UNIVERSITY COLLEGE OF WALES
ABERYSTWYTH.

DEPARTMENT OF AGRICULTURAL ECONOMICS

GRASS DRYING IN WALES, 1949.

Experiences on Some Welsh Farms together with an Account of the Operations at a Communal Grass Drying Centre.

by

A. M. M. Rees, M.Sc.

AGRICULTURAL RESEARCH BUILDING, PENGLAIS, ABERYSTWYTH

Price: Two Shillings.

ACKNOWLEDGEMENTS.

The thanks of the Department of Agricultural Economics of the University College of Wales, Aberystwyth are tendered to the farmers whose willing collaboration made available the records which forms the basis of this report, and to the staff of the Co-operative Centres concerned for much assistance.

December, 1950. J. Pryse Howell.

GRASS DRYING IN WALES, 1949.

Experiences on Some Welsh Farms together with an Account of the Operations at a Communal Grass Drying Centre.

Section I - Introduction.

Before 1939, Britain was very largely dependent on overseas countries for supplies of feedingstuffs rich in protein. The war and the difficulties with which we have been faced in the post-war years, however, have made it necessary for the home producer to adopt measures of greater self-sufficiency. In this connection it has been realised that an increase in the productivity of grassland could do much to bridge the gap caused by the deficiency in imported supplies of protein, and, moreover, that any such increase would have to be associated with methods of conserving surplus summer grass for feeding in winter-time. Accordingly, a considerable amount of attention has been focussed recently on the conservation of grass in its different forms, particularly with regard to protein conservation.

Haymaking, silage-making and grass drying are the three methods available for conserving surplus summer grass for winter use. All three can play their part in the conservation process, but the one that can produce a product resembling most closely the pre-war imported concentrate is the artificial drying of green crops.

Grass drying is a relatively recent development in the agricultural industry. Pioneer work in this field was done in the late 1920's and early aspects/1930's by Woodman at Cambridge and, in the engineering/of the problem, by Imperial Chemical Industries Limited, and by Ransomes, Sims and Jefferies Limited. It was reported that only seven grass driers were in operation in 1933 and 1934; and the process was first demonstrated on a commercial scale in Great Britain in 1936, when 46 driers were in operation. By the outbreak of war in 1939, about 120 driers were in use; but little further progress or development was possible during the war years owing to the shortage of steel for the manufacture of plants and the general shortage of fuel. Emphasis during this period was placed instead on silage-making as a means of grass conservation. This method made fewer demands on national raw materials which were in short supply than did the artificial drying of green crops, which involved the use of steel and large quantities of fuel. With the end of hostilities, however, and the availability once more of steel for manufacture into drying plants, there has again been an increased amount of interest in grass drying and big developments have taken place. Some indication of the increase in the number of grass driers is given in Table 1.

Table 1.

Number of Grass Driers.*

	January 1946.	January 1948.	January 1950.
Anglesey	1	2	2
Brecon	-	-	1
Caernarvon	5	2	3
Cardigan	3	-	7
Carmarthen	4	4	4
Denbigh	2	1	10
Flint	-	1	5
Glamorgan	3	3	6
Merioneth	1	1	2
Monmouth	2	1	1
Montgomery	1	1	3
Pembroke	1	3	3
Radnor	-	-	1
Wales	23	19	48
England	205	300	615
England and Wales	228	319	663

* Agricultural Machinery. Results of January 1946, 1948 and 1950 Censuses. Ministry of Agriculture and Fisheries, (Statistics Branch).

Amongst post-war developments that have helped to foster the process of artificial drying is the establishment by the Milk Marketing Board of communal grass drying centres. The first of these was established experimentally during 1947 in Gloucestershire and was followed by a further eleven centres in the following year. The pioneer work of the Board with its pilot plants in the organisation of communal drying has led to the setting-up of drying centres by co-operative groups of farmers, and there is every likelihood that this form of organisation will develop further. The Ministry of Agriculture has encouraged it by the provision of grants towards the cost of approved grass drying installations, as well as by the provision of loans on favourable terms. One result has been that, for the first time in the history of the process, grass drying has been brought within measurable reach of the small farmer, and is consequently of increased interest to Welsh farmers.

Other influences which have given an impetus to grass drying in the post-war period include the increased interest of manufacturers of plant and field equipment. A large number of new types of drier have appeared on the market, varying from those suitable for a small farm to those suitable for factory-size drying centres. Mention should also be made of the appearance for the first time of mobile-type driers.

Finally, the continuing scarcity of protein-rich feedingstuffs has accentuated the necessity for grass conservation. This factor, coupled with the removal of the £36 million feedingstuffs subsidy in the spring of 1950 and the resulting rise in the price of concentrates, has made even a relatively expensive process such as grass drying attractive to many farmers.

An investigation into grass drying in Wales was initiated during the 1949 season, and in all eighteen drying plants were visited. Fifteen of these were commercial farm drying plants, only one of which did any work on a contract basis. Two centres were run by co-operative grass drying societies. The remaining centre was run as a private company. The farms and communal centres visited probably represented about 50 per cent of those in operation in Wales during the 1949 season.

This report deals firstly with the costs of dried grass production on eight farms during the summer of 1949, and secondly with the operations at a communal grass drying centre. It also attempts to assess the value of dried grass and to compare it with that of other feeds.

Section II - Farm Grass Drying.

The Farms.

The eight farms for which costs were completed were situated in the counties of Anglesey, Cardigan, Denbigh, Montgomery and Radnor. Two of them, (Nos. 2 and 3,) were over 600 acres in size. Farms Nos. 4, 7 and 8 were between 200 and 280 acres, while the other three ranged between 125 and 150 acres.

Five of the farms, (Nos. 1, 5, 6, 7 and 8,) were embarking on grass drying for the first time in 1949; Farm No. 4 had started on this method of conservation during the previous year; while the other two farms had been drying for a number of years. The drier on Farm No. 2 was in its thirteenth season, but its use during this time had been relatively slight and in all it had turned out less than 500 tons of dried grass.

In all cases dried grass was produced for supplying additional home-grown protein for farm consumption, and in no instance was grass dried with the object of sale in view. Except in the case of the two older-established driers, the farms concerned hoped ultimately to eliminate haymaking entirely from the farm routine. In all cases except one, the main enterprise on each farm was the dairy herd, for the feeding of which the dried grass was produced.

The Driers.

Five different makes of drier were installed: Opperman Mobile, Ransomes,, I.C.I. Mark III, Slade-Curran, and Kennedy and Kempe.

Two farms operated Opperman driers of the mobile-tray type. In each

case they were purchased in order to dry for part of the season on two other farms run in close conjunction with the ones costed. These other farms were situated 5 and 8 miles away respectively. One of the mobile driers operated in the field cut for drying, while the other was sited in a Dutch barn at the stackyard during its stay on the farm. One of the two farms operated a two-shift system for most of the drying on the farm, and consequently had a normal working day of fifteen hours. In the other case no fixed or regular daily period of working was organised. Both plants operated with a normal team of three men, and usually baling was carried out to keep pace with the throughput of dried material. Both farms experienced a certain amount of baler trouble, at the commencement of drying operations. After a short period of drying work the Opperman on one farm was moved permanently to the owner's second farm and a Farmac D.H. 101 Crop Dryer was purchased in its place. Both the Opperman driers were automatically oil-fired.

Two farms were equipped with conveyor-type driers, one of these being a Ransomes and the other a Kennedy and Kempe. The Ransomes drier, which had been operating for a number of years, was sited in a substantial shed and was used in conjunction with a hopper-baler sunk below ground level to facilitate the handling of the dried material. The plant was operated by two men, one stoking the furnace and feeding in wet grass and the other sweeping the dried material to the sunken baler and operating the baling mechanism. Although this drier was in its thirteenth season few repairs had been incurred, apart from the renewal of firebricks for the furnace. The Kennedy and Kempe grass drier, on the other hand, was in its first season and had been erected in the farm stackyard adjoining a Dutch barn. It was operated by two men and the previous day's dried grass was baled each morning prior to the start of drying. It was found, however, that the dried material tended to pick up a certain amount of moisture overnight. The Kennedy and Kempe drier was automatic oil-fired, while the Ransomes was stoked with anthracite. In both cases care had to be taken in the feeding in of the wet material so as to ensure that it was well shaken out and uniformly fed to the conveyor.

Fixed-tray types of drier were installed on four of the eight farms costed. Two of these were Slade-Curran driers operating for the first time during the 1949 harvest, while the other two were I.C.I. Mark III driers, one of which had been operating since the beginning of the war. Both the Slade-Curran and the I.C.I. driers are designed for 'batch drying', but their potential outputs are very different. The Slade-Curran has been designed for the small farm. It has a low output of dried grass, but has also the advantage of low capital costs and low labour requirements: it can, in fact, be operated by one man. The I.C.I. drier, on the other hand, normally requires a team of three men. It is interesting to note that the I.C.I. drier erected in 1940 cost only £417, whereas the one erected in 1948 cost £970. Again, the capital costs on one of the farms equipped with a Slade-Curran drier have been substantially increased by the use of an International Automatic Baler, the cost of which was more than 50 per cent higher than that of the drying plant. The Slade-Curran driers fitted in admirably with the general routine of a small farm, and the process of drying a batch of grass could be timed so as to cause little interference with milking and with the general farm work. Both the I.C.I. and Slade-Curran driers had coke-fired furnaces.

The capital costs of the driers are shown in Table I, (Appendix B).

The Field Equipment.

A variety of field equipment was used for cutting and delivering the grass to the driers. In most cases it was also used for other farm operations such as haymaking or silage-making, and very little machinery was specifically purchased for the field operations in connection with grass drying alone.

Only one farm, Farm No. 2, used a Cutlift. This had been operating quite satisfactorily over the previous thirteen seasons and was used in conjunction with a team of two men.

Three farms, Nos. 1, 6 and 8, were equipped with buckrakes. In the case of Farm No. 6 the haul from field to drier was short and the buckrake

only was used; but in the case of the other two farms a trailer was used for carting from the more distant fields, and the green material was either green crop loaded or forked.

Four farms relied entirely on green crop loaders, while Farm No. 8 used a green crop loader in conjunction with a buckrake. These implements were used with varying degrees of satisfaction, and, in one case, a side-delivery rake was used prior to green crop loading.

Table 2 shows the capital invested in field equipment on the different farms.

Table 2.

Capital Invested in Field Equipment.*

Farm No.	Equipment.	Original Cost.	Depreciated Value.
		£.	£.
1	Buckrake; Rake; Mower; Trailer.	173	119
2	Cutlift; Trailer.	159	28
3	Butterley Green Crop Loader; Mower; 3 Trailers.	369	289
4	International and Bamford Green Crop Loaders; 2 Trailers; 3 Mowers.	743	565
5	Butterley Green Crop Loader; Trailer; Mower.	330	262
6	Buckrake; Mower.	113	86
7	Butterley Green Crop Loader; Side-Delivery Rake; Mower; Trailer.	403	320
8	Salopian Green Crop Loader; Buckrake; 2 Trailers; Mower.	427	374

* Excluding Tractors.

Work Done by the Driers.

The costs and incidental data relating to Farms Nos. 1, 2, 3, 4 and 7 apply to the whole season's work in connection with grass drying on these farms. In the case of Farm No. 5, the make of drier used was changed after only a short period of working and the recording of costs was discontinued. The drier on Farm No. 6 dried some additional rough material from a playing field, while Farm No. 8 dried a cereal-legume mixture, and the costs in relation to these crops have therefore been excluded.

The acreages cut for drying and the yield of dried grass are shown in Table 3.

Table 3.

Acreage Cut and Yield of Dried Grass.

Farm No.	Acreage cut i.e. "Cutting Acres"**	Yield of Dried Product. Total	Per Cutting Acre.
		Tons.	Tons.
1	42.0	38.0	0.90
2	37.5	34.5	0.90
3	23.8	18.5	0.78
4	88.0	73.6	0.84
5	5.0	6.1	1.22
6	2.5	4.5	1.81
7	52.8	35.5	0.67
8	28.5	9.6	0.34

**e.g. 1 acre cut twice = 2 cutting acres.

Except in the case of Farm No. 6, where it comprised a mixture of oats, peas and beans undersown with grass seeds, all the material dried consisted of either permanent grass or temporary leys. For convenience, the term 'dried grass', has been used in this report to apply to all green material dried. Farm No. 2 dried only permanent grass while Farms Nos. 3, 4 and 8 dried a certain amount of permanent grass. In the case of Farm No. 4, 64 per cent of the acreage cut for drying consisted of lucerne-cocksfoot leys. Except for the lucerne leys on this farm, none of the fields used for grass drying was sown with a special seeds mixture for drying, although some of the farmers concerned have the intention of adopting this practice in future years. The rest of the grass dried consisted of about 50 per cent of first year seeds and 50 per cent of older leys.

During the 1949 season, 229 acres of grass were cut for the eight driers and costed. If, however, one acre cut twice is counted as two cutting acres, and one acre cut three times as three cutting acres, the total number of cutting acres amount to 280. Four of the farms took only one cut of grass for drying; another three farms cut a small area twice. Only Farm No. 7 practised the taking of more than one cut to any extent, and here three cuts were obtained from most of the grass reserved for drying. In four cases, however, that is on Farms Nos. 3, 4, 5 and 8, further cuts were taken for purposes other than grass drying, i.e. for silage or hay. In most cases the aftermath was grazed.

None of the eight driers worked to anywhere near full capacity during the 1949 season and their total output of dried material was low. Four of them operated for only two to three weeks, although the other four, on Farms Nos. 2, 4, 7 and 8, had slightly longer periods of working. The only farms that succeeded in producing in excess of 30 tons of dried material were Farms Nos. 1, 2, 4 and 7, the costed outputs on the others being slight. The only driers that worked an average of more than ten hours per day were those on Farms Nos. 1, 2 and 4. Thus, even when material for drying was available, the driers were not used to full capacity. The total costed output of dried grass on the eight farms came to 220.3 tons. (See Table 4).

Table 4.

Work Done by Driers.

Farm No.	Date of 1st Day's Drying.	Date of Last Day's Drying.	No. of Days Worked.	Average Number of Hours Worked per Day.	Total Output of Dried Material during these dates.
					Tons.
1	June 10th	June 25th	13	13.73	38.0
2	May 6th	June 10th	30	10.08	34.5
3	June 7th	June 21st	13	7.88	18.5
4	May 9th	Oct. 18th	44	13.36/	73.6
5*	May 23rd	June 4th	12	5.63/	6.1
6**	June 22nd	July 15th	14	9.00/	4.5
7⊕	May 6th	Sept. 8th	46	5.62/	35.5
8⊕	June 6th	Sept. 29th	24	5.67	9.6

* Represents 11.4 per cent of season's output on this farm.
** " 37.5 " " " " " " " "
⊕ " 80.0 " " " " " " " "
/ Excludes time spent baling.

Again, the commencement of drying for the 1949 season was relatively late on most of the farms. In certain instances it was delayed by the late delivery of newly-ordered driers or by lack of field equipment. Much of the grass intended for this purpose had reached the hay-stage before it was possible to commence operations, and the unusually good weather at hay-time also discouraged a certain amount of drying. Moreover, the prolonged drought and general shortage of grass on most farms later on in the season had a considerable effect in shortening the period of operations. In fact, the only

farms to carry on drying operations later than mid-July were Farms Nos. 4, 7 and 8. Most of the other five farmers stopped their driers with the original intention of resuming work later on in the season, but the scarcity of grass and the need to keep the dairy herds supplied with grazing made a resumption impossible. It was apparent that grass drying was as much affected by weather conditions as were most other farming activities, and in all cases far less grass was dried than was the original intention.

As regards the quality of the dried grass produced on the farms studied, results are available from only five of them. Samples submitted for analysis showed the value of the product from Farm No. 3 to be low, the dried grass having a crude protein content of between 8.0 and 9.5 per cent. In the case of the grass dried on Farm No. 4, the percentage of crude protein varied between 9.7 and 16.7. The relatively small quantity of grass dried on Farm No. 5 had an analysis of 17 per cent crude protein, while the mixture of oats, peas and beans dried on Farm No. 6 on analysis showed from 14-16 per cent crude protein. On Farm No. 7, over three-quarters of the total output of dried grass had a crude protein content of 17.5 per cent, while the remainder varied between 9 and 12 per cent.

Table 5 provides an illustration of the great range in output of the driers studied. Variation took place not only in the output of driers of different makes, but also in the output of driers of the same make. For instance, the two Opperman driers, of the same rated capacity, had very different actual outputs of dried material under field conditions on their respective farms, the amounts being 4.26 and 1.74 cwt. per hour respectively.

Table 5.

Rates of Working.

Farm No.	Make of Drier.	Total No. of Hours Worked.	Total Output of Dried Material.	Average No. of Hours Taken to Produce 1 Ton of Dried Material.	Output of Dried Material per Hour.
			cwt.		cwt.
1	Opperman Mobile	178½	76C	4.7	4.26
2	Ransomes	302½	691½	8.8	2.29
3	I.C.I. Mark III	102½	369	5.6	3.60
4	I.C.I. Mark III	586	1472¼	8.0	2.51
5	Opperman Mobile	70½	122½	15.6	1.74
6	Slade-Curran	126	90½	27.8	0.72
7	Kennedy & Kempe	258½	710¾	7.3	2.75
8	Slade-Curran	136	192¾	14.1	1.42

These figures probably reflect the influence of conditions such as the management of the plant; the stage of growth of the grass cut; the extent of 'wilting' in the field; and the moisture content of the grass used for drying.

Again, the rates of working can be examined in relation to the average number of hours taken to produce one ton of dried material. The fastest rate of output was achieved on Farm No. 1, where one of the Opperman driers was able to produce one ton of dried material in 4.7 hours of running time. A large proportion of the material dried on this farm, however, bore a closer resemblance to 'super-hay' than to high-quality dried grass. As was to be expected, the number of hours required to produce one ton of dried material in a small-type drier, such as the Slade-Curran, was considerably higher than in the case of any of the other types.

The Costs.

The costs have been grouped under three main headings:-

(1) Rent and treatment of the fields.
(2) Cutting and delivering the grass to the drier.
(3) Drying and baling.

That is, they have been grouped into the costs of growing the material for drying, the costs of collecting the raw material, and the costs actually incurred at the drier. The costs per ton of dried grass are shown in Appendix B, Table II, while the total costs incurred on each farm are set out in Appendix B, Table III.

The total costs per ton ranged from £12.1.5 on Farm No. 1 to £23.7.10 on Farm No. 8. As the type of drier used varied from farm to farm and as general conditions were also far from uniform, it is rather unfair to present average figures for the sample of farms under review; but it should be mentioned that the average cost of production of dried grass came to £16.13.8 per ton on the eight farms.

The percentage of the total costs borne by the separate operations involved in the process and the share of the costs represented by the different items are shown in Table 6.

Table 6.

Costs Per Ton of Dried Grass (Percentage Distribution).

Farm No.	1.	2.	3.	4.	5.	6.	7.	8.
	%	%	%	%	%	%	%	%
Rent and Treatment of Fields	14.2	9.4	22.8	27.3	8.9	22.1	25.9	24.6
Cutting & Delivering to Drier	14.8	20.7	24.3	15.5	7.2	6.6	15.8	22.0
Drying and Baling	71.0	69.9	52.9	57.2	83.9	71.3	58.3	53.4
Total Cost per Ton	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	%	%	%	%	%	%	%	%
Rent and Treatment of Fields	14.2	9.4	22.8	27.3	8.9	22.1	25.9	24.6
Cutting & Delivering to Drier (Horse & Traction)	4.6	7.9	8.8	5.2	1.9	2.8	4.8	7.1
Field Labour	7.9	11.9	11.2	6.5	2.5	2.1	7.2	6.7
Labour for Drying & Baling	16.0	16.8	10.3	16.8	24.9	17.1	11.0	8.2
Managerial Labour	-	-	-	2.9	-	-	-	-
Total Labour	(23.9)	(28.7)	(21.5)	(26.2)	(27.4)	(19.2)	(18.2)	(14.9)
Fuel & Power for Drying & Baling	21.3	35.5	28.2	22.5	35.5	24.9	18.0	12.6
Banding, Insurance and Sundries	3.8	4.5	2.7	3.0	1.5	4.6	2.1	3.4
Depreciation & Repairs: Field Machinery & Drying Plant	32.2	14.0	16.0	15.8	24.8	26.4	31.0	37.4
Total Cost per Ton	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

By far the most expensive item in producing dried grass on the farm was the actual operation of drying and baling. This represented between 53 per cent and 84 per cent of the total costs. The costs of cutting and delivering the grass to the drier, on the other hand, were relatively low and varied between 7 per cent and 24 per cent of the total costs.

As far as the individual items of cost were concerned the most important were fuel and power, depreciation and labour. Fuel and power accounted for 13-36 per cent; depreciation for 14-32 per cent; and labour for between 15 and 29 per cent of the total costs.

The labour costs in the field and at the drier, together with the fuel consumption and costs, are shown in detail in Appendix B, Tables IV, V, and VI. A table is also presented showing the costs incurred per hour of running time on the different farms (Appendix B, Table VII).

In order to reflect the influence of quality on the costs, the unit costs of production of crude protein have been worked out for the five farms where analyses of the dried grass are available. The results are set out in Table 7.

Table 7.

Costs of Crude Protein Production.

Farm No.	Total Costs Per Ton of Dried Grass.	Total Output of Dried Material.	Crude Protein Content.	Costs of Crude Protein Production.	
				Per lb.	Per cwt.
	£. s. d	Tons.	%.	Pence.	Shillings.
3	17. 3. 1	18.5	7.98 - 9.44	20.92	195
4	17. 5. 5	73.6	9.70 - 16.70	14.44	135
5	19. 2. 4	6.1	17.00	12.05	113
6	19. 9. 5	4.5	14.00 - 16.00	13.64	127
7	20.16. 0	35.5	9.00 - 17.50	14.09	132

From an examination of Table 7 it becomes apparent that any assessment of the relative costs of production on the different farms is inadequate if based solely on the costs per ton of dried grass. The only fair basis of comparison is in relation to the unit costs of production of crude protein. Weight is given to this view by the fact that, of the five farms listed in Table 7, the one with the highest costs of crude protein production has the lowest total costs per ton for the production of dried grass. For economy in feeding, therefore, it is obviously essential to have analyses taken of all cuts from each field, and, at the same time, to recognize the prime importance of cutting material at the correct stage of growth and of growing special leys for drying in order to achieve high protein production.

Section III - Co-operative Grass Drying.

Co-operative grass drying centres are a post-war innovation to assist in the conservation of green crops in Britain. The idea of communal grass drying is new to this country, but since 1939 it has been developed on the continent to a considerable extent and with a marked degree of success; and Switzerland, Holland, Sweden and Denmark have all had ventures in this field. The general trend in grass drying in Holland and Sweden has, in fact, been away from the small type of farm drier towards the larger installations owned either co-operatively or privately. In a report submitted in 1948 by the British Mission to study the drying green crops in Holland, Sweden and Denmark it was stated that:

> "Although all three countries visited are noted for their high proportion of small farms it was clear that there were no small grass driers being made for use on small farms. The expansion of the drying industry during the last decade has taken place along two distinct lines of development: through farmers' co-operative societies and through provender merchants, estate owners or companies operating private plants on factory lines."*

These developments on the Continent showed that communal grass drying centres afforded opportunities to the small farmer for the artificial drying of green crops, and the first experiment along these lines in

* Agriculture Overseas. Report No. 7. "Green Crop Drying in Holland, Sweden and Denmark", p. 10. H.M.S.O. 1948.

Britain took place in 1947 at Thornbury in Gloucestershire. The Milk Marketing Board, in conjunction with Imperial Chemical Industries Ltd., organised an experiment in communal grass drying amongst milk producers which laid the foundations for further developments in this field. As a result of the success of the Thornbury experiment the Milk Marketing Board set up a further eleven centres in the following year, and the lead given to farming by these pilot plants has encouraged other groups of small farmers to co-operate together in the setting up of communal grass drying centres. Again, the Government has given every encouragement to this form of development and in 1948 introduced a temporary scheme to provide grants and loans towards the initial cost of approved communal grass drying centres. This scheme has now been extended to render assistance to all approved co-operative grass drying projects in operation by June 1st. 1951.

Where grass drying was commenced before May 31st, 1948, the government grant amounted to 40 per cent of the approved total capital outlay. Since that date it has amounted to 33⅓ per cent of the total approved cost, while loans have been made available for another 33⅓ per cent of the total approved cost, repayable in four annual instalments at an interest rate of 3 per cent. Table 8 gives some indication of the expansion in co-operative drying.

Table 8.

Numbers of Communal Grass Drying Centres Operating in England and Wales 1947-1950.

	1947.	1948.	1949.	1950.
Farmers' Co-operative Societies	-	7	13	31
Milk Marketing Board	1	12	12	12
Total	1	19	25	43

In addition to the 43 centres noted above there are a further 12 schemes which have either been approved or are in course of preparation. At present there are about 3,000 farmers participating in these schemes and in 1949 approximately 16,000 tons of dried grass were produced. The total cost of the 43 centres has been about £600,000. Of this, approximately £200,000 has been contributed in the form of Ministry grants, while a similar sum has been advanced in the form of Ministry loans.

The principal reason for the establishment of communal grass drying centres is the fact that so many of the farms in Britain are limited in size and that it would be uneconomic to contemplate the installation of expensive drying plants on so many small units. Again, emphasis is given to the importance of establishing co-operative grass drying plants, particularly as an aid to milk production, by the fact that there are in England and Wales approximately 100,000 dairy farmers owning 14 cows or less. In short, if this method of conservation is to be brought within reach of the small farmers who predominate in this country the only possible means is by the establishment of communal grass drying centres, where facilities can be provided for the conservation of members' own crops at a reasonable charge.

The raison d'être for the setting-up of communal grass drying is accentuated in Wales by the smaller scale of farm operations in the Principality. Approximately 60 per cent of the milk-selling herds contain less than ten cows, while the distribution of holdings by size shows a larger proportion in the small acreage groups than is the case in England (see Table 9).

By establishing three of its twelve pioneer grass drying centres in Wales the Milk Marketing Board gave Welsh farmers a lead which they quickly followed. In fact, the first farmers' co-operative society to be established in Britain for the purpose of grass drying was a Welsh society - Gower Farm Services Ltd. - which started operations in the Gower Peninsula of Glamorgan in 1948. Several other grass drying societies have since been formed or, alternatively, existing co-operative societies have developed communal grass drying services. By the summer of 1950 there were a total of 12 centres,

Table 9.

Distribution of Holdings by Size.*

	Size of Holdings (Acres of Crops and Grass).				
	5 -25	25-100	100-300	300-700	700 and over.
	%	%	%	%	%
England	34	37	24	4	1
Wales	40	44	15	1	-
England & Wales	35	38	22	4	1

including the three Milk Marketing Board centres, operating in Wales. The complete list is as follows:-

List of Communal Grass Drying Centres Operating in Wales in 1950.**

Society or Centre.	County.
Milk Marketing Board:	
Milford Haven	Pembroke.
Pwllheli	Caernarvon
Llanwnen	Cardigan
Farmers' Co-operative Societies:	
(a) Gower Farm Services	Glamorgan
(b) Wynnstay Farmers' Association	Montgomery
(a) South Pembroke Grass Driers Assoc.	Pembroke
(b) Montgomeryshire Farmers' Assoc.	Montgomery
(a) Amaethwyr Ogwen Limited	Caernarvon
(a) Aberystwyth Grass Driers Limited	Cardigan
(a) Nantgaredig & District Grass Driers Limited	Carmarthen
(a) St. Peters Grass Driers Limited	Carmarthen
(b) Foel Agricultural Co-operative Society	Anglesey

(a) Centres organised by newly set-up grass drying societies.
(b) Centres which have been organised by a parent society.

Grass Drying at a Centre Organised by a Welsh Co-operative Society.

The Department of Agricultural Economics, University College of Wales, Aberystwyth, had the opportunity of examining the records covering the operations during the 1949 season at one of the grass drying centres operated by a farmers' co-operative society in Wales. In addition, all the farmer-members of the society were visited in order to obtain information relating to the costs of herbage production for drying. Thus, a complete record was obtained of the costs of dried grass production at this centre, together with information relating to the management and organisation of the group.

---

* National Farm Survey of England & Wales (1941-43). A Summary Report. Appendix IV, Table A2, p. 92. H.M.S.O. 1946.

** List supplied by the Welsh Agricultural Organisation Society, Limited., Aberystwyth.

The Organisation of the Centre and Capital Costs.

The 1949 season was the first full season of operations for this communal grass drying plant, and drying was commenced on 11th April. Altogether the centre operated for 132 days and drying finished for the season on 13th October. From the point of view of maintaining continuous working of a communal grass drying centre the 1949 season was far from satisfactory. Shortage of grass for drying interfered considerably with the work and as a result the centre had to close down completely for two periods. The first of these occurred between July 12th and July 25th, while the second was from September 22nd to October 4th. Again, lack of grass for drying shortened the season itself, and caused an earlier closing down of the plant than had been anticipated. It had been hoped to continue operations until the end of October or beginning of November, but the dry season again caused an early curtailment of drying. Apart from those stoppages due to light crops and to lack of grass which have already been mentioned, there were only two hold-ups at the centre; and these can be attributed to breakdowns in field equipment, which interfered with the supply of grass to the drier. Altogether, the drier operated for a total of 1,112 hours during the season, which gives an average of 8.4 hours worked per day. The throughput of dried material averaged 4.23 cwt. per hour, and on this basis it took 4.73 hours of running time to produce 1 ton of dried material.

The staff at the centre consists of a manager, a working foreman and five men, together with part-time clerical assistance. The society has also appointed a management committee to help in administration, while the Chairman and Honorary Secretary assist the manager in an advisory capacity. All the labour force is permanent, and one problem that consequently arises is that of finding remunerative work during the winter months. A machinery repair service for the benefit of members is operated in conjunction with the grass drying plant, but as this requires skilled labour it is not a wholly satisfactory solution to the problem of winter employment. It is now operated separately from the grass drying section of the society and the chief standby for the drier labour during the winter has become contract baling. Another method of keeping the labour force profitably employed during this period is by hiring it out as gang labour.

The centre has so far operated on a one-shift basis, the difficulty of obtaining labour in the area being one of the factors which has acted as a deterrent against operating a two-shift system. A five-and-a-half-day week is worked and the centre closes down for Saturday afternoon and Sunday. On weekdays the drier is in action from 7.30 a.m. until 6.0 p.m., while on Saturdays the hours are 7.30 a.m. until 12.30 p.m. Thus a total of 57½ hours is worked by the drier in a normal week. The total man hours worked during the season were 6,756, and these were shared on approximately a fifty-fifty basis between the field operations and the work at the drier itself. The total man hours required to produce 1 ton of dried grass were 28.7.

The system adopted at the centre during the period under review was that half the labour force started work at 7.30 a.m. and finished work at 5.30 p.m. on weekdays or 12.0 noon on Saturdays, while the other half started work at 8.0 a.m. and finished work half an hour later than the rest. Three men were engaged at the centre on drying and baling, while the other three were employed on field operations. Of the three fieldmen, one was fully occupied mowing and side-raking while the other two operated the tractor, trailer and green crop loader. One of the fieldmen also assisted the staff at the drier by getting the furnace fire going first thing in the morning and by stoking at mid-day or on periodic visits to the drier with a load of green material. Normally the furnace had to be fired four times each day. With this help the three men at the drier were able to cope with the drying and dealt with the baling as material accumulated. Of the six men comprising the labour force, the foreman received a wage of £6. 0. 0 for a 47-hour week plus 3s. per hour overtime, while the other five received the standard agricultural wage of £4.14. 0 plus ordinary overtime rates. In addition, a system of bonus payment on the output of dried grass was also operated and all six men qualified for this. The bonus amounted to 1s. per ton per man, making a total of 6s. per ton. For the 1949 season each man received a total bonus payment of £11.15.0.

The service provided by this particular grass drying centre covers the cutting, raking, collecting and haulage of the grass to the centre; the drying and baling of the grass; and the delivery of it back to the farmer. No arrangements are made by the society for fertilizing the fields for drying, this being left to the discretion of the individual members. Again, the method of charging for the drying services of the society is different from that adopted by a number of other communal grass drying centres, such as those operated by the Milk Marketing Board, since it is not based on a uniform charge per ton dried. Instead, a charge on an hourly basis is made and for the 1949 season this amounted to £2.10.0 per hour of actual drying time. Originally it was thought that £2. 0. 0 per hour would be sufficient to cover costs, but it was found that the rate had to be increased. The charge is based on a possible working week of 57½ drying hours and is intended to cover all costs at the centre and in the field, including overheads. This system of charging members has certain advantages over the method of charging according to the weight of dried grass produced. To begin with, it takes into account the moisture content of the material, and this enables a member to get a high throughput of super-hay or a lower throughput of high quality short grass of a high moisture content for the same cost. Again, it eliminates the necessity of weighing the grass belonging to each individual farmer, a process that becomes essential if a charge on a weight basis is made. It is also a method that ensures the fullest co-operation from the farmer whose grass is being dried, as any delay will only be an expense to himself. There is, however, one criticism that can be levelled at this system of charging and this is that throughput is bound to be lower on a wet than on a fine day, and that no allowance is made for the weather conditions under which the grass is cut and over which the member has no control.

The capital costs of the plant and field equipment are shown in Table 10.

Table 10.

Capital Costs of Plant and Field Equipment.

	Original Cost.
	£. s. d
Plant:	
I.C.I. Mark 3 Drier and Furnace	975. 0. 0
Baler	711. 0. 0
Hammer Mill	293.13. 4
Power for Fan (Electric Motor)	55. 5. 6
Shed for Drier	1,017. 3. 2
Cost of Erection of Shed and Buildings (Materials and Labour)	798.13. 1
Water Supply	49. 7. 2
Shafting, Small Tools etc.	54.19. 6
Mobile Engineering Shed	43. 0. 0
	3,998. 1. 9
Field Equipment:	
Three Trailers	218. 9. 0
Allis Chalmers Mower	55. 1. 8
Allis Chalmers Tractor	346. 0. 0
Fordson Major Tractor	330.17. 9
Butterley Green Crop Loader	174.10. 0
International Green Crop Loader	115. 0. 0
15 cwt. Ford Truck	100. 0. 0
	1,339.18. 5
Total Capital Cost	5,338. 0. 2

The total capital costs amounted to £5,338; and of this nearly £4,000 was spent on the drier and its ancillary equipment, on the cost of installation, and on the erection of a shed and buildings. A further £1,340 was expended on field equipment.

The drier installed at this centre is a coke-fired I.C.I. Mark 3. This is a fixed-tray type of drier with two pairs of trays and operates on the 'batch' system, hot air being circulated by an electrically driven fan. There are relatively few moving parts and thus maintenance is reduced to a minimum. Wet grass is loaded on the outside trays and, after the greater proportion of the moisture has been evaporated, is transferred by being forked to the inside trays where the drying process is completed. The method of operation is for one pair of trays to be dried while the other pair is being emptied and loaded with grass. The I.C.I. Mark 3 dryer is guaranteed to produce 4 cwt. per hour of dried grass from raw material containing not more than 80 per cent initial moisture, provided that the machine is worked strictly in accordance with the instructions given in the "Operating Manual" supplied with each dryer."* Owing to variations in the raw material for drying and in its moisture content, the actual throughput at the centre during the season varied considerably; but it averaged 4.23 cwt. per hour. The total consumption of fuel for the drier was 3861½ cwt. of coke. The average consumption of fuel per ton of dried material amounted to 16.4 cwt., while the consumption per hour the drier was running came to 3.47 cwt.

The centre possesses an automatic string-tying baler which is petrol-driven. Usually it has been operated for about 1¼ hours each day; and except for a certain amount of powdering of the dried material, which is more or less inevitable in baling dried grass, it has worked very satisfactorily. A hammer-mill is also included amongst the accessory equipment at the centre, but so far the demand for dried grass meal has not been great, probably owing to the difficulty and wastage that arises in feeding. It has been suggested that a cubing machine would be a useful asset at the centre and that there would be a demand amongst members for dried grass in cubed form.

All the buildings for the centre were specially erected. In order to allow for expansion a shed large enough to house twin driers was constructed. The buildings also include office accommodation and the machinery repair shop. No storage space for dried grass is provided, since the material is returned to members as it is dried and none is retained by the society for re-sale.

All the grass is cut with an Allis Chalmers mower and tractor, while all the haulage is done with a Fordson Major. The society does not possess a side-delivery rake amongst its field equipment; but, where the farmer whose grass is being cut owns one, that is generally used. During the 1949 season there was little need to practice wilting and the grass was not long in the field before loading took place. International and Butterley green crop loaders were used, but it was felt that the purchase of a cutlift for very short material would be a help. The plant has managed to operate with three large trailers, two of which were generally at the drier while one was in the field. No real difficulty was experienced in keeping the plant supplied with grass so far as haulage was concerned. It was all managed with one Fordson Major tractor, but occasionally, for instance when the centre's tractor had a puncture, assistance was rendered by the loan of a member's tractor. The average haulage distance from field to drier was something in the neighbourhood of 4½ miles each way, all members' farms being situated within approximately 6 miles of the centre. A procedure sometimes adopted to ease the haulage problem was to alternate the grass from a distant field with that from a field situated fairly near the drier. With a view to allowing the manager to supervise field operations, etc. a 15 cwt. Ford truck was in use during the 1949 season, but this is shortly to be replaced by a Land Rover which is on order.

Owing to a demand for the drying of a larger acreage, the centre was to be expanded for the 1950 season. The plans included the installation of a second drier identical with the present one. This would necessitate not only an enlargement of the shed, together with the purchase of an additional tractor and two or three extra trailers for the field operations; but also the employment of additional labour - probably four extra men - which would intensify the whole problem of winter employment.

The membership of the society for the 1949 season totalled 43 farmers, and all but one of these utilised the services of the centre for drying crops. The limiting factor in the case of the one member who did not

* The I.C.I. Mark 3 Dryer. Farm Production Series No. 5, p. 14. Imperial Chemical Industries Limited.

utilise the drier was lack of grass. In addition to the 17 members who used the centre, two non-members also had crops dried. Again, in view of the expansion for the 1950 season half a dozen additional members have been admitted to the society.

Herbage Production and Utilisation.

All the 19 farmers for whom grass was dried at the centre were visited and information was obtained relating to the costs of herbage production. Altogether a total of 333¾ cutting acres was dealt with during the season, giving an average of 2½ cutting acres for each day the drier was working. The acreages of the different crops cut for drying are shown in Table 11. Itwas apparent that greatest reliance was placed on the use of temporary leys for drying, even though a number of special crops such as lucerne and trefoil were also tried. Lucerne seems to be a particularly suitable innovation for the area, and where sown it met with a marked success. The society has received a good deal of assistance from the local N.A.A.S. Grassland Advisor in the drawing up of the season's cutting programme, as well as in the management of the leys for drying. Advice was also given regarding the sowing of special mixtures for drying, and it is encouraging to note that more and more of the members are now sowing these mixtures. By experience they have learnt the importance of producing high quality herbage for drying and have learnt, too, the part that grassland management can play in achieving this goal. The rates of application of fertiliser were fairly high and a large proportion of the total acreage received dressings of up to 10 cwt. per acre of complete fertiliser. In addition the crops were generally given fairly generous top-dressings of nitro-chalk or sulphate of ammonia in between cuts.

Table 11.

Acreages of Different Crops Cut for Drying.

Crop.	Number of Acres Cut.				Total Cutting Acres.	Percentage.
	Once.	Twice.	3 Times.	4 Times.		
Permanent Grass	31	-	-	-	31	9.3
Seeds	137	55¾	27¾	8¼	228¾	68.5
Lucerne	13	13	13	8	47	14.1
Italian Ryegrass	7½	7½	-	-	15	4.5
Trefoil	4	-	-	-	4	1.2
Oats and Vetches	4	4	-	-	8	2.4
Total	196½	80¼	40¾	16¼	333¾	100.0
Percentage	58.9	24.0	12.2	4.9	100.0	-

An attempt was made by the centre to achieve a uniform level of grass supply for the drier, and a cutting calendar was drawn up in consultation with the National Agricultural Advisory Service. Any idea of adhering strictly to such a cutting programme was out of the question in 1949, but, nevertheless, the general aim was to induce a regular succession of grass throughout the season. A number of the farmers concerned were beginning to adopt a definite system of management for their grassland in order to have a sequence of fields ready for cutting at intervals during the summer. The following two examples of sequences of cropping of grassland for drying should serve to illustrate how members of the society faced up to the problem:-

	Farm A.	Farm B.
Early-Season	Italian Ryegrass Ordinary Ryegrass Leys	Italian Ryegrass
Mid-Season	Cocksfoot-Clover Leys Lucerne Leys	Lucerne-Cocksfoot Leys Cocksfoot Leys
Late-Season	S.23 & S.24 Ryegrass	Italian Ryegrass

Originally, basic acreages for drying were allocated to members of the society, and capital for the formation of the centre was raised from members on the basis of those acreages. Thus each member of the society contributed according to the acreage of grass he intended to dry. With the expansion of the centre for 1950 it was agreed that members should each provide three times their basic acreage for drying each season. In this connection it is interesting to note that during the 1949 season no less than 59 per cent of the acreage was cut once only for drying, while only 17 per cent was cut three or more times. This was largely due to the dry summer and to lack of grass, but partly also it was due to the use of fields for other purposes besides drying. Of the 259¾ acres of permanent and temporary grass cut for drying, 72¾ acres provided a hay crop as well. In addition some fields yielded a silage crop, while others were grazed either before or after cutting. It was apparent that relatively few fields were reserved exclusively for drying purposes.

Altogether, 40 fields were used for drying, the average size of which was just under five acres. The number of cuts taken from each field varied between one and four, but actually only five fields were cut as many as four times. The average yield of dried grass per cutting acre varied considerably and ranged from 2½ cwt. to 48.2 cwt. The range in yield per cut is shown in Table 12.

Table 12.

Range in Yield of Dried Grass.

Number of Fields.	Yield per Cutting Acre. (cwt).
4	Under 5
9	5 and " " 10
27	10 " " " 15
14	15 " " " 20
14	20 " " " 25
3	25 " " " 30
3	30 " " " 35
1	Over 35

During the 1949 season the total throughput at the centre amounted to 235 tons, of which 231 tons were baled and 4 tons milled. This amount gives an average yield per cutting acre for all crops of 14 cwt. of dried grass. As far as bulk per acre was concerned, the lucerne crops exceeded those from the grass fields by 5 cwt. per acre per cut., while in the one instance where an oats and vetch mixture was dried the yield was higher still. Whereas the grass fields tended to be multi-use fields and were not exclusively reserved for drying, the lucerne fields on the other hand were all kept solely for this purpose. This resulted in a higher total output of dried grass from the lucerne fields than from the grass fields; 3 tons 5½ cwt. compared with 1 ton ¼ cwt. (see Table 13).

Table 13.

Yield of Dried Grass per "Actual Acre"* and per "Cutting Acre"**

Crop.	Actual Acres.	Cutting Acres.	Total Yield of Dried Grass.	Yield per Actual Acre.	Yield per Cutting Acre.
			Tons. Cwt.	Tons. Cwt.	Tons. Cwt.
Grass	179½	278¾	182 0	1 0¼	0 13
Lucerne	13	47	42 10	3 5½	0 18
Oats & Vetches	4	8	10 10	2 12½	1 6
All Crops	196½	333¾	235 0	1 4	0 14

* e.g. 1 acre cut once or more = 1 actual acre
** e.g. 1 acre cut twice = 2 cutting acres.

The best sample of a field showing high yield was a $4\frac{1}{4}$-acre 1st-year ley which was directly reseeded after potatoes in September, 1948. The seeds mixture consisted of ryegrass and clover - S.101, S.23, S.24, New Zealand H.1 Short Rotation Ryegrass and clovers. The field was given a good dressing of ground limestone and basic slag in the autumn; and later, in 1949, it received top-dressings of nitro-chalk and "complete". In all, four cuts for drying were taken after which the field was grazed. The yields are shown in Table 14.

Table 14.

An Example of a High Yielding Field.

No. of Cut.	Month.	Total Yield.		Yield per Cutting Acre.	Analysis.
		Tons.	Cwt.	Cwt.	(% Crude Protein)
1st.	April	3	15	17.6	19.16
2nd.	June	10	5	48.2	15.67
3rd.	July	2	7	11.1	-
4th.	August	3	0	14.1	-
All Cuts		19	7	22.8	(Average Yield per Cutting Acre)

The $4\frac{1}{4}$-acre field yielded a total of 19 tons 7 cwt. of dried grass in four cuts, which gives a figure of 22.8 cwt. per cutting acre or 91.1 cwt. per actual acre. Although the yield from this field was outstanding, it demonstrates the high level of output that can be achieved from grassland even in a dry season. Generally speaking, it was found that the later cuts in September and October had low yields.

One of the objections that is sometimes levelled at communal drying schemes is that only a relatively small acreage can be dried for individual members, with the result that only a small quantity of dried grass is available per farm. In the case of this particular centre the average quantity of grass dried and returned to the nineteen farms co-operating amounted to 12.37 tons per farm, which was not an inconsiderable contribution to their supplies of feedingstuffs. In a more normal season, when throughput should be greater, the contribution would be even higher still. The range in the quantity dried per farm is shown in Table 15.

Table 15.

Range in Quantity of Dried Grass per Farm.

Number of Farms.	Quantity of Dried Grass. (tons.)
4	Under 5
8	5 and " 10
2	10 " " 15
2	15 " " 20
1	20 " " 30
1	30 " " 40
-	40 " " 50
1	50 " " 60
19	

Of the nineteen farms which received dried grass from the centre, fifteen possessed dairy herds and in all these cases the dried grass was fed to dairy stock. The method of feeding varied considerably, but the

majority of the farmers regarded the material as a concentrate and fed accordingly. On some farms dried grass was fed once each day at a rate of 4-8 lb.; on others, two feeds were given. One farmer resorted to the practice of only feeding concentrates to cows giving over 3 gallons, and he found that this system cut down the use of purchased concentrates by one-half. Generally some of the dried grass was spared for young stock. For instance, the calves on one farm received dried grass ad lib for two months and then one feed each day plus hay. On the four farms where no dairy stock was kept the dried grass was fed to store or fattening cattle and ewes at lambing time. In one or two cases a certain amount of dried grass was sold at a price £10 above the percentage of crude protein (e.g. if percentage crude protein = 17 per cent. then selling price = 17 + 10 = £27 per ton). All the farmers visited were full of praise for the feeding qualities of dried grass, and their only complaint was lack of a large enough quantity.

Any discussion of feeding is incomplete without some reference to the analysis of the dried grass. A large number of samples were sent away during the summer for analysis, the charge for each sample being 7s.6d. Although samples were not taken from every field, enough were provided to allow a fairly good picture to be built up of the quality of the material throughout the season. (see Table 16).

Table 16.

Average Analysis of Dried Grass Samples During Different Months.

Month.	% Crude Protein.
April	15.22
May	14.27
June	15.25
July	16.97
August	17.69
September	21.38
October	13.00

The highest protein content recorded during the season was 27.53 per cent crude protein from a sample taken from a lucerne field. If the analyses of dried grass samples are examined according to the type of crop involved, lucerne shows consistently the highest percentage of crude protein (see Table 17).

Table 17.

Average Analysis of Dried Grass Samples for Different Crops.

Crop.	% Crude Protein.
Grass	14.97
Lucerne	17.97
Oats and Vetches	15.60
All Crops	15.74

Altogether analyses were available for 36 samples and for these the crude protein content averaged 15.74 per cent. The range in protein content is shown in Table 18.

Protein Analyses of 36 Samples of Dried Grass.

No. of Samples	% Crude Protein
3	10 and under 12
9	12 " " 14
11	14 " " 16
5	16 " " 18
4	18 " " 20
3	20 " " 22
1	Over 22
36	Weighted Average = 15.74

The Costs.

The total costs of herbage production and those incurred at the centre itself are set out in Table VIII (Appendix B). As far as herbage production was concerned the average costs per ton of dried grass averaged £3.11. 5, while the average costs incurred at the centre came to £11.18. 4. This gives a total cost for dried grass of £15. 9. 9 per ton, but it should be noted that certain financial charges - interest on Ministry loan, repayment of loans and bank charges - have been excluded from this figure (see Notes on Costing Method, Appendix A).

The rate of throughput of dried material at the centre is a factor that plays an important part in determining the cost to the farmer of dried grass under a system whereby an hourly rate is charged for the use of the society's facilities. The type of material for drying and its moisture content will be the basic factor determining the throughput of any one particular drier, and the throughput is found to vary inversely with the moisture content. Table IX, (Appendix B) shows the variation in cost to the farmer per ton of dried grass as a result of differences in throughput.

It was not found possible in this investigation to measure in terms of cost the effect of "wilting" on the drying process. Again, no information was available relating to the moisture content of the fresh grass brought to the drier. At the same time, however, one of the most promising avenues open to exploration as a means of reducing costs appears to be that of "wilting", or using natural means to reduce the moisture content of the fresh grass prior to drying. Partial wilting, at any rate, has been shown to cause little reduction, if any, in the feeding value of dried grass; while its results in terms of a lowering of costs could be quite large. The usual moisture content of fresh grass on a normal day is something in the neighbourhood of 80 per cent - probably slightly above this figure in the morning and slightly less in the afternoon. By partial wilting in the field for about 24 hours it is possible to reduce the moisture content to 75 per cent or less. This reduction of 5 per cent will result in the ratio of water: dry matter being reduced from 4:1 to 3:1, or, in other words, the quantity of water to be evaporated by artificial means in order to produce one ton of dried material will be less by one ton. The effect of the water content of the fresh material the quantity of water to be evaporated is illustrated in Table 19.

Table 19.

The Effect of the Water Content of the Herbage on the Quantity of Water to be Evaporated. (a)

Moisture Content of Fresh Grass.	Ratio of Water: Dry Matter. (b)	Tons of Fresh Grass Required to Produce 1 Ton of Dried Grass.	Quantity of Dried Grass (in lbs) Produced From 1 Ton of Fresh Grass.
Per cent.		Tons.	Lbs.
95	19.0 : 1	20.0	112
90	9.0 : 1	10.0	224
85	5.6 : 1	6.6	336
80	4.0 : 1	5.0	448
75	3.0 : 1	4.0	560
70	2.3 : 1	3.3	672
65	1.9 : 1	2.9	784
60	1.5 : 1	2.5	896
55	1.2 : 1	2.2	1008
50	1.0 : 1	2.0	1120
45	0.8 : 1	1.8	1232
40	0.6 : 1	1.6	1344
35	0.5 : 1	1.5	1456

(a) Calculations are based on the assumption that complete evaporation of moisture takes place.

(b) This is known as the Water-Ratio and represents the amount of water that has to be evaporated to produce 1 Ton of dried grass.

Any discussion on the costs of production of dried grass is lessened in value unless the protein analysis of the dried material is also taken into consideration. It has already been stated that the percentage crude protein for the analyses available averaged 15.74 per cent. If the costs of production of dried grass which averaged £15. 9. 9 are examined on this basis, it will be found that the cost of producing 1 lb. of crude protein averaged 10.54d. Table 20 has been constructed to illustrate how the cost of production of crude protein will vary depending on the crude protein content of the dried material, assuming a constant cost of £15. 9. 9 for producing 1 ton of dried grass.

Table 20.

Variation in Cost of Production of Crude Protein where the Cost of Production of Dried Grass is £15. 9. 9.

% Crude Protein in Dried Material.	Cost per lb. of Crude Protein.	Cost per Cwt. of Crude Protein.
%	Pence.	Shillings.
10	16.59	155
11	15.09	141
12	13.83	129
13	12.76	119
14	11.85	110
15	11.06	103
16	10.37	96
17	9.76	91
18	9.22	86
19	8.73	81
20	8.30	77
21	7.90	73
22	7.54	70
23	7.21	67
24	6.91	64
25	6.64	62
26	6.38	59
27	6.15	57
28	5.93	55

A further table showing the costs per cwt. of crude protein in dried grass produced at varying cost levels, and containing varying percentages of crude protein, is presented in Table X (Appendix B).

Section IV - The Value of Dried Grass together with a Comparison with Other Feeds.

The artificial drying of green crops is generally recognized as being the method of conservation which results in the production of material corresponding most closely, in composition and feeding value, with the properties of the original crop. As in the case of the production of all feedingstuffs, the aim of the process is to produce a feed rich in protein and starch equivalent. At the same time, however, dried grass also has the added advantage that it contains certain factors which help to promote health. It contains carotene, vitamins, a balance of minerals and certain other accessory food factors which help to enhance its value, and which it is difficult to assess. Broadly speaking, dried grass is valued on most farms for its contribution towards protein supplies; but owing to the variability in its composition and protein content its value as a feed shows wide differences. It has already been shown that the analysis of the crude protein content varied considerably from sample to sample. The extreme range within which these protein contents are found can be stated as being between 6 and 36 per cent, with the normal range lying between 11 and 24 per cent.* This variability of composition is typical of most farm-produced feedingstuffs, as opposed to the greater uniformity of composition of purchased feeds, and, thus, in any assessment of the relative value of home-grown feeds this variability in composition has to be borne in mind.

An attempt has been made in Table 21 to measure the food value per acre, in terms of starch and protein equivalent, for a number of farm-produced feedingstuffs. For these calculations the yields for dried grass and silage are based on the results of special (1949) cost investigations, while the yields for other crops are based on the unpublished results of investigations into the costs of production of certain crops in Wales for 1949.

From this assessment of the relative contributions of starch and protein provided by various farm-produced feeds on a per acre basis, it is apparent that well-managed grassland conserved in the form of dried grass or silage can contribute much towards the provision of winter food and towards the solution of the problem of self-sufficiency. If one assumes that a field reserved for drying is cut three times during the season, then its contribution towards both starch and protein supplies is quite considerable. The only other crops listed in Table 21 that approach it as sources of protein are kale, beans and silage. As a crop, however, kale is hardly comparable with dried grass, while the acreage of beans grown in Wales has never been large. Silage-making, on the other hand, is on the increase and can be expected to contribute a larger share towards winter feed supplies in the future. Dried grass and silage, particularly grass silage, therefore, are the two crops which hold most promise as sources of extra protein. An acre of grass cut three times during a season for drying at the very leafy stage can yield 685 lb. of protein equivalent. In the form of 1st quality silage, however, the yield would be only 426 lb. An acre of good meadow hay, on the other hand, would yield only 129 lb. Calculations have also been made of the yields of starch and protein on a per ton basis and these are contained in Appendix B, Table XI. Again, in terms of yield of protein per ton the contribution of dried grass is only exceeded by that of beans, and thus we are given further evidence of the relatively concentrated nature of dried grass as a feed.

A farmer who is contemplating the production of dried grass is concerned not only with the quantitative aspects of protein production, but also with the cost level at which that protein can be produced. Moreover, he is interested in the relative cost levels of protein production in different crops, and particularly in a comparison between the costs at which

---

* W. R. Muir: "The Feeding Value of Conserved Crops". Report of N.F.U. Crop Conservation Conference, May 1949, p. 38.

Table 21.

Yields of Starch Equivalent and Protein Equivalent Per Acre From Different Crops.

Crop.	Total Yield of Crop.		Yield of Starch Equivalent. (c)	Yield of Protein Equivalent. (c)
			Per Acre.	
Dried Grass:-	cwt.		lb.	lb.
3 Cuts. Very Leafy	45	(a)	2838	685
3 " Leafy	45	(a)	2606	469
3 " Early Flowering Stage	45	(a)	2520	413
3 " Lucerne Meal	65	(a)	3647	983
Grass Silage:-				
3 Cuts. 1st Quality	200	(a)	2867	426
3 " 2nd Quality	200	(a)	2822	381
3 " Hay Maturity	220	(a)	2513	345
Cereal and Legume Silage:-				
Oats, Green	126	(a)	1256	113
Vetches & Oats, green fruity	126	(a)	1806	226
Vetches & Oats, acid brown	126	(a)	1835	395
Meadow Hay:-				
Good	25.1	(b)	1040	129
Very Good	25.1	(b)	1349	219
Seeds Hay:-				
Ryegrass and Clover	29.2	(b)	1256	209
Kale:-				
Thousand Head	374.4	(b)	4319	587
Marrow-Stem	374.4	(b)	3774	545
Mangolds, intermediate	540.24	(b)	3751	242
Oats (grain)	17.69	(b)	1179	151
Beans	17.0	(b)	1253	375

(a) 1. Based on unpublished results of special Grass Drying Investigation (1949). Department of Agricultural Economics, University College of Wales, Aberystwyth.

2. A. M. M. Rees: "Silage-Making in Wales, (1949): The Present Position and Costs of Production". Department of Agricultural Economics, University College of Wales, Aberystwyth.

(b) Based on unpublished results of investigations into the costs of production of certain crops in Wales for the cropping year 1949. Department of Agricultural Economics, University College of Wales, Aberystwyth.

(c) Based on Standard Tables of Composition and Nutritive Value of Feeding-stuffs. J. C. B. Ellis: "The Feeding of Farm Livestock" (Appendix). Crosby Lockwood, 1947.

protein can be produced in dried grass, silage and hay - the three products of grass conservation. A fair assessment of the position cannot be obtained by a straight comparison between costs of production per ton or even by a comparison based on the costs per unit protein or costs per unit starch. Questions such as the general availability of feeds, their suitability for feeding to the different classes of stock, and the way in which the production of the different conservation products can be fitted in to the farm routine, are all questions which have to be considered and it is impossible to place any cash value upon them.

Table 22 has been constructed to show the relative costs of production of starch and protein in dried grass, silage, hay and a number of

Table 22.

Cost per lb. of Starch Equivalent and Protein Equivalent from Different Crops.

Crop.	Cost of Production Per Ton.	Cost per lb. of S.E.	Cost per lb. of P.E.
Dried Grass:-	£. s. d	Pence.	Pence.
3 Cuts. Very Leafy	16.10. 0 (a)	3.14	13.00
3 " Leafy	16.10. 0 (a)	3.42	19.01
3 " Early Flowering Stage	16.10. 0 (a)	3.45	21.56
3 " Lucerne Meal	16.10. 0 (a)	3.53	13.10
Grass Silage:-			
3 Cuts. 1st Quality	1.11. 3 (b)	1.31	8.81
3 " 2nd Quality	1.11. 3 (b)	1.33	9.85
3 " Hay Maturity	1.11. 3 (b)	1.49	10.87
Cereal & Legume Silage:-			
Oats, green	2.16. 4 (b)	3.39	37.73
Vetches & Oats, green fruity	2.16. 4 (b)	2.36	18.86
Vetches & Oats, acid brown	2.16. 4 (b)	2.32	10.78
Meadow Hay:-			
Good	4.11. 7 (c)	1.33	10.67
Very Good	4.11. 7 (c)	1.02	6.29
Seeds Hay:-			
Ryegrass and Clover	4. 5. 8 (c)	1.19	7.17
Kale:-			
Thousand Head	2. 0. 0 (c)	1.96	14.40
Marrow-Stem	2. 0. 0 (c)	2.24	15.51
Mangolds, intermediate	1.15. 0 (c)	3.05	47.25
Oats (grain)	11. 1. 8 (c)	2.01	15.71
Beans	19.18. 3 (c)	3.24	10.83

(a) Cost of £16.10. 0 per ton for production of dried grass derived as follows:-
Communal Centre with output of 4 cwt. per hour charging £2.10.0 per hour
Contract charge for Drying 1 Ton = £12.10. 0
Cost of Growing Herbage = 4. 0. 0
£16.10. 0

(b) Based on results of special Silage-Making investigation, 1949. A.M.M. Rees, "Silage-Making in Wales (1949), the Present Position and Costs of Production". Department of Agricultural Economics, University College of Wales, Aberystwyth.

(c) Based on unpublished results of investigations into the costs of production of certain crops in Wales for the cropping year 1949. Department of Agricultural Economics, University College of Wales, Aberystwyth.

other home-grown feedingstuffs. The costs of production for the different foods are based on the results of actual investigations in Wales in 1949, and they have been related to the usual feed-standards - starch and protein equivalent. It has been assumed that the whole value of each feed is either, firstly, in the starch equivalent, or, secondly, in the protein equivalent. From an examination of Table 22 it is apparent that the production of dried grass is by no means the cheapest method of producing an energy food. In fact, the cost per unit S.E. was found to be lower in the case of practically every other home-grown feed and dried grass could not be compared with grass silage, hay or oats as a cheap source of energy supply. The cost per lb. of S.E. came to 3.14 pence in the case of very leafy dried grass compared with 1.31 pence for 1st quality grass silage, 1.33 pence for good meadow hay and 2.01 pence for Oats (grain). But dried grass is produced primarily for its protein and not for its energy value in terms of starch equivalent. If a comparison is made on the basis of the cost per lb. of protein equivalent it is again found that the costs per unit protein are considerably higher in the case of dried grass than they are for grass silage and many other home-grown feeds. For instance, the cost per lb. of P.E. came to 13.00 pence in the case of very leafy dried grass compared with 8.81 pence for 1st quality grass silage, 10.67 pence for good meadow hay and 10.83 pence for beans. Nevertheless, despite these differences in comparative costs, producers still persist in making dried grass; and some of the reasons for the persistence can be stated as follows:-

(1) The loss of nutritive matter is much less in the case of artificial drying than that involved in other methods of grass conservation. Watson* has summarised the position in Table 23.

Table 23.

Relative Nutritive Value of Hay, Artificially-dried Crops, and Silage, Based on 100 lb. in the original crop.

Product.	Starch Equivalent. lb.	Digestible Crude Protein lb.
Fresh Crop	100.0	100.0
Artificially-dried	95.0	92.5
Silage made with sugary materials or acid	77.5	90.0
Ordinary silage	65.0	60.0
Hay made with special appliances	60.0	75.0
Hay made on the ground	55.0	67.5

(2) There is less labour involved in feeding dried grass than is necessitated by silage.

(3) There is a ready market available for the sale of dried grass at profitable prices.

(4) There is far more certainty that a feed for winter use can be conserved by artificial drying than by other means, taking into account the vagaries of the British summer and the possibilities of waste involved in silage-making.

(5) Dried grass is a far more concentrated feed than many other home-grown feeds and is more comparable with some purchased concentrates.

Cost indices have been constructed using as bases the cost per unit S.E. and cost per unit P.E. in good meadow hay and in oats (grain). An attempt has also been made to construct combined S.E. and P.E. cost indices and these

* S.J.Watson, "The Science and Practice of Conservation: Grass and Forage Crops". Table CCCCIX. P. 738. The Fertilizer & Feedingstuffs Journal. 1939.

are contained in Appendix B, Table XII.

Another method of comparison that can be applied is that of calculating feed values for the different crops based on the cost per unit of starch and protein equivalent. The unit values are calculated according to the system laid down in the "Report of the Departmental Committee on the Rationing of Dairy Cows" and are based on the market price plus carriage of two typical starchy foods, and of two high protein foods. These unit values are issued at intervals by the Ministry of Agriculture and Fisheries and, when applied to different foodstuffs, really represent their market replacement values: that is, the cost of replacing them by purchased concentrates. Table XIII (Appendix B) has been constructed on the above principle for a number of home-grown foods. At the same time, the feed value of the different crops has been related to the costs of production. The resulting margin between the feed value and the cost of production shows dried grass up in rather an unfavourable light in comparison with hay and grass silage, but it should be remembered that no allowance has been made for the value of carotene and other accessory food factors.

So far in this discussion on the value of dried grass in relation to other feedingstuffs, a comparison has been made only with home-grown feeds such as hay and silage. There has been no attempt to state categorically that one of these home-grown feeds is better than another, as it is felt that on most farms dried grass, silage and hay are not competitive but complementary to one another, and that they can all play a part in the feeding programme. It is, however, in relation to purchased feedingstuffs or concentrates that a comparison of this kind can be of value. Grass drying, as originally conceived, was designed for the production of a commodity which would replace purchased concentrate feedingstuffs, and it is in that light that much of the expansion in grass drying has been undertaken. The cheapness and abundance of purchased concentrates in pre-war days were some of the factors least encouraging to the production of dried grass, whereas today their dearness and scarcity are the factors which chiefly encourage its development. Any advantage that grass drying has must depend on whether its cost of production can compare fairly reasonably with the cost of purchased concentrates; in the remainder of this section therefore, a comparison is made between the value of dried grass and that of a number of purchased feedingstuffs.

Table 24 sets out the yields of starch equivalent and protein equivalent in dried grass and in certain purchased oil cakes and meals. It is apparent that on this basis dried grass compares not too unfavourably

Table 24.

Comparative Values of Various Feedingstuffs in Terms of Starch and Protein Equivalent.

Feedingstuff.	Starch Equivalent (a)	Protein Equivalent (b)	Yield of S.E. per Ton.	Yield of P.E. per Ton.
Dried Grass:-			lb.	lb.
Very Leafy	56.3	13.6	1261	305
Leafy	51.7	9.3	1158	208
Early Flowering Stage	51.2	8.2	1147	184
Lucerne Meal	50.1	13.5	1122	302
Oil Cakes and Meals:				
Linseed Cake	74.0	25.1	1658	562
Ground-Nut Cake, decorticated	73.0	41.3	1635	925
" " " undecorticated	56.8	27.2	1272	609
Coconut Cake	76.8	16.4	1720	367
Cotton Cake, Bombay	40.0	15.2	896	340
" " Egyptian	41.6	17.3	932	388
Palm Nut Kernel Cake, English	73.2	16.9	1640	379
" " " " Imported	81.7	13.9	1830	311
Maize, flaked	34.0	9.2	1882	206
Fish Meal, White	58.9	53.0	1319	1187
Barley Brewers' Grains, Fresh	18.4	5.3	412	119
" " " Dried	48.3	12.5	1082	280
Weatings	56.5	10.8	1266	242
Broad Bran	42.6	10.0	954	224

(a) & (b) Based on Tables of Composition and Nutritive Value of Feedingstuffs.

with certain purchased concentrates, even though it cannot be compared with the very high protein feeds such as linseed cake, ground-nut cake or fish meal. As far as yield of protein is concerned, dried grass is fairly closely analagous to flaked maize, brewers' grains, weatings and bran, and can thus be classified as an intermediate concentrate.

If the yields of starch equivalent and of protein equivalent are related either to the cost of production in the case of dried grass, or to the purchase price on the farm in the case of other concentrates, it is found that the cost per lb. of P.E. in high quality dried grass is approximately the same as in the majority of concentrates. (see Table XIV, Appendix B). As the average prices per ton for purchased concentrates are based on the prices ruling in December 1949, and as no account has been taken of the more recent increases in their cost, it appears that at today's prices the advantage rests with dried grass.

Section V - Conclusions.

Grass drying is now becoming firmly established as a regular feature of farming practice in Britain. It is a method of grass conservation, however, that has given scope to a number of different methods of organisation which can be broadly classified as follows:-

I. Commercial farm grass drying organised for:-

(a) The production of dried grass for farm use.
(b) The production of dried grass for sale.
(c) Drying crops on contract.
(d) A combination of (a), (b) and (c).

II. Co-operative grass drying organised by:-

(a) The Milk Marketing Board.
(b) An old-established Farmers' Co-operative Society.
(c) A specialist Farmers' Co-operative Society formed for grass drying.

III. Grass drying organised by a partnership of, say, half a dozen farmers for:-

(a) The production of dried grass for use on their own farms.
(b) The production of dried grass for sale.
(c) Drying crops on contract.
(d) A combination of (a), (b) and (c).

IV. Grass drying organised by a profit-making joint-stock company for:-

(a) Growing and drying its own crops for sale.
(b) Purchasing crops grown by others and drying them for sale.
(c) Drying crops on contract.
(d) A combination of (a), (b) and (c).

This report has dealt with only two methods of organising grass drying. It has dealt with some of the economic aspects of grass drying on the farm and at a communal centre organised on co-operative lines. Although these two methods differ very much from one another in some respects, the fundamental problems confronting each set of producers are basically the same.

To begin with, whether an individual farmer or a group of farmers is embarking on grass drying a certain number of considerations have to be weighed up carefully before the project is finally decided upon. These considerations include questions such as those relating to the capital requirements; the type of drier to be used and its potential output; the labour requirements and supply; the supply of material for drying; and, most important of all, the fundamental question of whether this process of grass conservation is worth undertaking.

As far as capital requirements are concerned, there is no denying the fact that heavy capital expenditure has to be incurred/and equipment for

grass drying. Even for a small type of drier the minimum initial capital outlay can be placed at between £1,000 and £2,000, while in the case of a communal centre £6,000 - £12,000 is generally required. The number of farmers who can afford to raise £1,000 - £2,000 for investment in a new farm enterprise such as grass drying is bound to be limited, especially in a country like Wales where the scale of farming activity tends to be small. On the majority of Welsh dairy farms, even where the capital is available, it is probably true to say that it could be more profitably invested either in the improvement of buildings or in the purchase of more essential machinery than in the outlay on plant and equipment for grass drying. It is evident that as an individual farm enterprise this method of grass conservation is beyond the means of the majority of farmers, and can be contemplated only by the minority who are more successful and in a bigger way of business. On the other hand, grass drying along co-operative lines is an altogether different proposition and opens up possibilities of bringing the artificial drying of crops within the reach of the thousands of small dairy farmers who predominate in this country. By contributing, say, £200 towards the share capital of a co-operative grass drying society, a farmer may have the opportunity of drying 20 cutting acres each season at a fixed contract charge, and in terms of dried grass this acreage may yield him 20 tons of valuable winter feed. The financial assistance available from Ministry of Agriculture funds has lessened the capital demands on individual farmers and has given an added incentive to this type of organisation.

There are today in Great Britain at least fifteen different manufacturers who are interested in the production of grass driers, and the drying plants on the market range from the small-size farm drier to the large factory installation. The price range is also considerable, while the rated outputs of the different machines vary from about 1 cwt. to 20 cwt. per hour. The farmer or group of farmers contemplating the installation of a grass drier thus has a wide range of types to choose from and can select according to the circumstances prevailing. At the same time, however, the advantages of economy accruing from the use of automatic stoking arrangements for the furnace and from the use of automatic feeding and tedding devices for the wet grass should not be ignored. Nevertheless, the prime consideration should be reliability of working; and in this respect driers possessing the minimum of moving parts seem to have an advantage.

The introduction of a grass drier to the farm may involve a serious dislocation in the organisation of the farm labour supply, and may result in undue interference with regular farm work. In order to eliminate as much as possible any such interference, it was generally found advisable on most farms to ignore the possibility of continuous working of the drier and to rely instead on the operation of a single shift, corresponding to an ordinary farm working day with possibly the addition of some overtime. Again, with the smaller type of drier with its lower labour requirements, there are possibilities of organising drying to fit in between the morning and evening milkings. Nevertheless, if the advantages of continuous working are to be obtained and if a fairly long drying season is contemplated, the factory-like process of grass drying will inevitably result in the imposition of a considerable strain on the farm personnel unless the labour force is supplemented by additional labour. The operation of a drying plant, whether small or large, calls for continual skilled attention and will thus demand either a fair amount of the farmer's managerial time or else the employment of reliable men at the plant. In the same way, much of the success in running a co-operative grass drying centre will depend on the ability of the manager. Moreover, one of the problems that has to be faced in the organisation of any communal centre is the employment of the labour force in winter. Unless profitable work can be found during the non-drying winter months the overhead labour costs will be heavy. On the other hand, if the labour force is employed only seasonally and dispensed with at the end of the drying season, then the question of obtaining a fresh gang and training it will have to be faced each year. Some advantage may lie in the organisation of communal grass drying as an adjunct to existing farmers' co-operative requisite societies rather than as a separate entity, since the drier labour force could then be absorbed on work for the parent society during the winter months.

Possibly the most important consideration that has to be borne in

mind when deciding whether or not to embark on grass drying is the adequacy or otherwise of the supply of material for drying. The dry season of 1949 has shown that grass drying can be seriously affected by prevailing weather conditions, but the risks of a shortage of herbage supply can be reduced by planning and by good grassland management. A problem that can be practically as serious as under-supply is over-supply; and this involves the problem of maintaining a high enough output from the drier to keep pace with the growth of herbage. A method that can sometimes be employed to combat this difficulty on the farm is to divert surplus grass to silage-making, and to regard the two methods of grass conservation as complementary to one another. Above all, however, as the ultimate value of the product must depend on the original value of the grass cut for drying, the success or failure of the process is bound to depend on the ability to induce a succession of good quality grass throughout the season. On the average farm there are many difficulties to surmount before such a flow of good quality grass can be achieved, and the number of farms where the grassland acreage is large enough to supply the needs of a drier working continuously is small. It thus appears that in the majority of cases of farm grass drying full and continuous output cannot be achieved, and the drier will produce only a percentage of its potential output each season. A communal grass drier, on the other hand, stands a considerably greater chance of producing an output approaching its potential, and from the point of view of efficiency in that light has to that extent a considerable advantage over the farm grass drier.

After some of the economic considerations relating to both farm and communal grass drying have been examined, there still remains the question of whether this method of grass conservation is worth while. Such a question must be looked at not in isolation, but in relation to conditions on individual farms and to external factors such as the price levels of feedingstuffs. From the discussion on the value of dried grass in comparison with other feeds, it was seen that at today's cost of production it compared fairly favourably with purchased feedingstuffs as a source of protein. The relationship between the cost of production of dried grass and the purchase price of concentrates is bound to be one of the most important factors deciding the future of the process. At present, purchased feeds are in short supply, and they show every sign of continuing to be so in the immediate future. Moreover, their price still shows an upward trend; and it is doubtful whether the British farmer can ever hope to look forward to the day when cheap concentrates will be readily available once more. If, therefore, the present relationship between costs continues, there is every incentive to continue also the expansion of grass drying, particularly on a co-operative basis. This argument applies especially in Wales and in the wetter western parts of Britain, where there are limiting factors to the attainment of self-sufficiency in feedingstuffs by way of growing cereals, but where grass can be readily produced and is thus available for conservation. Again, in an area such as Wales, where more often than not the hay crop has to be harvested under poor weather conditions, the production of dried grass offers an alternative which has the advantage not only of certainty but also of higher quality. If silage-making is suggested as a substitute for grass drying, the answer can be given that the two methods of conservation are not competitive, but complementary to one another. It is possible even to envisage the time when much of the grass conservation in Wales will be a matter of silage-making on the farms, on the one hand, complemented by grass drying at co-operative centres, on the other; the advantage of such a system being the elasticity and flexibility which would inevitably be introduced into the farming system as a result of it. Again, if enthusiasm for grass drying is any indication of its merits, the general satisfaction both in the product as a feed and in the process as a whole, experienced by both grass drying farmers and by participants in co-operative schemes, should be sufficient evidence to justify its expansion.

APPENDIX A.

Notes on Costing Method.

Rent and Treatment of Fields.

Grassland Overheads. A figure of 12½ per cent was added to the grassland costs to cover the cost of maintaining ditches, gates, hedges etc., and other grassland overheads.

Allocation of Grassland Costs. Based on the use made of each field during the year, whether for grass drying, silage-making, haymaking or grazing. The apportionment was roughly as follows:-

8/9ths. where the whole of the summer's production went for drying;
1/3rd. to each cut if the grass was cut twice;
2/9ths. to each cut if the grass was cut more than twice;
16/27ths. where the grass was cut once only, at the hay stage;
4/9ths. where the grass was cut once only, fairly young;
8/27ths. where the aftermath only was cut.

Cutting and Delivering the Grass to the Drier.

Labour. Except where special rates of pay applied, labour was charged at 2s.3d. an hour, ordinary time, and 2s.6d. an hour overtime.

Traction. The rates per hour for the different categories of tractor were:

Light	-	2s.6d. per hour
Medium	-	2s.9d. " "
Heavy	-	3s.0d. " "
Crawler	-	4s.6d. " "

Horse Labour. Charged at 1s.2d. per hour.

Depreciation of Field Equipment. Inland Revenue rates were used, but these were apportioned on a rough time-basis to cover the period of use for grass drying. In the case of the costs relating to the co-operative drying centre only 60 per cent of the depreciation was allowed, the remaining 40 per cent being accounted for by the Government grant.

Drying and Baling.

Power. Where power was derived from a stationary tractor, the tractor was charged at the standard rate per tractor hour, but 28 per cent of the total charge was allocated as representing depreciation.

Depreciation. In the case of the driers, this was based on the diminishing balance method; and the following rates were used for the different types of drier:-

15 per cent for Mobile type driers
12½ " " " Conveyor " "
10 " " " Tray " "

Unfortunately, this method of depreciation takes no account of the varying amounts of work done by the different driers each season, and no weight is given to the number of hours worked, or the total season's throughput. However, the potential working life of grass driers is extremely difficult to estimate, and it was decided that it would be unfair to base depreciation on any hypothetical estimate of future life. Again, it was

felt that with those types of equipment which, like driers, are in the process of rapid technical development, obsolescence factors would have a considerable influence. The diminishing balance method was thus used as according most closely to the facts. For an alternative method see:

Dixey & Askew: "Grass Drying: A study of production costs in 1936", (Oxford, Agricultural Economics Research Institute, 1937, p. 28).

Buildings & Sheds. Basis of depreciation used was an estimated life of 40 years.

Engines. Basis of depreciation used was an estimated life of 20 years.

Shifting. Basis of depreciation was an estimated life of 10 years.

Balers. Inland Revenue rate of 12½ per cent used.

In the case of equipment used for work other than grass drying, depreciation was allocated. Again, in the case of the costs relating to the co-operative drying centre, only 60 per cent of the total depreciation was allowed, the remaining 40 per cent being accounted for by the Government grant.

Overheads and Administration.

The majority of charges falling under this heading were allocated in order to make allowance for the other activities of the co-operative grass drying society.

Overhead Labour. The wages incurred during the summer period when the drier was idle, less any receipts earned by the labour force during these weeks, were charged as overhead labour.

APPENDIX B.

Table I.

Capital Costs of the Driers.

Farm No. / Drier No.	1.	2.	3.	4.	5.	6.	7.	8.
Make	Opperman Mobile.	Ransomes.	I.C.I. Mark III.	I.C.I. Mark III.	Opperman Mobile.	Slade-Curran.	Kennedy & Kempe.	Slade-Curran.
Type of Drier	Mobile Trays.	Conveyor.	Fixed Trays	Fixed Trays	Mobile Trays.	Fixed Trays	Conveyor.	Fixed Trays
Year of Installation	1949	1937	1940	1948	1949	1949	Nov. 1948	1949
	£.	£.	£.	£.	£.	£.	£.	£.
Drier and Furnace with Cost of Erection	1125	599	417	970	1150	450	1143	450
Power	48*	381	154	70	150*	32	133	63
Baler	100	185	195	234	253	710	225	225
Shed	-	694	176	1293	-	-	-	200
Type of Power	Stationary Tractor	Electric Motor	Diesel Engine	Electric Motor	Stationary Tractor	Paraffin Engine	Diesel Engine	Paraffin Engine

* Fuel Tanker.

Table II.

Costs per Ton of Dried Grass.

Farm No.	1.	2.	3.	4.	5.	6.	7.	8.
Rent & Treatment of Fields:-	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d
Rent	0.13. 1	0.18. 0	0.14. 5	1. 6. 2	0. 7. 3	0.11. 6	0.19. 0	1. 2. 5
Cultivations	0. 4. 9	0. 1. 4	0.17. 9	0. 9. 0	0. 2. 0	0.12.10	1. 6. 5	0.14. 5
Fertilisers	0. 7. 0	0. 3. 0	1. 9. 8	1.14. 1	0. 3. 5	0.15. 7	2. 1. 8	1.19.11
Seeds	0. 5. 8	-	0. 7. 8	0.14. 8	0.17. 8	1.16. 8	0. 8. 7	1. 5. 5
Grassland Overheads	0. 3.10	0. 2.10	0. 8. 8	0.10. 6	0. 3.10	0. 9. 7	0.11.11	0.12. 9
Total	1.14. 4	1. 5. 2	3.18. 2	4.14. 5	1.14. 2	4. 6. 2	5. 7. 7	5.14.11
Cutting & Delivering to Drier:-								
Labour	0.19. 2	1.11. 8	1.18. 4	1. 2. 6	0. 9. 7	0. 8. 1	1. 9.11	1.11. 6
Traction	0.11. 1	1. 1. 1	1.10. 1	0.18. 1	0. 7. 2	0.10. 9	0.18.11	1.13. 5
Depreciation and Repairs	0. 5. 5	0. 2. 4	0.14.11	0.12.10	0.10. 9	0. 6.10	0.15.11	1.18. 2
Horse Labour	-	-	-	-	-	-	0. 1. 2	-
Total	1.15. 8	2.15. 1	4. 3. 4	2.13. 5	1. 7. 6	1. 5. 8	3. 5.11	5. 3. 1
Drying and Baling:-								
Labour	1.18. 8	2. 4. 9	1.15. 6	2.17.10	4.10. 6	3. 6. 6	2. 5. 8	1.18. 2
Managerial Labour	-	-	-	0.10. 0	-	-	-	-
Fuel	2. 0. 0	3.11. 6	4. 7. 0	3.11. 5	5.10.10	4. 9. 0	3. 9. 9	1.18. 9
Power	0.11. 4	1. 3. 2	0. 9.11	0. 6. 4	1. 4.11	0. 7.11	0. 5. 4	1. 0. 4
Banding and Sundries	0. 6. 7	0. 8. 5	0. 3. 2	0. 8.10	0. 4. 0	0.14. 0	0. 5. 6	0.11. 7
Repairs	0. 2. 7	0. 4. 4	-	0. 1. 5	-	-	0. 5. 9	-
Depreciation of Plant	3. 9. 8	1.10.10	1.19.11	2. 0. 5	4. 3.10	4.16. 0	5. 7. 4	6.16.10
Insurance	0. 2. 7	0. 3. 6	0. 6. 1	0. 1. 4	0. 1.10	0. 4. 2	0. 3. 2	0. 4. 2
Moving and Erecting Drier	-	-	-	-	0. 4. 9	-	-	-
Total	8.11. 5	9. 6. 6	9. 1. 7	9.17. 7	16. 0. 8	13.17. 7	12. 2. 6	12. 9.10
Total Costs	12. 1. 5	13. 6. 9	17. 3. 1	17. 5. 5	19. 2. 4	19. 9. 5	20.16. 0	23. 7.10

Table III.

Total Costs of Dried Grass Production.

Farm No.	1.	2.	3.	4.	5.	6.	7.	8.
Rent & Treatment of Fields	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d
Rent	24.17. 9	31. 2. 3	13. 6. 8	96. 8.11	2. 4. 5	2.11.11	33.16. 2	10.15.11
Cultivations	9. 1. 3	2. 5. 2	16. 7. 0	33. 1. 6	0.12. 4	2.18. 3	46.18. 6	6.19. 2
Fertilisers	13. 6. 8	5. 3. 8	27. 7. 6	125. 7. 8	1. 0.11	3.10. 7	73.19. 6	19. 4. 9
Seeds	10.15. 1	–	7. 1. 6	53.19. 1	5. 8. 4	8. 5.11	15. 5. 7	12. 5. 0
Grassland Overheads	7. 5. 1	4.16. 5	8. 0. 5	38.12. 2	1. 3. 3	2. 3. 4	21. 5. 0	6. 3. 1
Total	65. 5.10	43. 7. 6	72. 3. 1	347. 9. 4	10. 9. 3	19.10. 0	191. 4. 9	55. 7.11
Cutting & Delivering to Drier								
Labour	36. 9. 0	54.11. 3	35. 8. 2	82.19. 7	2.18. 6	1.16. 7	53. 3. 9	15. 3. 9
Traction	21. 0. 0	36. 7. 6	27.15. 0	66. 9. 0	2. 4. 0	2. 8. 9	33.12. 9	16. 2. 6
Depreciation and Repairs	10. 5. 8	4. 0. 2	13.15. 1	47. 3. 9	3. 5. 9	1.10.10	28. 5. 5	18. 7. 6
Horse Labour	–	–	–	–	–	–	2. 2. 0	–
Total	67.14. 8	94.18.11	76.18. 3	196.12. 4	8. 8. 3	5.16. 2	117. 3.11	49.13. 9
Drying and Baling								
Labour	73. 8. 6	77. 3. 9	32.14. 9	213. 1. 0	27.14. 7	15. 1. 0	81. 3.10	18. 7.11
Managerial Labour	–	–	–	36.15. 0	–	–	–	–
Fuel	76. 0. 0	123. 6.10	30. 5. 2	262.19. 3	33.18. 9	20. 2. 9	124. 0. 5	18.14. 0
Power	21.12. 7	40. 0. 0	9. 4. 1	23. 6. 7	7.12. 3	1.16. 0	9. 8. 3	9.15. 5
Banding and Sundries	12.10. 0	14.10. 5	2.19. 0	32. 9. 5	1. 5. 0	3. 3. 4	9.13.10	5.11. 3
Repairs	5. 0. 0	7.10. 0	–	5. 5. 2	–	–	10. 4. 8	–
Depreciation of Plant	132. 7. 0	53. 3. 2	36.16. 7	148.14. 5	25.13. 2	21.14. 4	190.13. 6	65.18.11
Insurance	5. 0. 0	6. 0. 0	5.12. 0	5. 0. 0	0.11. 5	0.18. 9	5.12. 6	2. 0. 0
Moving and Erecting Drier	–	–	–	–	1. 9. 3	–	–	–
Total	325.18. 1	321.14. 2	167.11. 7	727.10.10	98. 4. 5	62.16. 2	430.17. 0	120. 7. 6
Grand Total	458.18. 7	460. 0. 7	316.12.11	1271.12. 6	117. 1.11	88. 2. 4	739. 5. 8	225. 9. 2
Total Output of Dried Grass (tons)	38.0	34.5	18.5	73.6	6.1	4.5	35.5	9.6

Table IV.

Labour for Cutting and Delivering.

Farm No.	Total Man Hours.	Man Hours per ton of Dried Grass.	Labour Cost per ton of Dried Grass.	Normal Field Team.
			£. s. d	Men.
1	322	8.5	0.19. 2	2 - 3
2	485	14.1	1.11. 8	2
3	313	17.0	1.18. 4	2
4	690½	9.4	1. 2. 6	2 - 3
5	26	4.2	0. 9. 7	1 - 2
6	16¼	3.6	0. 8. 1	1
7	467	13.1	1. 9.11	2
8	135	14.0	1.11. 6	1 - 2

Table V.

Labour for Drying and Baling.

Farm No.	Total Man Hours.	Man Hours per ton of Dried Grass.	Labour Cost per ton of Dried Grass.	Normal Team at Drier.
			£. s. d	Men.
1	651	17.1	1.18. 8	3
2	665	19.3	2. 4. 9	2
3	291	15.8	1.15. 6	3
4	1881	25.5	2.17.10	3
5	237½	38.7	4.10. 6	3
6	133	29.4	3. 6. 6	1
7	693¼	19.5	2. 5. 8	2
8	163½	17.0	1.18. 2	1

Table VI.

Fuel Consumption and Costs.

Farm No.	Kind of Fuel.	Total Fuel Consumed.	Fuel Consumed Per Ton of Dried Grass.	Fuel Consumed Per Hour Drier Running.	Fuel Cost Per Ton of Dried Grass.
					£. s. d
1	Oil	1920 galls.	51 galls.	10.76 galls.	2. 0. 0
2	Anthracite	479 cwt.	13.9 cwt.	1.58 cwt.	3.11. 6
3	Coke	369 cwt.	20.0 cwt.	3.60 cwt.	4. 7. 0
4	Coke	1002 cwt.	13.6 cwt.	1.71 cwt.	3.11. 5
5	Oil	846 galls.	138 galls.	12.00 galls.	5.10.10
6	Coke	89½ cwt.	19.8 cwt.	0.71 cwt.	4. 9. 0
7	Oil	3027 galls.	84 galls.	11.71 galls.	3. 9. 9
8	Coke	90½ cwt.	9.4 cwt.	0.67 cwt.	1.18. 9

Table VII.

Costs of Dried Grass Production Per Hour Drier Running.

Farm No.	Make of Drier.	Total Costs incurred on Dried Grass Production.	Total Number of Hours Worked by Drier.	Cost per Hour of Drying Time.
		£. s. d		£. s. d
1	Opperman Mobile	458.18. 7	178½	2.11. 5
2	Ransomes	460. 0. 7	302½	1.10. 5
3	I.C.I. Mark III	316.12.11	102½	3. 1. 9
4	I.C.I. Mark III	1271.12. 6	586	2. 3. 5
5	Opperman Mobile	117. 1.11	70½	1.13. 3
6	Slade-Curran	88. 2. 4	126	0.14. 0
7	Kennedy and Kempe	739. 5. 8	258½	2.17. 2
8	Slade-Curran	225. 9. 2	136	1.13. 2

Table VIII.

Total Costs and Costs per Ton of Dried Grass.

	Total Costs.	Costs per Ton.	Percentage Distribution.
	£. s. d	£. s. d	%.
Rent & Treatment of Fields			
Rent	132. 2. 1	0.11. 3	3.6
Cultivations	125. 0. 3	0.10. 8	3.5
Fertilisers and Manures	393.11. 8	1.13. 6	10.8
Seeds	95.12. 9	0. 8. 1	2.6
Grassland Overheads	93. 6. 0	0. 7.11	2.6
	839.12. 9	3.11. 5	23.1
Cutting & Delivering to Drier			
Labour	443. 0. 0	1.17. 8	12.2
Traction	365. 5. 5	1.11. 1	10.0
Depreciation, Repairs and Renewals to Field Equipment	91.17. 1	0. 7.10	2.5
	900. 2. 6	3.16. 7	24.7
Drying and Baling			
Labour	476. 0. 0	2. 0. 6	13.1
Fuel	757. 0.11	3. 4. 5	20.8
Power	27.16. 2	0. 2. 4	0.8
Banding	92. 0. 0	0. 7.10	2.5
Repairs, Renewals & Sundries	45. 0. 0	0. 3.10	1.2
Depreciation of Plant	104.17. 4	0. 8.11	2.9
	1502.14. 5	6. 7.10	41.3
Overheads and Administration			
Managerial & Secretarial Expenses	224.13. 4	0.19. 2	6.2
Chairman & Secretary: Expenses	16.14.11	0. 1. 5	0.5
Telephone and Postage	8.11. 0	0. 0. 9	0.2
Rates	8.16. 8	0. 0. 9	0.2
Insurance	20. 0. 0	0. 1. 8	0.5
Transport	28. 0. 0	0. 2. 5	0.8
Costs of Analyses	21. 3. 0	0. 1.10	0.6
Audit Fee	8.15.10	0. 0. 9	0.2
Overhead Labour	59. 0. 0	0. 5. 0	1.6
Sundries	1.14.11	0. 0. 2	0.1
	397. 9. 8	1.13.11	10.9
Total	3639.19. 4	15. 9. 9	100.0

Total Output of Dried Grass = 235 tons.

Table IX.

Influence of Throughput on Cost Per Ton of Dried Grass.

	Throughput of Dried Material Per Hour in Cwt.								
	2	2½	3	3½	4	4½	5	5½	6
No. of Hours Drying Time required to Produce 1 Ton of Dried Material	10	8	6.67	5.71	5	4.44	4	3.64	3.33
	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d
Hourly Contract Charge Levied by Centre	2.10. 0	2.10. 0	2.10. 0	2.10. 0	2.10. 0	2.10. 0	2.10. 0	2.10. 0	2.10. 0
Cost Per Ton levied by Centre at a Charge of £2.10. 0 per Hour	25. 0. 0	20. 0. 0	16.13. 4	14. 5. 9	12.10. 0	11. 2. 3	10. 0. 0	9. 1.10	8. 6. 8
Average Farmers' Cost of Herbage Production for 1 Ton Dried Material	3.11. 5	3.11. 5	3.11. 5	3.11. 5	3.11. 5	3.11. 5	3.11. 5	3.11. 5	3.11. 5
Total Cost per Ton of Dried Grass to Farmer	28.11. 5	23.11. 5	20. 4. 9	17.17. 2	16. 1. 5	14.13. 8	13.11. 5	12.13. 3	11.18. 1

Table X.

Costs Per Cwt. of Crude Protein in Dried Grass Produced at Varying Cost Levels and Containing Varying Percentages of Crude Protein.

Content of Crude Protein in Dried Material.	Costs of Production of Dried Grass Per Ton.									
	£10	£12	£13	£14	£15	£16	£17	£18	£20	£22
%	sh.	sh.	sh.	sh.	sh.	sh.	sh.	sh.	sh.	sh.
10	100	120	130	140	150	160	170	180	200	220
11	91	109	118	127	136	146	155	164	182	200
12	83	100	108	117	125	133	142	150	167	183
13	77	92	100	108	115	123	131	138	154	169
14	71	86	93	100	107	114	121	129	143	157
15	67	80	87	93	100	107	113	120	133	147
16	63	75	81	88	94	100	106	113	125	138
17	59	71	77	82	88	94	100	106	118	129
18	56	67	72	78	83	89	94	100	111	122
19	53	63	68	74	79	84	90	95	105	116
20	50	60	65	70	75	80	85	90	100	110
21	48	57	62	67	71	76	81	86	95	105
22	46	55	59	64	68	73	77	82	91	100
23	44	52	57	61	65	70	74	78	87	96
24	42	50	54	58	63	67	71	75	83	92
25	40	48	52	56	60	64	68	72	80	88
26	39	46	50	54	58	62	65	69	77	85
27	37	44	48	52	56	59	63	67	74	81
28	36	43	46	50	54	57	61	64	71	79

Table XI.

Yields of Starch Equivalent and Protein Equivalent Per Ton From Different Crops.

Crop.	Starch Equivalent (a).	Protein Equivalent (a)	Yield of S.E. Per Ton of Crop.	Yield of P.E. Per Ton of Crop.
			lb.	lb.
Dried Grass:-				
3 Cuts. Very Leafy	56.3	13.6	1261	305
3 " Leafy	51.7	9.3	1158	208
3 " Early Flowering Stage	51.2	8.2	1147	184
3 " Lucerne Meal	50.1	13.5	1122	302
Grass Silage:-				
3 Cuts. 1st Quality	12.8	1.9	287	43
3 " 2nd "	12.6	1.7	282	38
3 " Hay Maturity	10.2	1.4	228	31
Cereal and Legume Silage:-				
Oats, green	8.9	0.8	199	18
Vetches & Oats, green fruity	12.8	1.6	287	36
Vetches & Oats, acid brown	13.0	2.8	291	63
Meadow Hay:-				
Good	37.0	4.6	829	103
Very Good	48.0	7.8	1075	175
Seeds Hay:-				
Ryegrass and Clover	38.4	6.4	860	143
Kale:-				
Thousand Head	10.3	1.4	231	31
Marrow-Stem	9.0	1.3	202	29
Mangolds, intermediate	6.2	0.4	139	9
Oats (grain)	59.5	7.6	1333	170
Beans	65.8	19.7	1474	441

(a) Based on Standard Tables of Composition and Nutritive Value of Feedingstuffs. J. C. B. Ellis: "The Feeding of Farm Livestock". (Appendix). Crosby Lockwood, 1947.

Table XII.

Indices showing the Relative Costs of Production of Starch Equivalent and Protein Equivalent in Different Crops.

Crop.	Comparison with Good Meadow Hay (Base = 100).			Comparison with Oats (Grain). (Base = 100).		
	Index Cost of S.E.	Index Cost of P.E.	Combined Index Costs of S.E. & P.E.	Index Cost of S.E.	Index Cost of P.E.	Combined Index Cost of S.E. & P.E.
Dried Grass:-						
3 Cuts. Very Leafy	236	122	135	156	83	91
3 " Leafy	257	178	187	170	121	127
3 " Early Flowering Stage	259	202	208	172	137	141
3 " Lucerne Meal	265	123	139	176	83	94
Grass Silage:-						
3 Cuts. 1st Quality	98	83	84	65	56	57
3 " 2nd Quality	100	92	93	66	63	63
3 " Hay Maturity	112	102	103	74	69	70
Cereal and Legume Silage:-						
Oats, green	255	354	343	169	240	232
Vetches & Oats, green fruity	177	177	177	117	120	120
Vetches & Oats, acid brown	174	101	109	115	69	74
Meadow Hay:-						
Good	100	100	100	66	68	68
Very Good	77	59	61	51	40	41
Seeds Hay:-						
Ryegrass and Clover	89	67	70	59	46	47
Kale:-						
Thousand Head	147	135	136	98	92	92
Marrow-Stem	168	145	148	111	99	100
Mangolds, intermediate	229	443	419	152	301	284
Oats (grain)	151	147	148	100	100	100
Beans	244	101	117	161	69	79

Table XIII.

Value per Ton of Different Crops Based on Feed Values, together with the balance between the Feed Value and the Cost of Production.

Crop.	Cost of Production per Ton(a).	Feed Value of S.E. Per Ton of Crop(b).	Feed Value of P.E. Per Ton of Crop(c)	Total Feed Value per Ton of Feed Crop.	Balance(d).
Dried Grass:-	£. s. d	£. s. d	£. s. d	£. s. d	£. s. d
3 Cuts. Very Leafy	16.10. 0	13. 4. 0	1.13. 9	14.17. 9	- 1.12. 3
3 " Leafy	16.10. 0	12. 2. 5	1. 3. 0	13. 5. 5	- 3. 4. 7
3 " Early Flowering Stage	16.10. 0	12. 0. 1	1. 0. 4	13. 0. 5	- 3. 9. 7
3 " Lucerne Meal	16.10. 0	11.15. 0	1.13. 5	13. 8. 5	- 3. 1. 7
Grass Silage:-					
3 Cuts. 1st Quality	1.11. 3	3. 0. 0	0. 4. 9	3. 4. 9	+ 1.13. 6
3 " 2nd "	1.11. 3	2.19. 1	0. 4. 2	3. 3. 3	+ 1.12. 0
3 " Hay Maturity	1.11. 3	2. 7.10	0. 3. 5	2.11. 3	+ 1. 0. 0
Cereal & Legume Silage:-					
Oats, green	2.16. 4	2. 1. 9	0. 2. 0	2. 3. 9	- 0.12. 7
Vetches & Oats, green fruity	2.16. 4	3. 0. 0	0. 4. 0	3. 4. 0	+ 0. 7. 8
Vetches & Oats, acid brown	2.16. 4	3. 1. 0	0. 6.11	3. 7.11	+ 0.11. 7
Meadow Hay:-					
Good	4.11. 7	8.13. 6	0.11. 5	9. 4.11	+ 4.13. 4
Very Good	4.11. 7	11. 5. 1	0.19. 4	12. 4. 5	+ 7.12.10
Seeds Hay:-					
Ryegrass & Clover	4. 5. 8	9. 0. 1	0.15.10	9.15.11	+ 5.10. 3
Kale:-					
Thousand Head	2. 0. 0	2. 8. 4	0. 3. 6	2.11.10	+ 0.11.10
Marrow-Stem	2. 0. 0	2. 2. 2	0. 3. 3	2. 5. 5	+ 0. 5. 5
Mangolds, intermediate	1.15. 0	1. 9. 1	0. 1. 0	1.10. 1	- 0. 4.11
[illegible]s (grain)	11. 1. 8	13.19. 0	0.18.10	14.17.10	+ 3.16. 2
Beans	19.18. 3	15. 8. 7	2. 8.10	17.17. 5	- 2. 0.10

(a) See Footnote to Table 22.

(b) and (c) Based on the 1949-50 figures provided by the Ministry of Agriculture & Fisheries for the National Investigation into the Economics of Milk Production, viz.:- Unit Value of Starch: N.P.S.E. = £0.2344920
Unit Value of Protein: D.P.E. = £0.1239476

(d) This is the Balance between Total Feed Value per Ton of Crop and the Cost of Production (+ or -).

Table XIV.

Comparison between the Value of Dried Grass and of Various Purchased Feedingstuffs.

Feedingstuff.	Cost of Production or Purchase Price Per Ton.	Cost Per lb. of S.E.	Cost Per lb. of P.E.	Feed Value of S.E. Per Ton of Feedingstuff (c).	Feed Value of P.E. Per Ton of Feedingstuff (d).	Total Feed Value Per Ton of Feeding-stuff.	Balance(e).
Dried Grass:-	£. s. d	Pence.	Pence.	£. s. d	£. s. d	£. s. d	£. s. d.
Very Leafy	16.10. 0 (a)	3.14	13.00	13. 4. 0	1.13. 9	14.17. 9	- 1.12. 3
Leafy	16.10. 0 (a)	3.42	19.01	12. 2. 5	1. 3. 0	13. 5. 5	- 3. 4. 7
Early Flowering Stage	16.10. 0 (a)	3.45	21.56	12. 0. 1	1. 0. 4	13. 0. 5	- 3. 9. 7
Lucerne Meal	16.10. 0 (a)	3.53	13.10	11.15. 0	1.13. 5	13. 8. 5	- 3. 1. 7
Oil Cakes and Meals:-							
Linseed Cake	25.13. 0 (b)	3.71	10.95	17. 7. 1	3. 2. 3	20. 9. 4	- 5. 3. 8
Ground-Nut Cake, Decorticated	24.12. 0 (b)	3.61	6.38	17. 2. 4	5. 2. 4	22. 4. 8	- 2. 7. 4
" " " Undecorticated	18. 7. 6 (b)	3.47	7.24	13. 6. 4	3. 7. 5	16.13. 9	- 1.13. 9
Coconut Cake	22.14. 6 (b)	3.17	14.86	18. 0. 2	2. 0. 8	20. 0.10	- 2.13. 8
Cotton Cake, Bombay	23.12. 0 (b)	6.32	16.66	9. 7. 7	1.17. 8	11. 5. 3	- 12. 6. 9
" " Egyptian	23.12. 0 (b)	6.08	14.60	9.15. 1	2. 2.11	11.18. 0	- 11.14. 0
Palm Nut Kernel Cake, English	21. 7. 6 (b)	3.13	13.54	17. 3. 3	2. 1.11	19. 5. 2	- 2. 2. 4
" " " " Imported	21. 7. 6 (b)	2.80	16.50	19. 3. 2	1.14. 5	20.17. 7	- 0. 9.11
Maize, Flaked	24. 5. 6 (b)	3.10	28.28	19.13.11	1. 2.10	20.16. 9	- 3. 8. 9
Fish Meal, White	36. 3. 6 (b)	6.58	7.31	13.16. 3	6.11. 5	20. 7. 8	- 15.15.10
Barley Brewers' Grains, Fresh	2. 4. 6 (b)	1.30	4.49	4. 6. 3	0.13. 1	4.19. 4	+ 2.14.10
" " " Dried	15.12. 6 (b)	3.47	13.39	11. 6. 6	1.11. 0	12.17. 6	- 2.15. 0
Weatings	13.17. 6 (b)	2.63	13.76	13. 4.11	1. 6. 9	14.11. 8	+ 0.14. 2
Broad Bran	18.19. 0 (b)	4.77	20.30	9.19.10	1. 4. 9	11. 4. 7	- 7.14. 5

(a) See Footnote to Table 22.

(b) Average Price Per Ton on Farm, based on Ministry of Agriculture & Fisheries Feedingstuffs Prices Enquiry, December, 1949.

(c) & (d) Based on the 1949-50 figures provided by the Ministry of Agriculture & Fisheries for the National Investigation into the Economics of Milk Production, viz.:- Unit Value of Starch - N.P.S.E. = £0.2344920
Per Ton " " " Protein - D.P.E. = £0.1239476

(e) Balance between Total Feed Value of Feedingstuff and the Cost of Production or Purchase Price (+ or -).