different techniques within each approach, do not, of course take into account the quality of the end product which would have required more information of a different kind than was possible from this survey.

DEFINITIONS OF TERMS USED AND COSTING METHODS

HARVEST COSTS

Labour

The number of labour hours used for the harvesting operations of each crop were recorded and standard rates of £2.20 per hour for men/women and £1.50 per hour for youths/girls were applied for both paid and unpaid labour. Casual labour was entered at actual cost.

Tractor and Machinery

(i) Tractor

Tractor hours expended on harvesting were recorded and charged at rates of between £2.60 and £6.00 per hour depending on tractor size.

(ii) Depreciation and repairs

Depreciation was calculated on a written-down replacement cost basis for machinery other than tractors, and allocated according to use on the hay/silage crops.

Repair costs were calculated using a formula based on Farm Management Survey findings according to farm size and type.

(iii) Contract charges

This covers the actual cost of hiring machines, tractors and operators.

(iv) Other costs

Included here was the actual cost of fuel to power machinery, other than tractors, with their own engines.

Sundries

This category includes cost of twine, additives and clamp covering materials.

NON-HARVEST COSTS

These consist of a share, based on livestock unit grazing weeks, of ley establishment, sprays, fertilisers, rent, and the costs of labour and machinery for cultivations and FYM spreading.

TYPES OF FORAGE HARVESTER

Double chop forage harvesters

These are trailed, offset machines consisting of knife-type flails for cutting or picking up the crop. Further chopping is performed by a flywheel chopping mechanism to which the crop is conveyed sideways by means of an auger. The material produced is not uniform in length, ranging from 5 to 15 cm. Double chop forage harvesters were designed to harvest the crop directly, but are also able to pick up the cut crop from the swath.

Precision (or metered) chop forage harvesters

This type of forage harvester is usually trailed but can also be self-propelled, and is generally used for picking up wilted crops. Most machines now have a cylinder chopping mechanism with chop length and rate of delivery to the chopping mechanism controllable. A re-cutter screen, which results in a very short chop, can also be fitted. The ability to produce a short chopped crop of uniform length are the two main characteristics of this machine and result in subsequent advantages in the ensuing silage and silage-making process ie more dry-matter is able to be carried at one time, easier handling of the crop, better consolidation and easier flow of the material for either self or mechanical feeding systems. The high initial capital cost of this type of machine is compensated for by a large increase in potential output, which is very important to the large-scale operator.

Self-loading forage wagons

Forage wagons are large mobile containers which pick up and slice the crop by means of a bank of knives at the front of the machine. Use of more knives increases the shortness of chop obtained, although chop is somewhat variable. These machines, originating in Europe, can be used in hilly conditions and are able to be operated as part of a system with a low labour requirement of two men, as opposed to the conventional forage harvester which, to be utilised efficiently, requires a team of three/four men. They are, therefore, suitable for small livestock farms with a low labour availability, offering the basis of a complete silage-making system resulting in high output in relation to labour requirements.

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