BRACKEN CUTTING
ON
WEST OF SCOTLAND FARMS

An Economic and Botanical Survey of Past Work

By

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REPORT No. 15
May, 1954.
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INTRODUCTION

The extent of bracken infestation and its effects on pastoral farming are sufficiently well known not to need amplification here. It is perhaps sufficient to say that bracken is estimated to occupy some \( \frac{3}{4} \) to 1 million acres of Scottish grazings and, more important, it is often the more fertile areas of hill land which are affected. Indeed, bracken infestation is one of the most urgent practical problems in hill land management at the present time.

Although there is abundant scientific data on the botanical and other related aspects of the plant, there is little or no recent information on the costs and economic effects of controlling this widespread and tenacious weed. One important exception to this was the article, by Sir John H. Milne Home, in the Spring issue of Scottish Agriculture\(^x\) 1952. Detailed costs of bracken cutting, and a description of its effects were given for several years' operations on the Buccleuch Estates.

At the 1952 Bracken Conference of the Agricultural Research Council, it was suggested that, in addition to the trials of bracken eradicating machines at present being carried out at Bovemont, Roxburghshire, and Comrie, Perthshire, an investigation into bracken cutting programmes being undertaken privately on farms, would be of value.

This report is the result of such an investigation over some sixty West of Scotland farms. An attempt has been made to bring together economic and botanical observations on bracken cutting and to assess the benefits derived therefrom.

Acknowledgments

The writers are indebted to a considerable number of people who helped them during the survey. Sincere thanks are extended to all. Grateful acknowledgment is also made to Professors K.W. Braid and W.W. Fletcher for their helpful criticism and advice.

John B. McCreaath.

David J. Martin.

\(^x\) Scottish Agriculture Vol. XXXI. No.4.
PART 1 - THE COST OF BRACKEN CUTTING
J. B. McCREATH

Survey Method

The field enquiry and botanical observations were carried out in the summer of 1953. With the assistance of the County Advisers in the districts concerned, (viz. North and South Argyll, Dumfries, Kirkcudbright, Stirling and West Perth), visits were made to over 60 farms. A member of staff from the Botany Department and one from the Economics Department visited each farm. The areas of bracken treated were inspected and frond counts taken. (Details of the botanical method are given in Part 2 of the report).

Costing Method

The expenditure on bracken cutting was discussed with the farmer and costs were calculated, where available, for the seasons 1950 to 1953. Where the work had been done by a contractor, the costing figures were easily obtained as the contract rate per acre was known. The rate is agreed between the farmer and the contractor and the acreage done is estimated, usually by eye. In the case of farmers cutting with their own machines and staff, it was more difficult and a certain amount of estimation had to be done. In many instances, the only figure available was the 50% bracken cutting grant received. In such cases the gross costs were calculated back from this figure, keeping in mind the items of cost covered by the grant. These were the wages paid to labour, including employer's share of insurance, and the running costs of machinery. Consequently the costs do not include repair bills or a share of depreciation on machines or tractors. Also where the farmer had himself spent some time on cutting, an estimated wage charge had to be added, as this item is not eligible for grant but there were very few cases where this had to be done. However, as approximately 80% of the acreage cut was done by contractors, the costs obtained are, as a whole, fairly accurate.

COSTS OF CUTTING:

Except where otherwise stated, the costs per acre given in the report are the gross costs (i.e. excluding grants received) of double cutting one acre in a season.

In Table I is a summary of the average costs per acre of operating the different types of equipment used by farmers and contractors. With one exception, all the farmers' machines were of the cutting or slashing type. The majority of the contractor-drawn machines were trailing-mowers, the remainder being driven from the power take-off unit.

COMPARISON OF COSTS

When interpreting this table, it should be kept in mind that the costs came from a wide area of the west of Scotland. Conditions vary greatly even on different bracken areas of the same farm. Consequently, and particularly so in the case of contract work, there may be wide variations in costs in the same season. The range of costs is given for the different methods of cutting in 1952, the season for which most costs were obtained. The range in contract rates was much wider than the other ranges.

As to the trend of costs over the four seasons from 1950, the operating costs of the self-propelled machines - in Part A - and the contractors' charges have risen each year. The figure of 32/6d per acre in 1953 for cutting by contract machine is probably an overstatement as there were only two costs involved and one was particularly high due to the nature of the ground. Unfortunately for scythe and tractor-drawn machines in Part A, there are not enough costs in each season on which to base any definite conclusions.

For comparison of the relative costs of the different methods, a more reliable figure is the cost per acre double-cut averaged out over the seasons 1951 to 1953.

From the costs available cutting would appear to have been cheapest where the farmer used his own staff and machines and from the solo aspect of cost there was little difference between using a self-propelled machine.
### Table I

**Bracken Cutting Costs**

**Summary of Average Costs per Acre (Double Cut) Over the Past Four Seasons**

<table>
<thead>
<tr>
<th>Season</th>
<th>Self-Propelled Machines</th>
<th>Tractor-Drawn Machines</th>
<th>Scythe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.6.</td>
<td>No. of Costs</td>
<td>1.6.</td>
</tr>
<tr>
<td>1950</td>
<td>1/5.</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>1951</td>
<td>1/5.</td>
<td>9</td>
<td>17/2</td>
</tr>
<tr>
<td>(Twice Cut)</td>
<td>16/11</td>
<td>12</td>
<td>16/-</td>
</tr>
<tr>
<td>1952</td>
<td>18/10</td>
<td>8</td>
<td>16/6</td>
</tr>
<tr>
<td>1953</td>
<td>16/5</td>
<td>29</td>
<td>16/5</td>
</tr>
</tbody>
</table>

**Average Cost per Acre**

- 1950: 1/5
- 1951: 1/6
- 1952: 16/11
- 1953: 18/10

**Average Cost per Acre (Over three seasons)**

- 1951-53: 16/5

**Range of Costs**

- 1952: 13/- to 20/-
- 1953: 13 1/4 to 21 8
- 1952: 18 6 to 20/-
- 1952: 18/- to 33 4
- 1952: 20/- to 35/-

**Note.** These are the gross costs before deducting grant.
and a tractor outfit. However, considerations other than cost have to be taken into account, one of the most important of which is the nature of the terrain. Self-propelled machines will cut bracken effectively in areas where no tractor could safely be handled, while scythes are often the only feasible tools on steeper or rocky slopes. Indeed it is this question of contour and rock cover, rather than cost, which ultimately decides which type of cutting is possible. The following statement of the acreages cut by the different outfits in 1952 brings out this point very forcibly.

<table>
<thead>
<tr>
<th>Method</th>
<th>Acreage</th>
<th>Percentage</th>
<th>No. of Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor Outfits</td>
<td>750</td>
<td>10.6</td>
<td>5</td>
</tr>
<tr>
<td>Self-Propelled Machines</td>
<td>951</td>
<td>13.4</td>
<td>12</td>
</tr>
<tr>
<td>Hand Scythes</td>
<td>5385</td>
<td>76.0</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>7086</td>
<td>100.0%</td>
<td>35</td>
</tr>
</tbody>
</table>

A large proportion of the acreage was cut twice in the season. Very few of the schemes came under Hill Farming Act programmes. Except for 40 acres, all the scythe work was done by contractors. Approximately one-third of the acreage cut by self-propelled machines was also under contract. All the tractor outfits belonged to the farms concerned. In 1952, contractors cut just over 80% of the bracken acreage covered in the report. The above figures exclude the area (almost 2000 acres) cut by eight self-propelled machines on the Bucclach Estates, where there are special facilities for tenants to use estate machines (See Page 7).

As shown in Table I, over the past three seasons contractors' charges for machine cutting have been on the average 10/- higher per double-cut acre than the costs on farms which used their own machines.

The difference in cost between the two methods of scythe work was much less, being only 4/3d per acre dearer by contract. However, as stated previously, the very small number of costs for farm scythe cutting invalidates any comparisons.

From the farmer's point of view a difference of 10/- per acre is substantial. It must be remembered however, that in most instances, the contractor's actual operating costs would be heavier than those of the farmer cutting with his own machine and staff on the same farm. The hourly wage rates paid by the contractor would tend presumably to be higher due to the seasonal nature of the work. Also his charge has to cover both or other accommodation for the men; houling to and from the farm; walking time to the bracken face and supplying and maintaining the machines or scythes. Also the managerial costs of organising and supervising the different cutting programmes under contract have to be covered.

The very fact that about 80% of the acreage cut in 1952 was handled by contractors indicates that, at least on the farms visited, the majority of farmers did not consider the charges, after allowing for the grant, excessive.

**Farm Power or Contract Power?**

Notwithstanding the foregoing paragraph, the fact remains that in most instances, it is cheaper for the farmer to cut his own bracken than to contract it out. Why then is more bracken not cut by farm labour? The general answer to this question again lies in the fact that considerations other than cost enter into the decision whether to cut by contract or otherwise. In particular the nature of the ground and the availability of labour and power play a decisive part.

Where steepness and/or rocks preclude the use of machines, the case for using contract facilities is stronger. The rate of scythe cutting is slow, 2/ to 1¾ acres per man per day, and if a worthwhile acreage is to be covered at the optimum cutting stage, a fairly large gang of scythe men is needed. Normally no such numbers of regular farm staff exist and in most districts the supply of casual labourers is very limited. On larger hill farms, where perhaps one or two regular men are available, the situation is again difficult due to competition of other work. Unfortunately, the best times for cutting bracken coincide with one of the busiest periods on a hill farm. The more urgent tasks of sheep handlings, such as the hogg clipping in June
and the ewe clipping in July, naturally claim priority. Not only is it a case of the gatherings on one farm but also several days are needed for mutual help at "neighbouring". Furthermore, lowground jobs such as hay-making claim prior attention.

On farms where the bracken can be cut by machine the above arguments still apply but not so forcibly. The machine only requires one man and with its higher rate of working - 4 acres per day on the average - more ground can be covered in the cutting season. If one of the regular staff cannot be spared, it is easier to obtain one casual worker than the gang required for scythe work.

Tractor outfits can cover up to 8 acres per day and normally only a driver is required. Since labour costs make up the heaviest single item of cost (See Table II), the acreage cut per man per day is an important factor.

Against machine cutting, there is the initial outlay on buying the machine and its subsequent maintenance but depreciation on machines is not a heavy item per acre (See Table II).

In the case of a farm where a tractor is part of the standard equipment, the only extra cost involved in bracken cutting would be the running costs. The number of hours spent on this would be very small in relation to the total annual tractor hours. Hence a share of depreciation would be almost negligible. One of the vital aspects in tractor cutting is the skill of the driver - otherwise "running" costs may be very heavy!

Another advantage of owning a machine is that the bracken cutting can begin at a time which will allow the maximum acreage to be cut at the optimum time for achieving the most effective 'kill'. In general bracken growth will be at the same stage over a district and naturally the contractor's men cannot be everywhere at once.

Summary

In this discussion of the advantages and disadvantages of the two methods of cutting, it must be stressed that a diminution in the amount of bracken cut by contract is not being advocated. On the contrary, the extent of bracken infested land is such that there is ample scope for all methods. The points being made are that, firstly, on suitable land self-owned machines or tractor outfits are cheaper and, secondly, a larger proportion cut by farmers would release contract labour for other areas. Particularly is this so where, at present, bracken capable of being cut by self-propelled machine is being handled by contract scythe.

BRACKEN CUTTING ON BUCCLEUCH ESTATES

It is probably no exaggeration to say that nowhere in Scotland has the control of bracken been so extensively and enthusiastically tackled as on the Buccleuch Estates. Over the past 30 years, up to the end of 1953, no fewer than 27,888 acres of bracken have been cut.

During the investigation, a day was spent visiting farms on the estate where bracken cutting was being done. Detailed information on costs and results achieved were made available for publication in this report.

Method

The estate owns and maintains the machines, - all of the self-propelled slashing type, - and supplies the labour. The tenants share the cost equally with the estate. In effect this means that the tenants contribute a quarter, the estate a quarter and the remaining half is defrayed by the 50% grant administered by the D.O.A.S. In practice, the grant received will not be as much as 50% of the total cost, as there are certain items included, (depreciation, interest, etc.) which are not eligible for grant.

The normal cutting programme is a double cut for the first two seasons and a single cut in the third year. It has been found expedient to link up

By courtesy of the estate factor, Captain J.G Milne Home.
acythe with machine cutting. Two men go with each machine, one operating the machine, while the other "mops up" small pockets of bracken with a scythe. By taking turns of each, undue fatigue is avoided. Also the effective cutting of all possible focal points of future re-invasion is very important from the botanical aspect.

Detailed Costs

On day work, the men are paid at the agricultural minimum wage rates; on piece work, machine operators receive 6/6d per acre (1953) and scythemens 10/6d per acre (1953). Depreciation of the machines is charged at 20% of the original value each year. Interest on capital is allowed for at the rate of 5%. A proportion of the salary of the person in charge of all the different cutting programmes in hand, is charged against each machine. Table II on page 7 gives the average costs of eight machines from 1951 to 1953.

Yages were the heaviest single item of cost, being between two-thirds and three-quarters of the total. Next came fuel. Repairs to the machines were fairly low except in 1953. It has to be remembered however, that these machines are working under Border conditions, where the ground is less rugged than in the Highlands.

The cost per acre over the three years has risen steadily, mainly due to an increase in wages and fuel. Indeed the 1953 costs per acre are 2/6d dearer than in 1947 (7/10d ). Despite this, the demand from tenants for estate machines has not diminished as the following figures show:

<table>
<thead>
<tr>
<th>Year</th>
<th>Acres cut by machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1948</td>
<td>1,449</td>
</tr>
<tr>
<td>1949</td>
<td>1,792</td>
</tr>
<tr>
<td>1950</td>
<td>1,970</td>
</tr>
<tr>
<td>1951</td>
<td>2,659</td>
</tr>
<tr>
<td>1952</td>
<td>2,430</td>
</tr>
<tr>
<td>1953</td>
<td>2,310</td>
</tr>
</tbody>
</table>

In addition to these acreages, over 1,000 acres were cut by scythe each year.

Effects of Cutting

On the areas visited, one of the most impressive features was the thoroughness with which the cutting had been done. There were very few fronds missed and it was difficult to get a patch of uncut bracken for botanical control counts.

On one farm a stretch of bracken, originally over five feet tall and dense in places, had received the following treatment: four cuts in 1941, two cuts in 1942 and a single cut in 1943. The resultant strong growth of grass made a second cut in 1943 impossible as well as unnecessary. Even after 10 years there was still a striking improvement. Grass was very abundant, almost tending to be "tufty". Fronds of 1'6" to 2' tall were still present and the average count was 14 fronds per square yard but at this density they were not interfering with the grazing. It appeared that a single cut in 1954 might be beneficial, as it would check the new bracken and the topping of the grass would improve the quality of the herbage.

On one area - cut twice in seasons 1949, 1950 and 1951 - the frond height was only 1' to 1'6" and with 15 to 20 fronds per square yard. Originally the bracken had been from 3' to 6' tall and very dense in patches. The impressive feature of this area was the excellent catch of young heather which had colonised the ground after the reduction in bracken growth.

As a general practice, the estate considers that renewed cutting programmes are necessary after 15 years.

Benefits

The opinions of the people concerned, regarding the value of bracken cutting, were well summed up by Sir John H. Milne Home in 1952. With his permission the following paragraphs have been quoted direct from his article.

"While exact figures as to the benefits derived cannot, because of the many other factors involved, be obtained, and while there has been no appreciable increase in the numbers of adult sheep kept, it is confidently believed by both land owners and tenants that the expenditure is worthwhile.\"
### Table II

<table>
<thead>
<tr>
<th></th>
<th>1951</th>
<th>1952</th>
<th>1953</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per Machine</td>
<td>Per Acre</td>
<td>Per Cent</td>
</tr>
<tr>
<td>Depreciation (20%)</td>
<td>10. 15.</td>
<td>8.</td>
<td>7.8</td>
</tr>
<tr>
<td>Interest (5%)</td>
<td>2. 15.</td>
<td>2.</td>
<td>2.0</td>
</tr>
<tr>
<td>Petrol, oil, etc.</td>
<td>15. 3.</td>
<td>11.</td>
<td>10.9</td>
</tr>
<tr>
<td>Repairs</td>
<td>4. 12.</td>
<td>3.</td>
<td>3.3</td>
</tr>
<tr>
<td>Wages and H.H.I.</td>
<td>91. 12.</td>
<td>5.</td>
<td>66.1</td>
</tr>
<tr>
<td>Overseer's Wages</td>
<td>13. 15.</td>
<td>10.</td>
<td>9.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£138. 12/-</strong></td>
<td><strong>£140. 5/-</strong></td>
<td><strong>£149. 2/-</strong></td>
</tr>
</tbody>
</table>

**Average Acreage Cut**: 332

**Cost per Acre (Single Cut)**: 8s. 4d.

**Cost per Acre (excluding Deprec., Interest & Overseer)**: 6s. 8d.

**Cost of Double Cutting % One Acre (excl. Deprec., etc.)**: 13s. 4d.

**Comparable costs with those in Table I.**
The tenant has benefited through having both a better-lambing and a lower death rate. The grazing is obviously better, and had it not been for the cutting, the numbers of sheep kept would probably have had to be reduced; otherwise deterioration from overstocking would have set in.

From the landlord's point of view the letting value of the farm has at least been maintained if not enhanced.

In the national interest, food production has been maintained, perhaps even considerably increased.

**GOVERNMENT ASSISTANCE**

All the figures of expenditure given previously have been the gross costs to the farmer before deducting bracken-cutting grants. Government assistance towards the control of bracken has been in operation since 1936 and the administration of this assistance has been in the hands of the Department of Agriculture for Scotland. From 1936 to date, there have been three distinct schemes of assistance. The details of each are briefly outlined in the following paragraphs.

**Scheme "A"**

Under this scheme, half the cost price of approved bracken cutting machines bought privately was refunded to the purchaser in three annual instalments. In the case of bracken cutting done by contract, 25% of the cutting costs were covered by the grant, provided the work was done by approved machines.

**Scheme "B"**

Scheme "B" was introduced in 1941. Here a proportion not greater than 50% of the cost of bracken cutting by any approved means was refunded to applicants. This is the scheme which is still in operation to date.

**Scheme "C"**

In 1942 Scheme "C" was introduced. It provided bracken cutting at subsidised rates by machines owned and operated by the Department.

All three schemes ran concurrently throughout the latter half of the war years, but, with the introduction of the more direct subsidies in Schemes 'B' and 'C', Scheme 'A' fell progressively out of favour. It was discontinued after season 1947. Scheme 'C', which was the least successful of the three, was also stopped in 1947. From a national point of view, this scheme was much more expensive to operate than the others. A comparison of the acreages cut and the grants (or net expenditure in Scheme 'C') paid, for the years (1942-47 inc.) in which the schemes were operating concurrently, illustrates the above points.

<table>
<thead>
<tr>
<th>Years</th>
<th>Total Acreage Cut</th>
<th>Grants Paid or Not Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1942-47</td>
<td>8,702</td>
<td>£645</td>
</tr>
<tr>
<td></td>
<td>188,197</td>
<td>£33,436</td>
</tr>
<tr>
<td></td>
<td>91,252</td>
<td>£73,524</td>
</tr>
</tbody>
</table>

Compared with Scheme 'B', under the 'C' scheme less than half the acreage, at more than double the amount of public expenditure, was treated. From the above figures it is possible to compare the three schemes in another way—viz.

<table>
<thead>
<tr>
<th>Scheme A</th>
<th>Scheme B</th>
<th>Scheme C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acreage cut per £1 of Treasury Grant</td>
<td>13.5</td>
<td>5.6</td>
</tr>
</tbody>
</table>

From the farmers' viewpoint, Scheme 'C' was not unsatisfactory in respect of cost. During the investigation, of the few farms visited which were not carrying on with bracken cutting, the majority had not had any brackens cut since Scheme 'C' was discontinued.

*Figures taken from Appendix No. 28. Agriculture in Scotland 1939-1948 D.O.A.S.*
Amount of Bracken Cutting

Scheme 'B' has worked satisfactorily since its inception and is the system under which the majority of the cutting schemes in this report were carried out. The acreage cut in Scotland under this scheme steadily increased from 26,278 4 acres in 1941 to some 40,000 acres in 1952. The equivalent acreage in 1953 was 35,000. Estimating the acreage of bracken infested land in Scotland at approximately 1,000,000 acres however, the above amount is clearly only impinging on the fringe of the problem. In view of the need for more cutting, especially by privately owned machines for reasons previously mentioned, there may be a case for the re-introduction of a modified version of Scheme 'A', to encourage occupiers to buy machines.

At present a 50% grant is paid in respect of approved schemes of double cutting, bruising or crushing in a season. Normally this grant will only be paid for three successive years on the same area. In the third and fourth years a single treatment may be eligible at the discretion of the D.O.A.S. inspector. No grant is paid for further cutting, which is regarded as maintenance.

Views on the Scheme

Some farmers were of the opinion this period was not long enough to get the most effective result under their particular conditions. They thought that a much reduced flat-rate maintenance grant (say 2/6 - 5/- per acre) would encourage a continued attack, which would lead to more beneficial results in the long run. It may be said that this opinion was a minority one.

A contractor, with long experience of bracken cutting, held the view that the most effective cutting programme was double cut for two years, single cut in the third, rest for a year then one further single cut. He was of the opinion that in the past there was a tendency to give grants too readily for single cuts. This was not so often the case to-day.

Another suggestion was that, where farm labour is doing the cutting, a keen but fair flat-rate grant per acre should replace the present 50%-of-cost grant. This would give a bigger incentive to the farmer to cut bracken more efficiently and economically. Whether or not this would be so, the administrative difficulties in fixing fair rates for all the varying cutting conditions would render such a scheme impracticable.

Summary

From all the views, criticisms and suggestions encountered, one point stands out - the present grant has played and is playing a vital part in the control of bracken and its withdrawal would lead to an immediate and considerable contraction in the acreage cut, with eventually a resulting drop in output from Scottish grazings.
General Notes on the Plant

The extent and rate of spread of bracken in Scotland is such as to cause concern to all those whose work lies within its reach. Estimates of the area of bracken-infested land in Scotland vary considerably, but it can be conservatively put at between 2½ and 4 million acres, about 8-10% of the rough grazing area.

In 1902 the H.A.S. set up a Committee to enquire into the bracken problem of those days; it reported that "while the growth of brackens on hill grazings had undoubtedly increased in recent years, there was no need for any further investigations or experiments as to the most effectual means of combating the plague". At the same time the Committee recommended that two premiums be offered for designs of machines or implements for cutting or destroying bracken, one of £20 for a horse-power machine, and one of £10 for a hand-power machine. In the following year, it was reported that no design for a machine capable of working efficiently on rough or stony ground had been put forward and the premiums were withdrawn.

At that time, then, bracken was accepted as a "plague", but little was being done on a large scale to combat it. A very different picture exists to-day. Concern is felt by many at the extent and rate of spread of bracken, numerous and varied experiments and investigations have been, and are being, carried out, and there are available many machines, powered by various means, specially developed for cutting bracken.

These machines are of three types - cutting, slashing, and bruising, and their effect on the bracken fronds varies. The cutting machines sever the fronds with a clean cut, the slashing machines with a jagged cut. The bruising machines roll and crush the bracken; it was thought that the latter would be very effective in that the plant would "bleed" at the wounds inflicted on the fronds.

The effect of both the cutting and the slashing types of machines is to render the bracken fronds totally incapable of passing food material to the underground stem, or rhizome, of the plant, since they are completely severed from it.

The bruising machines, on the other hand, affect this capacity to a varying extent, depending on the amount of damage done to the fronds, and also on weather conditions after treatment.

Since this report is mainly concerned with the machine or scythe methods of cutting in large scale use at the present time, only brief mention need be made here of other methods of destroying bracken. These include, among others, ploughing, burning, trampling by stock, flooding and the use of chemicals. In the latter case, experiments have been carried out at various centres using the "Hormone" weedkillers of MCPA and DCPA type. Results of these experiments have been variable, and they have not been especially successful.

The rhizome of the plant creeps forward slowly underground, sending up fronds at intervals along its length; contained in it also is the main food store of the plant. By removing, or severely damaging, the food manufacturing part of the plant, i.e., the fronds, at a time when they are completely expanded, the rhizome is, over a period of years, gradually starved and dies out. The time at which complete expansion of the fronds occurs is the optimum time for cutting, since at that time the fronds have used available food stores from the rhizome for their growth, but have not yet started producing food in enough quantity for it to be passed back to the rhizome for storage.

Almost the entire growth and spread of bracken is due to extension and branching of the rhizome. In the few cases where bracken plants arise very far removed from others, such plants may be due to spread by means of spores. These spores are formed inside other structures on the underside of the fronds in the summer. Such fertile fronds each produce thousands of spores.
which are shed and spread in dry weather, but very few indeed form new plants in the natural state. Possibly the germination of the spores and, later, the growth of the young plant in the open is a very vulnerable stage in the life cycle, being adversely affected by such factors as drought, frost and lack of suitable nutrients.

Spores will, however, readily germinate under the conditions of laboratory culture; it has been shown also that spores can remain capable of 65% germination after being stored dry for one year, and of at least 20% germination after being buried in containers in the soil for the same period.

Bracken can, in loose soil, produce an annual rhizome advance of three feet. In very loose sites, e.g. sawdust pits, this can be exceeded. In other cases no marked advance of bracken has been noted for many years. Thus there would appear to be various factors which affect the rate of spread of the plant. An advance of 1½-2 feet per annum would appear to be a reasonable general figure, this being affected by the soil type, climate and soil fertility amongst other factors.

Bracken prefers as a habitat a good, deep soil with some slight shelter from the elements. Soils within the pH range 3.5 - 8.2 are suitable for growth; sandier soils encourage better growth than the heavier clays. Also, bracken will grow in calcareous soils or in those which are calcium-free.

The effect of even a moderate growth of bracken is apparent on the sward below. The presence of bracken fronds tends to raise the humidity and temperature of the atmosphere below them. At the same time, they lower the wind velocity and light intensity in the same area. This leads to the grasses of the sward being to a small extent more succulent, less winter-hardy and of a paler-green colour than normally. Certain low densities of bracken tend to increase the grass growth below, and give protection from early frosts of autumn or winter, but densities of the higher order will kill out all the sward plants.

Under a moderate bracken canopy, neither the ground plants nor the soil suffer summer drought to the same extent as the open grazing swards. Thus in the autumn when the fronds die down, the herbage below is more attractive to the stock than that in the open swards; hence the grazing intensities on swards with a moderate bracken cover tend to rise in the third quarter of the year. Since, however, this type of sward is less winter-hardy, the stock carrying capacity of such grazing drops quickly with the onset of harsh weather.

Mention was made earlier of the burning of bracken. The ash of bracken fronds has a high content of potash, about 30% on the average, and at one time the ash was used as a fertiliser. Burning of bracken is most usual in the autumn when the fronds have withered and are fairly dry. The ash is washed into the soil by the autumn and winter rains, and, in Scotland especially, there is a tendency for this locally higher soil potash content to lead to an increase of bracken growth the following year. In England, with its lower rainfall and warmer soils, this effect is not so marked; also, the heat generated may destroy some of the upper frond buds, especially in the lighter soils, where the rhizome is near the surface.

After heather-burning, it has often been noticed that invasion of the burned area by bracken is very quick and complete, although there may have been no bracken visible in the heather area before burning. This is especially so in the case of old heather being burned, as the greater heat from this burn tends to kill all the heather and other plants, down to a few inches below the surface of the soil, and their seeds. Hence there is a very slow regeneration of surface plants on the area, and the bracken rhizomes from surrounding bracken, which have probably been invading the area at depth for many years, are able to send up fronds unopposed. These fronds are undamaged by the heat of burning, due to their depth in the soil at that time. With the lack of competition from other plants in the burned area the bracken can completely colonise such an area.

In the following pages are noted the botanical effects of cutting on the bracken as found in the survey, for different cutting programmes. Following therefrom is the discussion, linking the results and emphasising various points which arise from them.

Survey Method

On the survey, counts were taken in each area visited. These counts consisted of the number of fronds apparent in one square yard, (i.e. the frequency) and their average height. Where the bracken had been recently cut, the number of frond stumps was counted, and the height obtained from missed or otherwise uncut fronds. In each area the average of some ten counts was taken as the average for the area.

The following standards were used to link the actual frequency of the fronds with the visual appearance of an area:

- 0-5 fronds per square yard ....... very sparse
- 5-10 " " " sparse
- 10-20 " " " frequent
- 20-30 " " " abundant
- 30-40 " " " fairly dense
- over 40 " " " dense

In the survey results, to avoid repetition of the phrase "fronds per square yard", the heights and frequencies are given as, e.g. "3'0 at 25". This means that bracken of 3'0" in height and of 25 fronds per square yard was growing on the area.

The "uncut" results were obtained from nearby and similar areas of bracken which had been inaccessible or had not been included in the cutting scheme.

The survey results are grouped, primarily, according to the number of initial consecutive years of cutting in the cutting programme. Within each of these major groups there are the variations in the cutting programme, numbered 1, 2, 3, etc., and depending mainly on the year of the first cut. Each paragraph within a numbered section refers to a different farm or a separate area on the same farm.

Each major group, e.g. "Two Years' Consecutive Cutting", is subdivided into "Double Cut Programmes" and "Single Cut Programmes". By the first is meant a cutting programme where the same area was cut twice in any one year, and by the second, where the area had only one cut per year. In some of the groups there were no records of Single Cut Programmes.

RESULTS

One Year of Cutting

1A. "Double Cut" Programmes

In seven of the farms visited there were areas which had been cut for the first time in 1953, or had been cut once in a previous year, and lain uncut since.

1. On 170 acres cut twice in 1953, and so far as is known, previously uncut, the cut bracken was 1'6" at 7-12, whereas the uncut was 2'6" at 10-15. The ground was rather damp over much of the cut area, but in the drier parts, where the bracken had previously been 4'0", the double cut had reduced it to the same height and frequency as above, i.e. 1'6" at 7-12.

2. Other areas visited which were double cut in 1952 and uncut in 1953, comprise this group. In the first, bracken previously of 2'6" at 30 was now 1'5" at 20. Where bracken and heather grew together in this area, and it had been impossible to cut the bracken fronds at ground level, the frequency remained constant at 30, but the cutting had reduced the height from 2'6" to 1'3".

Nearly, in a similar area, but with no heather, uncut bracken was of 2'6" at 25, and the cut bracken of 1'0" at 10.

Again, another area previously covered by dense, 3'0" fronds, now showed fronds of 2'6", but still dense.
3. A third programme of double cut in 1950, single cut 1951, and uncut since, resulted in a decrease from 2'0" at 25 to just over 1'0" at 15.

4. In one area which was double cut in 1949, and had not been cut since, there was no measurable difference in frequency or height between the cut and uncut bracken.

1B "Single Cut" Programme

1. A single cut in late 1951 had reduced 2'6" high bracken to 2'3", the frequency of 35 remaining unaltered.

In most of the cases above it will be noted that the greatest difference is in height. The reductions in frequency are not proportionately so great.

Two Consecutive Years of Cutting

2A "Double Cut" Programmes

None of the areas visited had been double cut in both 1952 and 1953. All the areas below had been treated before that time, or had an initial cut of two years followed by another cutting programme.

1. The first was double cut in 1951 and 1952, and single cut in 1953. From bracken of 3'6" at 45, reduction was to 1'6" at 15-20. In patches there were uncut fronds, mainly in isolated, inaccessible places.

A similar cutting programme had taken place in the next area visited, with the difference that 3 tons of lime, and 40 cwt. of basic slag had been spread per acre, before the original cut. A very considerable reduction was evident here, from dense bracken of 4'0" at 45, down to 1'0" at 10-15. In patches the fronds were only a few inches high, the frequency as above, i.e. 10-15.

2. The next group were cut in 1951, 1952 and uncut in 1953. In the first, bracken of 3'0" at 20 had been reduced to 6" at 15-20, with patches of 1'3" fronds.

In the second, bracken was of 9" at 15-18, this a reduction from 1'6" at 20-25.

3. One area had been cut in 1949, 1950 and uncut since. In this there was a reduction from 3'10" at 48 to 1'6" at 25.

4. A further area had been cut in 1947 and 1948, and uncut since. Here the uncut bracken was 2'6" at 40. On the north facing cut slopes, the bracken was now 2'6" at 25, while on the south facing slopes it was 1'6" at 25.

5. In the next group, cutting had been in 1949, 1950 and 1952, uncut in 1951 and 1953. The first area, previously with bracken of 3'6" at 30-40 now had bracken of 1'0" at 10-15. This area was very easy to cut cleanly, yet along dyke-sides were found fronds of 1'6" at 15-20 which had not been cut so regularly.

In comparison, a less easily cut area now had bracken of 1'3" at 10. The uncut bracken here varied from 1'0" at 50 in very stony ground, to 2'3" at 20-25 where the rock cover was 25%. In this area also there was a sheep bank, with good shelter and a high organic content in the soil. The cut bracken here was 1'9" at 30-40, the uncut was 4'0" at 30-40.

2B "Single Cut" Programme

1. Two years single cutting in 1951 and 1952, uncut in 1953, resulted in a reduction from 2'9" at 40-50 to 1'3" at 40.

Three Consecutive Years of Cutting

3A "Double Cut" Programmes

1. The first area of this type was cut twice in the years 1951, 1952 and 1953. It was on a very steep slope and carried uncut bracken of 3'6" at 20,
the cut bracken being 2'6" at 30-40. On a lower flat where the bracken had been 3'0" at 30-40 it was now 1'6" at 25-30.

The next area had been cut for the same periods, but lime had been applied just before cutting commenced in 1951. In the uncut areas, the bracken was 3'0"-3'6" at 45, whereas in the cut areas it was 1'0" at 10-15.

2. The next three areas were cut twice in 1950, 1951 and 1952, and were uncut in 1953. In the first, bracken of 4'0" at 50 had been reduced to 1'6" at 10-20.

The second area, originally with bracken of 3'0" at 40, now had fronds of 2'0" at 15-20.

The last of this area was in a plantation which had been felled many years ago, and there was difficulty in cutting, due to tree stumps. Uncut bracken was 2'6" at 30-35; the cut areas had bracken of 1'6" at 20-25, where the ground was dry, and of 1'6" at 5-10 where it was wet.

3. The next group is of areas cut in the years 1949, 1950 and 1951, and uncut since. In the first the uncut bracken was of 3'0"-4'0" at 35, while the cut had been reduced to a constant height of 1'9" at 10-25. (Single cut in 1951).

In the second of the group, uncut bracken was 3'0" at 35-50, the cut being 1'0" at 10.

The next had uncut bracken of 2'9" at 40, the cut bracken being 1'0"-1'6" at 16.

The last of this group had bracken of 1'6" at 10-15, this a reduction from 3'0" at 40.

4. One area was seen which was double cut in 1948, 1949 and 1950, and uncut since. The bracken was now 1'6" at 14-18, this a reduction from 3'0" at 40.

5. The next area was cut in the years 1947, 1948, 1949 and in 1952 and 1953. Uncut bracken was 2'6" at 20, and the cut was 1'0" at 10.

6. The next two areas were cut some time ago, the first in 1946, 1947 and 1948. Here there was a difference only in height between the cut and uncut parts, 2'0" and 2'6" respectively, the frequency remaining constant at 25.

7. The other area referred to above was cut in 1937, 1938 and 1939. Here there was no difference in either height or frequency, although the bracken which had been cut was of a lighter green colour than the uncut.

8. Finally, there was an area which had been double cut in 1948, 1949 and 1950, single cut in 1951 and 1952, and uncut in 1953. Bracken was of 6"-1'0" at 20, the uncut bracken being 2'0" at 20-25.

3B "Single Cut" Programmes

There were no records of three years single cut programmes.

Four Consecutive Years of Cutting

4A "Double Cut" Programmes

In this group the effects of prolonged cutting are well seen.

1. The first area had carried bracken of 3'0" at 40, and double cutting in the years 1950, 1951, 1952 and 1953 had resulted in a decrease to 9" at 5-10.

In the second, the same cutting programme had reduced 3'0" at 20 bracken to 1'0" at 8-10, and in patches the bracken was even more sparse, of 9" at 5.

2. The next areas were double cut in the years 1949, 1950, 1951 and 1952, and uncut in 1953. The first had uncut fronds of 3'0" at 30. The cut areas had growth of 9"-1'0" at 15.
The second case was composed of two parts. In the first uncut bracken was 5'0" at 25, while the cut bracken was 6"-9" at 15-20. In the second part, uncut bracken varied from 2'0" to 5'0", but was mostly around 3'0" at 15. The cut bracken here was 1'0" at 10, while, where it had been protected by Juniper bushes, it was 2'0"-2'6".

4A "Single Cut" Programmes

1. Of four years single cutting, two records are available, both single cut in the years 1949-1952 inclusive. In the first, bracken of 9"-1'0" at 10 contrasted with uncut bracken of 2'6" at 40.

In the second, the cut bracken was very sparse, 9" at 4-5, and the uncut of 3'6" at 40.

Five Consecutive Years of Cutting

5A "Double Cut" Programmes

In both the cases below, double cutting had taken place in the years 1948-1952 inclusive.

1. In this area, lime had been applied in 1949, at the rate of 2 tons per acre of ground limestone. Bracken growth was now of 6"-9" at 1-8, as opposed to nearby uncut, and unlimed, bracken of 2'0" at 50. One patch had been cut but not limed, and here the bracken was 1'0" at 20.

In the second area, the same liming treatment had been carried out in 1951, the fourth year of cutting, and had resulted in an almost complete clearance of bracken from the cut areas. Only a few clumps, fronds of 6"-1'0" at 10-20 were seen. The uncut and unlimed bracken nearby was again 2'0" at 30.

5B "Single Cut" Programmes

No records of such programmes.

Six Consecutive Years of Cutting

6A "Double Cut" Programme

1. This area was double cut from 1947-1952 inclusive, and was a steep stony hillside. Uncut bracken was 2'0" at 40-65, while the cut was 1'0" at 12-15.

6B "Single Cut" Programme

1. This area was single cut in the years 1948-1953 inclusive. Uncut bracken was 2'6" - 3'0" at 30; cut bracken was 9" at 4-8.

From the above it would appear that the single cutting programme had a greater effect than the double cutting, but it must be borne in mind that in the first area clean cutting was difficult due to steepness, rock outcrops etc., whereas in the second area a clean cut was easily achieved. Also, the time of cutting might have been a big factor in achieving these results. Unfortunately, accurate information as to this was not obtainable.

Ten Years of Cutting

Cutting had been in progress in this area from 1943-1952 inclusive, but the whole area was not cut each year. From the records and results it would appear that each part had been double cut at least four times in the ten years.

Uncut bracken was 2'6" - 3'0" at 35, while the cut bracken was 6" at 5-10. In parts which were difficult to cut, the bracken was 1'6" at 15.

See also Appendix III where the results are shown in tabular form.
DISCUSSION

General. From the results given above it is evident that both frond height and frequency are affected by cutting treatments. In the case of height there is a continual, but not proportionate, decrease as the period of cutting is extended. Frequency, however, may rise after the first year or so of cutting. This may be, partly, because the bracken plant is induced, as a result of cutting, to send up more fronds than normal, having been deprived of its original ones. After a year or two, the effects of continual cutting, and hence starvation, of the rhizome begin to show, and frequency thereafter crops continually.

Effects of Cutting on Height and Frequency. If we take the ratio of "cut height" to "uncut height", we get an indication of the effect of cutting on the height. If, for instance, the frond height had been halved by a cutting treatment, then the ratio would be 1/2 or 50%. This can also be applied to the results regarding frond frequency, and the ratios have been worked out for the results of the double cut programmes in the survey. (See Table III and Diagram 1). The figures are grouped according to the number of years consecutive cutting, and within each group, i.e. 1, 2, 3 and 4 years' consecutive cutting, the appropriate results for all counties visited and all methods of cutting are taken together. No ratios were worked out for 5 or 6 years consecutive cutting since there were not enough results in these groups to give a reasonably accurate result.

TABLE III

<table>
<thead>
<tr>
<th>Number of Consecutive Years' Double Cutting</th>
<th>Height of Cut Fronds as a %age of Original</th>
<th>Frequency of Cut Fronds as a %age of Original</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>54</td>
<td>72</td>
</tr>
<tr>
<td>2</td>
<td>49</td>
<td>55</td>
</tr>
<tr>
<td>3</td>
<td>49</td>
<td>57</td>
</tr>
<tr>
<td>4</td>
<td>29</td>
<td>51</td>
</tr>
</tbody>
</table>

It will be seen that, in the first year of cutting, height is almost halved, to 54% of the original height, but that frequency is reduced much less, by just over a quarter to 72% of the original frequency. (See also Appendix II).

It will also be noted that, in the third year of cutting, frond height of the previous year is not reduced, while frequency shows a slight rise. This is no doubt a reflection of the induced growth mentioned above, in Paragraph 1.

It is recognised that bracken growth in any particular area, is not equally great each year, and that conversely there are years when the bracken growth is greater than normal. Since the results on which Table III is based refer to various years, and are composite, the effect of such variation in the general level of growth is more or less distributed uniformly amongst the groups.

Scythe or Machine? It is often asked whether or not the scythe is more efficient in bracken cutting than machines. From an analysis of the double cut areas, cut solely by scythe or machine, the following figures were obtained:

TABLE IV

<table>
<thead>
<tr>
<th></th>
<th>Height of Cut Fronds as a %age of Original</th>
<th>Frequency of Cut Fronds as a %age of Original</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scythe</td>
<td>48</td>
<td>53</td>
</tr>
<tr>
<td>Machines</td>
<td>59</td>
<td>51</td>
</tr>
</tbody>
</table>

These figures in Table IV are offered without comment, bearing in mind
DIAGRAM I  
EFFECT OF SEVERAL YEARS OF CUTTING ON
HEIGHT AND FREQUENCY

<table>
<thead>
<tr>
<th>One Year</th>
<th>Two Years</th>
<th>Three Years</th>
<th>Four Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>of Cutting</td>
<td>of Cutting</td>
<td>of Cutting</td>
<td>of Cutting</td>
</tr>
<tr>
<td>100</td>
<td>75</td>
<td>50</td>
<td>25</td>
</tr>
</tbody>
</table>

DIAGRAM II  
COMPARISON OF SECTIONS OF
SCYTHE CUTTING AND
MACHINE CUTTING

<table>
<thead>
<tr>
<th>Cutting By Scythe</th>
<th>Cutting By Machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>50</td>
</tr>
</tbody>
</table>

H = Height  
P = Frequency  

As explained in the text, both diagrams are prepared from composite figures of results. In both diagrams, the original heights and frequencies are expressed as 100.
the rather small number of cases involved, 24 and 14 respectively, and that the results are again composite. In all cases the number of years of cutting are grouped, and in the "Machine" results, all types of machines are grouped. In a great many cases, both scythe and machines had been extensively used together in the same area and the results from such areas could not be incorporated in the Table.

(Also, a comparison of the effects of bruising machines with those of cutting or slashing type would not be very accurate, since, on the survey, it was found that cutting or slashing machines in use outnumbered those of bruising type by almost 10 to 1).

Liming and Manuring. In all the cases studied on the survey where liming, with or without the addition of manures, had taken place, there was a very great decrease in bracken growth. There were four such cases, and the results are shown in Table V and in Diagram III.

TABLE V

<table>
<thead>
<tr>
<th>Group Reference</th>
<th>Treatment</th>
<th>UnCut Bracken</th>
<th>Cut Bracken</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A1</td>
<td>(3 tons Lime)(10 cwts Slag)</td>
<td>4'0&quot; at 45</td>
<td>1'0&quot; at 10-15</td>
</tr>
<tr>
<td></td>
<td>Comparable area untreated</td>
<td>3'6&quot; at 45</td>
<td>1'6&quot; at 15-20</td>
</tr>
<tr>
<td>3A1</td>
<td>Limed in 1951</td>
<td>3'0&quot;-3'6&quot; at 45</td>
<td>1'0&quot; at 10-15</td>
</tr>
<tr>
<td></td>
<td>Comparable area untreated</td>
<td>3'0&quot; at 30-40</td>
<td>1'6&quot; at 25-30</td>
</tr>
<tr>
<td>5A1a.</td>
<td>2 tons Lime in 1949</td>
<td>2'0&quot; at 30</td>
<td>6&quot;-9&quot; at 4-8</td>
</tr>
</tbody>
</table>
| 5A1b.           | 2 tons Lime in 1951 | 2'0" at 30 | A few clumps of
|                 | Comparable area untreated | 2'0" at 30 | 6"-10" at 10-20 |

(These figures are duplicated in Diagram III. In each case the uncut heights and frequencies are taken as 100%, and the cut heights and frequencies related to that figure. With examples 2A1 and 3A1 the average results of cutting alone for, respectively, 2 and 3 years' consecutive cutting, are added from the survey, i.e. from Table III). It will be seen that, in all cases, the effects of cutting were greatest where lime and/or manures had been applied. The effect may be that the sward is so much improved by the manurial additions that the bracken finds it more difficult to push its fronds through the denser and tougher grass cover.

Another factor closely linked to the above, and borne out by experimental work, is that the sward may benefit more from the additions than the bracken, because the roots of the bracken are mainly well below the roots of the sward, and can only benefit from manures washed down to that region. The bracken rhizome system in a good, deep soil, ranges from 4" to 16" depth. The lowest rhizomes, at 18" depth are those which are responsible for the forward advance of the plant; these give off side branches which lie nearer the surface, at about 9" depth, and from which most of the fronds arise. Branches nearer the surface, at 4" depth, are of limited growth and are liable to damage from hard frost or drought.

The main root systems, which grow from the rhizomes, are thus found between 10"-12" and 18"-20" down in the soil. The only fertilisers which reach this depth comparatively quickly are the nitrates; the phosphates, potash and lime being held much nearer the surface, and in the region of the sward roots, for many years.

Braid, K.W. 1954, Private communication.
Diagram III

Effect of Xi and/or Xverages of
Variables on Cutting

H = Height
F = Frequency

A....Results from treated area.
B....Results from comparable untreated area.
C....Average results from Diagram I of appropriate number of years of cutting.

Cross-lined areas represent variations in height or frequency.
Grazing. The question of grazing was briefly mentioned in the General Notes and should now be expanded. Firstly, the benefits as reported by the farmers met with in the course of the survey. All were agreed that there was an improvement in the herbage, even after only one cut, because, as they remarked "the bracken grew on the best ground". Others noted the movement of stock on to the cut areas and the use of these areas during rest periods, the ease of herding, and the topping of the grass when cutting small, sparsely bracken in the summer. In one case the farmer had to bring forward the time of fencing off his cut areas, to prevent his neighbour's sheep grazing on them.

The effect of sheep grazing on bracken areas has been studied recently, and the following points have emerged. Due to the sheltering effects of the bracken, the sward below is green and succulent in the summer while the open swards are drier. Thus, grazing intensity on the bracken areas is high during the autumn when the fronds have withered slightly, but drops sharply with the onset of winter, since the grass is less winter-hardy. The excessive autumn grazing tends to impoverish the sward, leading to an increase in bracken growth.

The effect of grazing by both sheep and cattle and the amount of damage done to bracken by such stock was also considered. The general opinion met with indicated that little damage to the fronds was done by stock in open areas, but that in enclosed parks, trampling and possibly, to a lesser extent, eating, by stock might be a helpful factor in the reduction of bracken growth. Most farmers considered that cattle would eat bracken fronds only if they were newly cut, or in a very young stage, and then only if other grazing was not available. Of the bracken fronds seen which had been grazed by stock, only the very top of the fronds was removed, and this would have little effect on the plant.

Bracken Poisoning. The possibility of poisoning of stock by bracken was considered on the survey. Of twenty definite answers concerning this point, eleven had no bracken poisoning, two had suspected cases, and seven had definite cases, involving in total the death of seven cows and one horse. Some farmers suspected young, uncut bracken, others suspected the freshly cut fronds, and in at least one case the stomach of a cow was full of rhizome from newly-ploughed bracken land.

There have been a variety of opinions regarding the poisoning abilities of bracken; some workers have considered the plant to be a cumulative poison, or a delayed poison, others that it is an immediate poison. The work of Stockman, and others†, makes it clear that the plant is in fact a cumulative poison, requiring 26-30, or more, days before its effects are seen.

All workers are agreed that the plant is poisonous, mainly to cattle, but also to horses, especially where there has been bracken in their hay.

Clean Cutting. One of the greatest difficulties in bracken cutting is to ensure the removal of fronds which are protected from the machine or scythe by rocks, dykes and tree stumps, etc. If these fronds are left, the rhizomes to which they belong are not starved out, and remain as possible focal points of re-infestation. Even when machines are used on level ground it has been noticed that some fronds are left untouched, and it is a good policy in all cases of machine cutting to have a follow-up by scythe. The scythe is the best implement for dealing with single, obstructed fronds, and its use is almost essential where complete extermination of bracken is the goal.

Time of Cutting. The time of cutting the bracken is a big factor in its reduction or extermination. From the data of those farmers who could give an accurate date of the time of cutting, the following table has been prepared:

Hunter, R.F. Thesis presented to Edinburgh University, 1953.
Stockman, Sir Stewart, J.Comp. Path. and Ther., 1917, p.30-311.
Naftalin, J.M. and Cushnie, G.H., J.Comp.Path. & Ther., 1954. 61, p.54-86.
It will be seen that the most usual cutting times are in the second week of June, and the first week of August. This is not always the time at which the farmer thinks the bracken should be cut, but depends on the labour supply and the weather.

In 1935 an experiment was laid down in the College area in an attempt to find the best time of cutting, which in this case was all done by scythe. In the report of this experiment, it was stated "our experiments show the advantage of cutting in June. Where two cuttings are possible a start should be made as soon as the bracken is sufficiently tall to cut. The optimum time is when the fronds are just fully unfolded, but cuttings before this are more effective than cuttings after this date. Cutting bracken for the first time after the end of July is uneconomical".

In Scotland, the "optimum time when the fronds are just fully unfolded", would appear to be about the 22nd June, an earlier or later optimum time depending on the weather and soil conditions.

Cutting Policies. There would appear to be three policies with regard to the treatment of a bracken infestation. These are:— 1. Complete extermination, 2. Cutting of all visible fronds each year and 3. Cutting sufficiently often to keep the bracken at a stage where it is not interfering to any great extent with the grazing of stock.

On some of the farms visited, it was obvious that complete extermination of the bracken would be extremely costly, require many years work, and the whole-hearted co-operation of neighbouring tenants. Patches of inaccessible, badly cut or uncut bracken, both on one's own or neighbour's land, could recolonise cut areas at an appreciable rate.

Complete eradication is, except in a few exceptional cases, almost unattainable, even by cutting methods. An area may appear free of past bracken growth, but there is usually some remnant still present below the surface, which may lie dormant for many years, and then restart frond growth.

The second policy closely approaches the first, in that continuation of it will eventually lead to complete extermination of bracken, but the number of years required and the total labour power consumed over these years make both policies hardly desirable from the monetary viewpoint.

The third policy merits closer attention. Firstly, a less lengthy cutting period is required. Secondly, labour is not required every year for bracken cutting at a time when much labour is already in demand for other, and often more important, work.

The stage at which cutting could profitably be temporarily suspended will vary with, e.g. the original bracken growth and the soil type. Also a given height of bracken will have a given frequency of fronds per square yard, and vice versa, over which the density of growth is too great for stock to graze the sward below. Again, as noted above, too great a bracken cover leads to impoverishment of the sward, and eventually to complete lack of grass growth.

A Suggested Cutting Policy. On the average, the following cutting programme would suffice for most areas, where the third policy above is envisaged, and where no previous cutting has taken place. Naturally, it is also applicable to areas which have been cut, but have been allowed to return to their original bracken coverage.

This policy has been derived from the experience of the many farmers visited, and from results seen in the field.

The programme is as follows - double cutting for three years, single cutting for one or two, uncut for four to five. (This latter is an average time, and may vary from three to ten years, depending on the climate and soil).

The programme can be easily modified to suit areas where the bracken infestation is not particularly heavy, or which respond quickly to cutting treatments or which have been cut previously. In such cases, a reduction of, say, the double cutting period to two years might suffice.

After a lapse of some years with no cutting, the bracken will have regrown to a stage where it is interfering to some extent with the grazing or herbage. At this stage it should be cut again. Probably a series of single cuts over two or three years will reduce bracken growth to a state where it can be profitably left alone once more for a few years. See also Appendix I where this policy is shown in diagrammatical fashion.

Small, Wiry Bracken. At this point it is well to note that when bracken has been cut for many years it tends to have fronds which are small, wiry and springy. These fronds are difficult to cut by machine, as the cutting or slashing types may be set so high, in order to clear stones or rocks, that their blades go over the top of such fronds. Where using a bruising machine, there is a tendency for the fronds of this type to bend when the machine passes over them, and to spring up again, unharmed, when the machine has passed. In these cases the use of the scythe is the best method of control.

Effect of Lightning. One hill was visited which had been struck by lightning in 1935. Next year it was noted that the bracken had ceased to grow there, and even now there is still no growth, although the area is surrounded by dense bracken. The sward had fully recovered from the effects of the lightning, after two seasons.

The application of high-voltage or high-frequency currents might then be a possible means of control, or even extermination. We cannot hope to produce voltages of the order found in lightning, but the extensive use of smaller voltages no doubt would give a comparable result.

Portable units for weed control are at present available using the high voltage system, and their application to bracken control is at present under investigation.

Reseeding. On suitable soils, where the bracken canopy has been so dense that no sward was present, then a reseeding with hayseed sweepings and the application of a fertiliser should help to encourage the colonisation of the bare ground with useful grasses, after the bracken has been cut.

Weeds. Sometimes the bare patches left after bracken cutting are colonised by such plants as Thistles, Docks and Nettles. Hence the land having been cleared of one weed is rendered almost useless due to another.

No very large-scale invasions of this type were seen in the course of the survey, despite the wide variety of soil types encountered, and at least these incoming plants will respond, more quickly than bracken, to cutting or chemical treatment.
PART 3 - IS BRACKEN-CUTTING WORTHWHILE?

J. B. McCREATH.

The important question on bracken control is:

"Is it worthwhile?" There can be several different answers to this question depending on the interpretation of "worthwhile". The botanical aspects having been discussed in Part 2, this part of the report deals mainly with the economic considerations in bracken cutting. Consequently the question could be defined in this context as: "Is it an economic proposition?" Again the answer cannot be a simple 'yes' or 'no', for there are several different viewpoints to be considered, e.g. the farmer, the landlord and the State. It is with the first mentioned that the following discussion is mainly concerned. Of course, in the case of owner-occupied or estate farms in hand, both tenancy and ownership considerations apply.

That bracken cutting is an expensive operation cannot be denied, but it does not necessarily follow that it is uneconomic.

One argument against bracken cutting which is sometimes put forward is from the viewpoint of land value. "What", it is said, "is the use of expending upwards of 4/- per acre per annum on land which is rented at only 1/2 or so per acre?" The basis of this reasoning is not sound. Firstly, in many instances, the rental value of the land has not moved proportionately with the rise, of recent years, in the value of live-stock carried on that land. Secondly, it is from such stock that tenancy returns are mainly derived. Finally, the above argument is based on a very short-term view and bracken control, by the very nature of the bracken plant, is an operation which requires a long-term approach.

During the course of the survey, the majority of farmers who had done a fair amount of cutting, were of the opinion that bracken control was worthwhile, indeed essential in some cases. This was not so much with a view to increasing the stock carrying capacity in the first instance - although on a number of farms this was achieved - but rather to maintain the present position or, in cases of bad infestation, to prevent an ultimate decrease. It is from this standpoint, - the effect that bracken is having on the stock carrying capacity over a period of years, - that the economics of bracken control must be judged.

Although it is plain from visual evidence, that in most instances bracken cutting must be beneficial, the actual measurement in monetary terms is difficult. The following methods are put forward more as new approaches to the problem rather than as a general answer. Indeed the question of whether bracken cutting pays or not will depend on the extent and rate of spread of bracken and the inherent stock carrying capacity of the ground.

In general, the farms cutting bracken fell into three distinct categories, depending on the extent of bracken infestation and the effect it was having on the stock-carry. To avoid repetition, the three groups have been called Cases, I, II, and III and each case is dealt with separately in the following pages.

CASE I

Farms where the extent and rate of spread of bracken are such that, if serious deterioration of the whole sheep stock is to be avoided, either the bracken must be brought under control or the number of stock reduced.

As shown in Table I on page 3, over the past three years 1951-1953 inclusive, the average annual gross cost of double cutting an acre of bracken per season was 16/- for farm machines, 25/- for contract scythe and 26/- for contract machines.
The average prices for Blackface store lambs and the price of Blackface wool over the same three years were:

<table>
<thead>
<tr>
<th></th>
<th>1951</th>
<th>1952</th>
<th>1953</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wedder Lambs</td>
<td>55/9</td>
<td>57/5</td>
<td>65/5</td>
</tr>
<tr>
<td>Ewe Lambs</td>
<td>56/-</td>
<td>52/6</td>
<td>61/2</td>
</tr>
<tr>
<td>Wool (per lb.)</td>
<td>5/10</td>
<td>4/6</td>
<td>4/6</td>
</tr>
</tbody>
</table>

Assuming that an area of bracken (preferably on the more fertile and recently invaded slopes) is cut by contract scythe for three consecutive years, then:

- Average cost per acre (twice cut) = 25/- per annum
- Cost over the three years = 75/- per acre
- Assume 50% grant received each year = 37/6 per acre
- Net Cost to Farmer = 37/6 per acre

Assume 4 acres needed to support 1 Ewe
- Net Cost of three years' cutting per Ewe = 150/-

Benefit to grazing lasts for say 5 years.
- Net Cost per Ewe spread over 5 years = 30/- per annum.

If the above treatment was effective from a botanical and husbandry point of view and the improvement in grazing obviated the need to reduce the ewe stock, then the annual income from the "retained" ewe would cover the annual expenditure in retaining her.

In 1952 for example a reasonable average income from a Blackface ewe might have been:

- 4 lbs. of wool @ 4/6 per lb = 18/-
- x 75% of one store wether lamb @ 56/- = 42/-
- Total 60/-

Thus in the first year the income per ewe was double the expenditure on bracken control expressed per ewe.

In 1953, average income per ewe:

- 4 lbs wool @ 4/8 2/3 = 19/- approx.
- 75% of the value of one ewe lamb (retained) @ 6/- = 4 1/2/-
- Total 6/-

Even in 1954 if wool fell to 4/- per lb and store lamb prices were well down on previous years:

- 4 lbs wool @ 4/- per lb = 16/-
- 75% of 1 store lamb @ 48/- say 36/-
- Total 52/-

The income is still almost double the annual bracken expenditure. By the end of the third year, the total expenditure (150/- per ewe) on the bracken cutting programme has been amply covered by receipts from the ewe (179/-). Also it is reasonable to assume that the ewe will be kept at least one other year, if not two, before casting. No allowance has been made for the money realised by the sale of such a cast ewe as, had it been decided not to cut bracken, the ewe would have been sold in any case. Furthermore it would be, presumably, the ewe's poorest in condition which would have been sold off first in any reduction policy. The difference in price between such ewes and the normal draft of cast ewes would not be great and would be more than covered by the excess of revenue over bracken expenditure even in just four years.

% Farm Economics Branch, D.O.A.S.

x Assuming a lamb marking percentage of 75
Thus by controlling the bracken, the farmer, in this theoretical case, has not only maintained his output and kept his stock up, but also this has been done without involving him in a financial loss. Indeed there would be a profit on the operation. Had landlord and tenant shared the cost equally, then the profit to the tenant would have been twice as great. The landlord has benefited, however little, by the enhanced value of the land. The nation has received at least three potential mutton carcases and some 20 lbs of wool. Most important of all, an area of land has been kept in production.

In the calculation both the stock carrying capacity and the number of years of benefit have been kept purposely low. The renewed cutting programme, needed after five years, would not be so long nor so costly and the benefits would last at least another five years.

It must be noted how important is the part played by the grant in the calculation. Had there been no state assistance, the cost per ewe would have been 60/- per annum for 6 years and the cutting would have been much more a border line proposition.

Now the above theoretical calculation points to a considerable benefit from cutting but was it borne out by evidence gathered during the survey? During the investigation several farmers gave information which upholds the foregoing synthesis.

Evidence in Support of Case I

The evidence was mainly visual and verbal. In an investigation of this nature, entailing as it often does, the recording of similar opinions at farm after farm, the investigator must guard against the natural tendency to attach too much importance to the less frequent and perhaps more spectacular opinion. In the report this safeguard was taken as far as possible.

(a) Hill Sheep Farm in West Porthshire:

<table>
<thead>
<tr>
<th>Seasons</th>
<th>1950</th>
<th>1951</th>
<th>1952</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>15/10</td>
<td>13/2</td>
<td>16/-</td>
</tr>
</tbody>
</table>

Farmer's Opinion

There was a big improvement in the grazing which was considered as likely to last for five years or so. There has been no increase in stock but a decrease has definitely been prevented. The sheep have moved into the cut areas. The lambs are in better condition but this may not be due entirely to bracken cutting. Stock-carry was approximately 5 acres per ewe.

Botanical Notes

The cutting area was sharply delimited by a rocky outcrop, above which no bracken cutting had been attempted. For twenty yards below this outcrop there was a 20/- rock cover, and then clear Fescue/Fiorin pasture.

In the rocky, uncut area, bracken was 1½'-2½' at 4½. The sward was very patchy in places due to the heavy bracken growth and consequent litter. Areas free of bracken were so because of dampness, and these areas carried Sphagnum moss and Blueberry.

The cut area was steep and rather stony, with a south-westerly aspect. The bracken was 9'-12' at 16. A good sward was found here, with Fescues, Fiorin, Sweet Vernal, Tormentill and a few Thistle plants.

(b) Hill Sheep Farm in West Porthshire:

Some 300 acres of bracken cut by contract scythe twice each season in recent years.

Cost: 1952 16/8d; 1953 20/- per acre double cut.

D.J. Martin.
Manager's Opinion

Without bracken cutting a proportion of the ground would have been useless. Farm was able to support 100 ewes which, but for the cutting, would have had to be sold. The sheep stock is in better general condition and the lambs are improved. The stock-carry was 2½ acres per ewe.

Botanical Notes

The area of bracken cutting was rather steep, and in parts heavily wooded. Within and around the wooded areas there was a bracken growth similar to that in the uncut areas. The uncut areas were heavily infested with bracken of 2'6"-3'0" at 30. There was no sward due to bracken litter.

The cut areas carried fronds of 9"-12" at 12-30, mainly nearer the lower frequency.

(c) Hill Sheep farm in Kirkcudbrightshire:

Some 60 acres of bracken, which had been cut previously in 1947 and 1948, were again cut twice per season in 1951 and 1952. Cost in 1952 was 21/8d per acre (double cut).

Farmer's Opinion

Cutting, by self-propelled machine, was well done and the bracken so reduced that even a single cut in 1953 was not worth-while, except perhaps on one small south-facing slope where growth was stronger. Both Blackface sheep and Galloway cattle had access to the cut area. Cutting made no difference to the numbers carried. If the bracken had not been kept in check by cutting however, the sheep stock would have had to be reduced. This was especially so when the plough-up campaign meant some 20 to 30 acres fewer of lowground grass.

On this farm too, an area which had been cut by scythe for three years (two double cuts and a single), was inspected. The bracken on this land was formerly so tall that no sheep could be seen amongst it. After the above programme, there were not enough fronds to give sufficient frond counts.

Cutting was considered well worthwhile and would be continued even if no grant were available.

Botanical Notes

The uncut areas carried bracken of 1'3" at 24, the sward below being rather poor due to bracken little. There were a few isolated plants of Fescue and Creeping Soft Grass.

In the cut areas, the bracken was 6" at 10-25. A good sward, of a Fescue and Bent mixture, was present here, due partly to the cutting of the bracken, and partly to the fact that lime had been spread on the area. In one part, which had a south-westerly aspect, the bracken was still rather strong although it had been cut. Here it was 1'0" at 20.

(d) Hill Sheep farm in South Argyll:

Bracken cutting has been enthusiastically tackled for many years on this farm. Different machines have been tried out from time to time.

In 1952, some 400 acres were cut by machines. The cost for a single cut worked out at 6/8d per acre with a tractor-mounted machine.

Farmer's Opinion

Farmer has always advocated the need for bracken cutting. He considered it a worthwhile investment and, although his stock numbers had not been increased, he felt that they would have had to be reduced had the bracken growth been allowed to go unchecked.

Botanical Notes

The uncut bracken was 3'0" at 45, with a very slight growth of Fescue below. In the cut areas and where the ground was level with
no obstructions, it was 1'0" at 4-6; where there were obstructions it was 2'0" - 2'3" at 12-15.

(e) Hill Sheep farm in North Argyll:-

Brackens were cut with a scythe by the farmer himself whenever there was a spare moment — therefore difficult to get an idea of cost. One year, it cost 16/6d approx. per acre (twice cut).

Farmer's Opinion

Great difference in the condition and amount of grazing available since present occupier took over. The sheep are in better condition and feeding heavily on areas where, formerly, grazing was impossible. Definitely worthwhile and, in his opinion, should be compulsory to cut a certain amount of bracken each year.

Botanical Notes

The uncut areas had bracken of 2'6"-3'0" at over 4.0, while the cut areas had reduced growth of 9" at 5-10.

(f) Hill Sheep farm in North Argyll:-

<table>
<thead>
<tr>
<th>Years</th>
<th>1945</th>
<th>1946</th>
<th>1947</th>
<th>(Uncut for 2 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acreage Cut</td>
<td>300</td>
<td>180</td>
<td>100</td>
<td>120</td>
</tr>
<tr>
<td>Cost per ac. (twice cut)</td>
<td>19/10</td>
<td>15/-</td>
<td>20/-</td>
<td>25/-</td>
</tr>
</tbody>
</table>

Farmer's Opinion

Some 80 ewe hoggs now being wintered at home but not entirely due to bracken control. Perhaps he would say that more cattle were being carried due partly to the cutting of bracken. Considering the high cost of present day hogg wintering, in the region of £25 to £30 per score, even one or two score of hoggs at home represents a considerable saving over the years.

Farmer doubted if a tenant could have afford to cut so much. He thought it worthwhile and would continue to cut a certain amount, even if there were no grant available.

No Botanical Notes.

Summary of Case I Farms

In the above six examples, only on the last farm were the costs of cutting as high as the costs used in the theoretical calculation. From visual evidence, there was no reason to suspect that their stock would be fetching below average prices. It can be fairly confidently claimed that on those farms, bracken cutting was a worthwhile long-term investment.

CASE II

Farms where bracken control had led to an increase in the stock carrying capacity of the grazings.

(a) Hill Sheep farm in West Perthshire:-

<table>
<thead>
<tr>
<th>Years</th>
<th>1951</th>
<th>1952</th>
<th>1953</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acreage</td>
<td>250</td>
<td>250</td>
<td>350</td>
</tr>
<tr>
<td>Cost per acre (double cut)</td>
<td>N.A.</td>
<td>24/-</td>
<td>28/7</td>
</tr>
</tbody>
</table>

Cut by scythe under contract.

Farmer's Opinion

The cutting has meant a big improvement — better grass and the sheep stock has been increased. (Numbers were not given). More hoggs were able to be wintered at home on the lowground. This ground would formerly have had to support some ewes, now being wintered on the lower slopes of the hill where bracken cutting had been done.
Botanical Notes

A very steep slope had been cut by scythe, and visually there seemed to be little difference between the cut and the uncut areas. However, counts gave these results - uncut 3'6" at 19, cut 2'6" at 35. This result shows the decrease in height and increase in frequency often encountered after the beginning of a cutting programme.

On a lower flat, where the bracken had been as strong as the uncut material above, it was reduced to 1'6" at 25-30. Here there was an excellent Fescue/Bent sward, although there was no sward in either the cut or uncut areas above.

(b) Several hill farms under one ownership in West Perthshire:

Bracken cutting had been carried out on different hirsels on these farms from 1942 to 1952. Due to the number of different schemes, it was impossible to summarise the acreages and costs. By 1951 and 1952 however, the contract charges had risen to 30/- per acre for two cuts in one season.

Manager's Opinion

It is difficult to assess how much of the improvement in sheep stock is due to bracken cutting. Without it, however, only half the numbers could have been carried on some hirsels. Worthwhile, but may not be continued on areas which are no longer eligible for grant. There was no cutting in 1953, for this reason.

Contractor's Opinion

When cutting began, in some areas the fronds were over six feet high in parts and the condition of the stock poorish. Now, the brackens are greatly reduced and, in his opinion, the stock are as good as any in the county.

Botanical Notes

Various hirsels were seen, and the results are as below. In each case, the uncut bracken can be taken as similar to the bracken found in Hirsel E.

Hirsel A: Bracken of a uniform 9" at 10-15. Good sward of Fescue, Sweet Vernal, Purple Moor Grass and some Male Fern.

Hirsel B: Bracken of 6"-9" at 15-20. Some yellowing of the bracken noticed, possibly due to soil conditions.

Hirsel C: Bracken of 6" -9" at 5-10.

Hirsel D: Bracken of 12" at 16-20. A heavy infestation of Male Fern in this area.

Hirsel E: Bracken of 3'-3'6" at 20. This may be taken as typical uncut bracken for the above hirsels.

(c) Hill sheep farm in North Argyll.

<table>
<thead>
<tr>
<th>Years</th>
<th>1950</th>
<th>1951</th>
<th>1952</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acreage</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Cost per acre</td>
<td>18/-</td>
<td>16/-</td>
<td>15/-</td>
</tr>
</tbody>
</table>

* These figures include depreciation at 25% and repairs to machine.

Cutting was done by a self-propelled machine belonging to the farmer. The rate of cutting was approximately 3 acres per day.

Farmer's Opinion

When present farmer took over, the brackens were very dense. His lambs used to be always cheaper than those from surrounding farms. In 1952 they were dearer. The neighbouring farmers are now beginning to show interest in the bracken cutting improvements. He was fairly sure that the increase in stock carry of 2 score of ewes was due, in the main, to bracken cutting. He would continue to cut even though no subsidy were available.

It must be pointed out that the above costs were thought to be
cheaper than average due to the enthusiasm and skill of his son, who handled the machine.

Botanical Notes
On cut slopes the bracken was 1'6" - 2'0" at 15-19. The uncut areas had bracken of 3'0" at 40.

(d) Hill Sheep farm in North Argyll:-

<table>
<thead>
<tr>
<th>Years</th>
<th>1951</th>
<th>1952</th>
<th>1953</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acreage</td>
<td>Not available</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per acre (double cut)</td>
<td>30/- each year</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Owner's Opinion
In 1950 the bracken fronds were some 7 feet high in places and dense bracken litter had smothered the grasses. On such brown patches, seed sweepings were scattered. Also in certain areas 3 tons of lime and 10 cwt's slag were applied per acre. The results were very good.

Sheep were improved in condition; the lambs were bigger and better; the stock had increased by approximately 2 score of ewes over the past five years.

On one southern exposure, sheep came into a cut area where previously they would never graze. Indeed, sheep from a neighbouring hill came over to this area.

Due to the supplementary manurial treatment, the resulting benefits cannot all be attributed to bracken cutting.

Botanical Notes
The cut areas had been improved by the addition of hayseed sweepings, lime and slag. The cut bracken was of 1'0" at 10-15, this a reduction from 3'6" at 35.

(e) Hill Sheep farm in North Argyll:-

<table>
<thead>
<tr>
<th>Years</th>
<th>1950</th>
<th>1951</th>
<th>1952</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acreage</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Cost per acre (double cut)</td>
<td>25/-</td>
<td>26/-</td>
<td>26/-</td>
</tr>
</tbody>
</table>

The cutting was done by scythe on a contract basis. In 1952 a machine was tried but, as it was financially more costly, it was discontinued.

Factor's Opinion
The cut area, formerly covered with thick bracken and little or no other vegetation, was on the lower slopes near the sea. It had now a sward and much improved sward.

As the farm was previously understocked, the considerable increase in stock carry achieved, masked the effects of bracken cutting. However, it was certain that the bracken cutting had helped to bring about an increase in stock carrying capacity. The cattle had done particularly well.

No Botanical Notes.

(f) Hill Sheep farm in South Argyll:-

<table>
<thead>
<tr>
<th>Years</th>
<th>1950</th>
<th>1951</th>
<th>1952</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acreage (approx.)</td>
<td>160</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>Cost per acre (double cut)</td>
<td>24/-</td>
<td>24/-</td>
<td>18/-(single)</td>
</tr>
</tbody>
</table>

The bracken had never been cut previous to 1950. The work was done by scythes with contract labour. In the worst areas bracken litter was abundant.
Owner's Opinion

By the third year, a double cut would only have been nominal. There was a big improvement in the quality of the grazing and in an area where grazing was most needed. One acre of land on which the bracken was cut was inherently worth four or five acres of bracken-free land higher up the hill.

The sheep stock looked better, wintered better and had been increased in numbers. This hill was now carrying 40 more breeding ewes and followers. The farmer considered that the hill was not previously understocked and that the increased carrying capacity was directly due to bracken cutting. There had been no other treatment with lime or slag etc. He was confident that it was financially worthwhile. He expects the benefit to the grazing to last for six or eight years and that any subsequent cutting programme needed at end of that time should not be any more expensive.

Indeed, in the botanist's opinion, in general two years of single cutting should suffice and the resulting benefits would last for a similar length of time (see Graph in Appendix I).

If it pays to cut bracken to prevent a decrease in stock numbers, one would normally expect it to be more profitable where cutting led to an increase in stock.

Although the farmers in the above seven examples were sure that bracken cutting, in their particular circumstances, was worthwhile, they did not know, in terms of money, by how much it had been worthwhile.

Economic appraisal of cutting on farm 'f'

Fortunately, during the course of another hill farm survey, detailed information on sheep prices, death rates, lamb marking percentages and general husbandry practices were obtained for the last mentioned farm (f). By combining the evidence from both surveys, the following calculation was built up.

<table>
<thead>
<tr>
<th>Actual Figures for (over 5 years)</th>
<th>Forecast Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamb Marking Percentage</td>
<td></td>
</tr>
<tr>
<td>Wedder Lamb Prices (Fat Average)</td>
<td></td>
</tr>
<tr>
<td>(Store Average)</td>
<td></td>
</tr>
<tr>
<td>Ewe Lamb Prices</td>
<td></td>
</tr>
<tr>
<td>Cost Ewe Prices</td>
<td></td>
</tr>
<tr>
<td>Ewe Death Rate</td>
<td></td>
</tr>
<tr>
<td>Lamb Death Rate (marking to speaning)</td>
<td></td>
</tr>
<tr>
<td>Wool Weight (per clipped sheep)</td>
<td></td>
</tr>
</tbody>
</table>

Since 1952 was, comparatively, a very good hill farming year, the estimated forecasts for the five years average have been altered unfavourably compared with 1952. Also the farmer's estimate of the number of years (6 to 8), which the grazing may benefit from cutting, have been reduced to five.

Cost of Bracken Cutting Programme:

Gross Cost per acre for three years '50, '51, '52 = 66/.
Less 50% grant = 33/.
Net Cost per acre for the three years = 33/.
Total Net Cost for 160 acres = £264.

The hill was now carrying 40 more breeding ewes and followers as a result of the above programme. Using the forecast figures, it was possible to draw up a probable profit and loss account for the extra forty ewes and followers over the five years of improvement. All the figures were discussed and agreed with the farmer.

# A Survey of an Argyllshire Hill-Farm District.
(J.B. McCrea and R.D. Murray)
### Profit and Loss Account for 40 Extra Ewes

#### Over Five Years

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Cost per Unit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 Breeding Ewes @ £6 (Nov. '51)</td>
<td></td>
<td></td>
<td>£240</td>
</tr>
<tr>
<td>11 Ewe Lambs for Stock (Nov. '51)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replacement @ £3</td>
<td>33</td>
<td></td>
<td>£8</td>
</tr>
<tr>
<td>1 Ram Purchased&lt;sup&gt;0&lt;/sup&gt;</td>
<td>24</td>
<td></td>
<td>£33</td>
</tr>
<tr>
<td>9 Fat Wedder Lambs @ 72/- per head</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of Bracken Cutting</td>
<td>264</td>
<td></td>
<td>£826</td>
</tr>
<tr>
<td>Cost of Wintering away</td>
<td>57</td>
<td>£52/- per head</td>
<td>£2928</td>
</tr>
<tr>
<td>50 hoggs @ 32/- per head</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extra Dip, Medicines, etc.</td>
<td>12</td>
<td>£30/- per head</td>
<td>£360</td>
</tr>
<tr>
<td>(40 x £4/- x 5 years)</td>
<td>10</td>
<td>£75/- per head</td>
<td>£750</td>
</tr>
<tr>
<td>Miscellaneous Expenses</td>
<td>190</td>
<td>£4/6 per lb.</td>
<td>£826</td>
</tr>
<tr>
<td>(1/- per Ewe per annum)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NET PROFIT</td>
<td>135</td>
<td></td>
<td>£2826</td>
</tr>
</tbody>
</table>

<sup>0</sup> Only one ram needed as there are several hirsels and the rams are changed over after two seasons.

With an average marking percentage of 70 and a 5% death rate, in 5 years there would be 133 lambs, say 67 ewe and 66 wedder. 11 ewe lambs would be retained each year. On this farm, normally one wedder lamb in seven was graded.

Excluding the bracken-cutting expenditure, the gross profit was £399 for the five year period. The average gross profit per annum therefore would be £80 approx. The bracken-cutting expenditure of £264 would be more than paid for by the end of the fourth year. The normal ewe casting policy on this farm was after five lamb crops.

Since, in the farmer's opinion, the whole sheep stock has benefited by this cutting programme, the above net profit does not represent the full value derived. The difficulties of measuring this benefit in money terms is unsuamountable. However, if the benefit only amounted to an estimated 1/- per head per annum, then over the total ewe stock (790) the amount so gained over 5 years would be quite substantial.

Looking at the problem from the point of view of reducing death rates, even if this cutting of thick bracken prevented the loss of one ewe per annum, then in five years, with the present day value of sheep, the saving would be worthwhile.

Further, the improvement in condition, if not in actual numbers, of lambs and other classes of sheep has not been taken into account.

The cutting programme needed at the end of five years might be two years of single cutting per season. The gross cost of recutting the area might be in the region of 36/- per acre. Whether or not this renewed programme would be eligible for the 50% grant is not certain. If it were, then the net cost per acre would be 15/- less than the initial scheme (33/-) and the net profit over five years would be much greater. Even if it were not, the 3/- per acre more or £24 in total would still be more than covered by the revenue from 4.0 ewes. The above calculations of course are based on the sheep industry remaining fairly stable throughout the time period. A recession in prices could alter the whole picture.

Comparison of other farms using farm ‘f’ as a standard

Although detailed information on lamb prices, ewe death rates, etc. was not available for the other five farms, those concerned were of the opinion that it was worthwhile. As a rough guide to whether or not there would be an actual financial gain, the following method has been devised, using farm ‘f’ as the standard of comparison.
On farm 'i', assuming a stock carrying capacity of 3 acres per ewe (actual figure was 2 1/2):

| Total net cost per ewe | = 99/- | Net cost per ewe spread over five years | = 20/- p.a. approx. | Gross profit per ewe average | = 35/- p.a. |

- Net Profit per Ewe = 15/- p.a.

Similarly:

<table>
<thead>
<tr>
<th>Farm</th>
<th>'a'</th>
<th>'b'</th>
<th>'c'</th>
<th>'d'</th>
<th>'e'</th>
<th>'f'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock Carry (Acres per Ewe)</td>
<td>(say)3</td>
<td>(say)3</td>
<td>(say)3</td>
<td>N.A.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Net Cost of Cutting per Acre (3 yrs. double cutting)</td>
<td>38/-</td>
<td>44/-</td>
<td>25/-</td>
<td>45/-</td>
<td>38/-</td>
<td>33/-</td>
</tr>
<tr>
<td>Net Cost of Cutting per Ewe</td>
<td>114/-</td>
<td>132/-</td>
<td>75/-</td>
<td>135/-</td>
<td>114/-</td>
<td>99/-</td>
</tr>
<tr>
<td>Net Cost of Cutting per Ewe per annum</td>
<td>23/-</td>
<td>26/-</td>
<td>15/-</td>
<td>27/-</td>
<td>23/-</td>
<td>20/-</td>
</tr>
</tbody>
</table>

| No. of Extra Ewes Carried | N.A. | Double on some Hirsels | 40 | 40 | N.A. | 40 |
| Assuming Gross Profit per Ewe per annum | (at 5/- less per ewe than on 'f') | 30/- | 30/- | 30/- | 30/- | 30/- | 35/- |

| Net Profit per Ewe per annum (on extra ewes) | 7/- | 1/- | 15/- | 3/- | 7/- | 15/- |

4 Cost spread over the 5 years' benefit to grazing.

It should be noted that on farm 'a' the 3/- per ewe profit would need to go to help pay for the cost of the liming and slagging programme. Due to this manurial treatment, this example is not fully comparable with the others.

It may be argued, and fairly, that on farms 'b', 'c', 'd' and 'e', 3 acres per ewe may be low. If this is increased to 4 acres per ewe, the position becomes:

<table>
<thead>
<tr>
<th>Net Cost of Cutting per Ewe per annum</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
<th>(e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Profit per Ewe per annum (or Net Loss per Ewe per annum)</td>
<td>35/-</td>
<td>20/-</td>
<td>36/-</td>
<td>30/-</td>
</tr>
</tbody>
</table>

The above calculations show how important it is this question of the inherent stock-carrying capacity of the grazing. At 3 acres per ewe on all six farms, assuming the gross profits per ewe shown, the bracken-cutting programmes were profitable. At 4 acres per ewe, farm 'c' still made a substantial gain (10/- per ewe per annum); three farms were not involved in any financial loss, and the remaining two made deficits of 5/- and 6/- per ewe.

Also, it should be borne in mind that the gross profits per ewe of 30/- were reduced by 5/- per ewe compared with 'f', although there was no evidence taken that any or all of the other five farms would be more or less profitable. It may be argued that the average figure of gross profit per ewe of 30/- per annum over 5 years is carrying on the high side. A recent report from the Aberdeen College covering 17 hill sheep farm accounts (60% Blackface and 40% Cheviot flocks), gave an average gross profit, before charging interest on capital and the value of the farmer's manual labour, of 27/- per ewe.

A detailed investigation of 12 hill sheep farms in Argyll producing Blackface lambs gave exactly the same equivalent gross profit per ewe. Both studies covered the disposal of the 1952 lamb crop.

From a preliminary scrutiny of accounts already forward for 1953 and bearing in mind the general increase in store lamb prices at most Scottish markets in that year, there is reason to believe that the 1953 average profits on hill sheep farms will be at least as good (and probably better) than in 1952. Also the wool price for 1953 was 23d per lb. higher than in 1952.

x Report No.56. "Hill Farming in the North of Scotland". A.Grant, N.S.A.C.
† "Survey of An Argyllshire Hill-Farm District. 1952". J.B.McCreath, W.S.A.C.
The level of profits over the next three years, of course, cannot be accurately predicted. At 3 acres per ewe, even if a gross profit per ewe of 27/- is taken, none of the above six farms would be involved in a financial loss over the bracken cutting programmes.

Further, as stated for farm 'f', the calculation does not allow for the increased benefits due to bracken cutting derived by the total sheep stock.

In addition, in the calculation for farm 'f' on Page 31, the cost (280) of wintering away the replacement ewe hoggs forms a large item of expenditure. On farms, where some or all of the ewe hoggs can normally be wintered at home, the margin resulting from the extra sheep carried, due solely to bracken cutting, would be correspondingly greater. On farms such as 'a', where the bracken cutting not only meant an increase in stock carry but also an increase in the number of ewe hoggs wintered at home, the resulting saving (not allowed for in the calculation on Page 32) would be of considerable help in combating any fall in sheep prices which might occur in the future.

Furthermore, except on farm 'c', the work was done by contract. Bearing in mind the previous remarks on the lower costs of self-owned machines, it is also true to say that had the five other farmers been using their own labour and equipment, their net profit per extra ewe would have been higher. It was considered, by the writers, that machine cutting would have been feasible on the greater part of the cut areas of farm 'a'; parts of the hillsides on farm 'b'; farm 'd' was already employing a contract machine. On farm 'o', a machine was tried and found to be more costly than scythe cutting and on farm 'f' machine cutting was not practicable.

It is significant that on farm 'c' the farmer, using his own labour and a self-propelled machine, had the highest estimated net profit per ewe even if one took the stock-carrying capacity at 4 acres per ewe. With regard to the question of the limiting factor of steep and rough terrain, on some other farms visited self-propelled machines were being used, and successfully, on fairly steep country. Also, as the recent tractor-operated machine trials at Conrie demonstrated, the nature of the land which can be safely covered by tractors, in the hands of good careful drivers, would be, in all probability, surprising to some farmers who were in doubt about the practicability of machines under their conditions. Too much emphasis, however, on this question of method must be avoided, as the farmer knows his own ground far better than any person who walks over it once.

Bracken cutting on cross-lamb hills

The foregoing paragraphs related to pure Blackface hills. The cost of cutting bracken on cross-lamb hills should be no more expensive. Indeed since Blackface flocks are generally found on the rougher and steeper hills, the cost of cutting bracken on these Blackface hills might reasonably be expected to be higher. Furthermore, the sale price of cross-lamb is generally much greater. In 1951 the weighted average price of cross lambs sold at the principal Scottish markets was 85/7 compared with 55/9 for Blackface wether lambs. In 1952 the figures were 91/9 and 57/5 respectively. Also, and more important, the stock-carrying capacity of cross-lamb hills is normally greater.

Taking all these factors into account, plus the fact of higher lamb marking percentages and lower death rates on the greener hills, it would be reasonable to assume that, where an increase in stock carry was accomplished due to bracken-cutting, the financial benefits so derived would be greater than on Blackface hills.

Despite the foregoing, it does not follow that, with bracken cutting costing approximately the same and with the same prices ruling for sheep and wool, bracken control will result in an increase in the financial return in all cases, even although an increase in stock is possible.

On another hillside of farm 'f' some 70 acres of dense bracken beside a wood was tackled. After two years of double cutting, the bracken was reduced but bramble bushes and rushes increased. Eventually the grass failed to grow.
compete with these colonisers and the area reverted to its original unpro-
ductive state. Probably the proximity of the wood, as a source of bramble
infestation, played a prominent part in the failure of this scheme. The
money spent on this cutting project would therefore be almost entirely lost.
It is a case such as this that makes a general assertion of the profitability
of bracken-cutting impossible.

Summary of Case II Farms

Summing up the evidence from the six farms, it would appear that in
general bracken cutting is profitable (taking a long-term view over say ten
years), if it leads directly to an increase in stock carry and provided:-

(i) The present day relationship of sheep prices to cutting costs
remains the same or increases.

(ii) The inherent stock-carrying capacity of the grazing is not
too low i.e. not more than 4 acres per ewe and preferably 3
acres or less.

(iii) The actual work is done thoroughly and at the optimum stage
of growth for cutting and the benefit to the grazing lasts
for at least as long as the normal breeding life (on the hill)
of a ewe.

(iv) The farm management is such that at least average profits are
being made with the existing stock.

On cross-lamb hills, although the above factors also apply, the margin,
within which the farmer can make a profit, is greater than on Blackface
grazings, for reasons given earlier (page 33).

CASE III

Farms on which the degree of bracken infestation has been such that there
were no immediate signs of a need to reduce the number of ewes carried and
where bracken cutting has not led to an increase in stock-carrying capacity:-

It would be easy to justify the cost of bracken control over a long term
period, by assuming that if the bracken was spreading and if cutting was not
carried out, then eventually the farmers would be faced with a deterioration
in stock or a reduction as in Case I. Although in general this "prevention
is better than cure" approach is probably correct, it is not sufficient to
 evade the argument in this facile manner.

Of the 23 cases in this category, 12 farmers plus the farms on Buccleuch
Estates were of the opinion that cutting was worthwhile; 6 farmers were
doubtful and the remaining 4 were sure it was not worthwhile under their
particular circumstances.

FARMS WHERE CUTTING WORTHWHILE

Although in all thirteen cases the people concerned were convinced that
cutting was worthwhile and effective from a husbandry and botanical point of
view, they found it difficult to assess, in money terms, the actual benefits
derived. That this should be so is not at all surprising, as the question
is indeed complex.

Assessment Difficulties

There are so many factors other than bracken cutting which affect the
hill farmer's financial year. Such major factors as the weather, the buoyancy
of the market and the varying degree of skill of different shepherds, all play
a big part. The element of luck in choice of marketing day alone can be very
important. The demand for store lambs and draft ewes can vary considerably
on different market days. The number of lowground buyers present on any
particular day can influence the price realised by store sheep. Also the
time at which the seller's sheep pass through the ring may mean a difference
of several shillings in the sale price. Hence a farm which can grade lambs
either straight off the hill or off rape etc, has an advantage over the store
lamb hill, because of the fixed price ruling for fat sheep meantime. The
foreshowing considerations did not apply so strongly in the past three years due to the heavy demand for sheep by lowground buyers.

Due to these elements of supply and demand, it is not sufficient for a farmer to compare the annual per head prices realised by his store sheep over a number of years. It would be preferable to compare these prices with either the averages of his local market or the Scottish average for that class of stock. It would further the comparison if he could compare the stock prices received with those from neighbouring farms in the district and preferably those where no bracken cutting was being done. This comparison should be done over several years' averages prior to bracken cutting as well as for the cutting and subsequent years. Provided that the same type of husbandry (other than bracken control) is practised in the district, then it would be reasonable to assume that the difference in increase (if any) of store lamb and draft ewe prices, was due to the main to bracken cutting. It was this type of comparison that farmer 'c' in Case II was making. His lambs, which prior to bracken cutting always fetched lower prices than his neighbours', were now fetching higher prices than the most of the lambs from non-bracken-cutting farms in the district.

It was impossible, of course, in this small scale investigation for the writer to get a series of average annual prices from both cutting and non-cutting farms.

Landlord and tenant sharing the net cost equally.

The majority of the farms cutting bracken on Buccleuch Estates fell into category III. That both the Estates and the tenants' considered it worth-while has already been stated (See Page 6).

One tenant on the Estates thought that the bracken cutting programme on his farm had led to an increase of 3/- to 4/- per head on his lambs and 5/- per head on his cast ewes. Allowing for the supposition that this increase did not take fully into account the general increase due to supply and demand factors, these estimates have been reduced to 2/6d per lamb and 3/- per ewe.

\[
\begin{align*}
\text{Average net cost (after deducting grant) per acre} & = 8/4 \text{ per annum} \\
\text{" " " to tenant per acre} & = 4/2 \text{ " "} \\
\text{" " per ewe (Stock-carry 2 acres/ewe) } & = 8/4 \text{ " "} \\
\text{Three years double cutting} & \text{ Total net cost per ewe } = 25/-
\end{align*}
\]

Then in the ten year period:-

\[
\begin{align*}
\text{Increased value of 8 lambs} & = 20/- \\
\text{" " 1st Cast Ewe } & = 2/90 \\
\text{" " 2nd " } & = 2/9 = 25/6
\end{align*}
\]

\[
\text{Average of the net costs per acre for the 3 years '48-'50 inc.} \\
\text{Assuming a weaning percentage of 80.} \\
\text{Assuming a ewe death rate of 7-8%.}
\]

Thus in 10 years, the ewe and her successor have contributed sufficient revenue to cover fully the cost of bracken cutting per ewe.

In actual practice the benefit of bracken cutting will not be confined solely to the arithmetical number of ewes than can be carried on the cut area. The actual number of sheep which would benefit would depend on the nature and size of the hirsel and the situation and proportion of the cut area to the area of the total hirsel. Presumably the additional grazing available on the cut area would attract sheep from surrounding areas. That in turn would free a certain amount of grazing on the nearby areas. This gradual easing of sheep 'pressure' on the pasture on successive areas would tend to diminish with an increase in distance from the cut area. Nevertheless, in the above instance it is clear that bracken cutting was a profitable proposition and the actual margin of profit would depend on the number of sheep, other than the theoretical number on the cut area, which benefited by the cutting.
Tenant bearing full net cost

With all other factors remaining constant, if the tenant had to bear the full net cost himself, then, over the 10 year period, the value of the increased produce per ewe on the cut area would have been some 25/- per ewe short of the bracken expenditure per ewe. This deficit would have to be met out of the extra revenue from sheep, other than those actually on the cut area, which benefited from bracken cutting.

If, for the purpose of this calculation, the acreage of bracken cut on the above farm was assumed to be 200 acres, then the total deficit would be £125 on 100 ewes, (with a stock carry of 2 acres per ewe). The actual number of sheep which would benefit, to the extent stated above, is, of course, not known. However, if in addition to the 100 ewes on the cut area, another 100 ewes on adjacent ground improved as much in condition, the deficit would be almost covered by the increase in value of the lambs and cast ewes from these additional 100 ewes.

Total deficit on the cut area = £125
In 10 years of improved grazing:
Increase in value of 800 lambs
(50 x 10 x 2/6 p.h.) £100
Increase in value of 140 cast ewes (14 x 10 x 3/- p.h.) 21 121
Deficit after 10 years if 200 ewes in all benefited = £4

It is also noteworthy that the calculation does not allow for any benefits other than an increase in sales value. Such factors as a decrease in both lamb and ewe death rates, an increase in the number of lambs marked, and an easing of 'herding' duties might be expected.

If ewes have improved in condition so much that this improvement is reflected in their cost prices at markets, (after allowing for market fluctuations) then surely it can be reasonably expected that during their working life on the hill, this extra vitality would mean an improvement in their physical health and a consequent increase in the number of lambs born and surviving in the flock. That the Blackface ewe is a prolific breeder, under suitable conditions, is proved by the high lambing percentages ruling on good cross-lamb hills and on low ground. If the drain of some 20% deaths in lambs at and from lambing time to marking time could be even slightly reduced, it would mean some saving. Even if bracken cutting meant that only one such lamb in fifty ewes was saved, then from the above 200 ewes this would mean an increase in lamb revenue of some £10 per annum or £100 over 10 years.

With the present day value of breeding ewes, one ewe surviving represents anything from £5 to £10 of capital and three potential lambs. The saving in the above calculation, at one ewe saved per 100 ewes, would be say £15 for the two ewes (alone) per annum.

The annual total of hours of shepherding duties saved due to the easier herding in the bracken area would make more time available for other work.

From the foregoing, assuming the relationship between cutting costs and extra value derived from the cutting remained constant over the ten year period, bracken control would be an economic proposition, even if the tenant had to bear the full cost. It would be particularly beneficial to the tenant where, as happens on Buccleuch Estates, the owners share the net cost equally with the tenant; remembering of course, the vital part played by the 50% Government grant.

In addition to these tenancy benefits, the Estates and the country are benefiting to a certain extent as shown on Page 6.

CUTTING ON LESS PRODUCTIVE HILLS

All the previous discussion has referred to a situation where the land is inherently better and the costs of cutting below average. Also the length of time which the bracken can be left uncut after the original programme, is longer than most estimates put forward by other farmers in Blackface country.
(a) Landlord and tenant sharing net cost equally.

If the average net cost, after deducting subsidy, is taken at 12/6 per annum and the stock-carrying capacity at 3 acres per ewe, the total net cost per ewe of a three year programme becomes 112/6d. If the landlord shares this net cost equally with the tenant the total net cost (per ewe) to the tenant would be 56/3d.

Where the number of years of improved grazing was five, it would require two cutting schemes to make the position comparable with the previous example. The second scheme of cutting would not be so long nor so expensive. Two years' double-cutting at a net cost to the tenant of 5/6 per acre per annum would give a total net cost per ewe of 33/- per annum. This would mean a total net cost per ewe of 89/3d over the 10 year period, compared with 25/- on the Buccleuch Estates. Assuming that the same benefits were enjoyed, namely an increase in money value of 2/6d per lamb and 3/- per cast ewe, the calculation becomes:

<table>
<thead>
<tr>
<th>Description</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased value of 7 lambs</td>
<td>17/6d</td>
</tr>
<tr>
<td>Increased value of 2 cast ewes</td>
<td>5/6d</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>23/-</strong></td>
</tr>
<tr>
<td>Deficit per ewe over the 10 years</td>
<td>66/3d</td>
</tr>
<tr>
<td>Deficit per 100 ewes</td>
<td>£331</td>
</tr>
</tbody>
</table>

Assuming a weaning percentage of 70% and a ewe death rate of 8%, 300 acres of bracken cut.

Working along the same lines as before, if another 100 ewes benefited equally the extra value of the lambs and cast ewes over ten years might be:

- 700 lambs @ 2/6 per head = £288 approx.
- 140 cast ewes @ 3/- per head = 42
- **Total** = £330
- **Deficit if 200 ewes in all benefited** = £222

Similarly from the same 200 ewes improved in condition:

- 4 extra lambs each year @ 50/- per head = £100 in ten years.
- 2 ewes saved @ 77 per head = 140
- **Total** = £240

Thus, despite the more unfavourable conditions, the bracken cutting expenditure would be more than met by the benefits derived therefrom, by the end of the ten year period. It is obvious however, that, unlike in the previous example, there is no hope of the increase in sales value alone, over 200 ewes, amounting to anything like the amount spent on bracken cutting. It is only after allowing for a fall in the ewe death-rate of 1% and an increase of 2% in the number of lambs surviving, that the expenditure is covered. If the improvement was confined entirely to an increase in condition, and consequently in sales prices, of lambs and cast ewes, then 400 ewes in all would need to be improved by the cutting of some 300 acres (stock-carry at the rate of 1 ewe to 3 acres). The number of ewes so affected and the actual changes in lamb marking percentages and death-rates, used in the calculations, are of course only arbitrary figures but they are not unreasonable. It would require a special study over several years and farms before actual figures could be ascertained.

(b) Tenant bearing full net cost

Except on Buccleuch Estates, there were no cases in the survey where the landlord contributed as much as half of the net cost of bracken cutting.

If the tenant had to bear all the net cost himself, the total net cost per ewe would be 178/6d and the deficit per ewe, if 300 acres were cut, would be 155/6d. The TOTAL DEFICIT on 100 ewes would be in the region of £777. Thus, if only 200 of the whole ewe flock were improved (£349), there would still be a deficit at the end of ten years of some £238. It is clear that at least a further 200 ewes would need to show the same degree of
improvement if this deficit were to be wiped out. Whether 400 ewes in all would so benefit from the cutting of 300 acres of bracken land twice in ten years is a matter for conjecture.

Summary

Due to lack of previous economic investigation in this field, the evidence concerning Case III is put forward more as an approach to the problem of the economics of bracken control rather than the final answer to it. Also due to the lack of general standards, so much of the evidence has to be based on arbitrary assumptions. Throughout however, the conditions have always been weighted unfavourably to counteract this.

The fact remains that, in addition to the tenants on Buccleuch Estates where there can be little doubt but that bracken cutting is a worthwhile proposition, there were 12 farmers out of 23 who felt that bracken cutting was worthwhile under their particular circumstances. They, after all, are the people who should know whether bracken cutting is worthwhile (on their farms), taking the long term view. Only two of the farmers were tenants and both of them bore the full cost of bracken cutting. On two of the estate farms it was stated that it was doubtful whether a tenant could have spent so much on bracken cutting.

Of the six farmers who were in doubt about the financial value of bracken control, three inclined to the view that it was probably beneficial while three did not.

Farms where bracken cutting was considered to be uneconomic

There were four cases where, although bracken putting was being carried out, it was considered that the cost outweighed any benefits derived. The four cases merit attention.

1. An estate farm in hand in West Perthshire:

Some 300-350 acres of bracken, most of which had been previously cut in 1937, 1938 and 1939, were double-cut by contract scythe in 1950 and 1951 and single-cut in 1952. The gross cost per acre was 28/- double cut and 14/- single cut. A 50/- grant was received and the total net cost per acre for the three years' programme was 35/-.

The owner's impressions of the results of cutting:

"Although the bracken has been weakened, there is still a definite growth of bracken and it is feared that in a few years' time, the bracken will be as strong as ever. The grass in the area does not appear to have altered to any appreciable extent. There has been no increase in the number of sheep that are normally in the area.

It is considered from a short term point of view, that although there might be a slight advantage from the cutting, it is feared that this relief is purely temporary. One disadvantage of employing a contractor is that it is not always possible to obtain his services when required and the first cut is apt to be late. Due to the steepness of the slopes and the rocky nature of the ground, it would not be possible to use a bracken-cutting machine.

It is felt that, until some method of killing the bracken outright, which cutting has failed to do here, is discovered, it is not economic to continue".

The net cost per acre of three years' cutting (35/-) was 6/- dearer than the average for contract scythe work in the said three years.

\[
\text{Table I }\ 22/3 + 23/2 + 12/8 = 58/1 \text{ (gross cost)}
\]
\[
= 29/- \text{ net cost}
\]

From a botanical point of view, the effects of this cutting scheme were better than average. The very fact that only a single cut was done in the third year and the scheme qualified for subsidy
speaks for itself.

Botanical Notes.

In the uncut areas the bracken was of 3'-6" - 4'0" at 35, with no sward below. In the cut areas it was of 1'-9" at 10-25, with a good Fescue/Bent sward.

Nevertheless, that those concerned considered it uneconomic, illustrates the point that, unless such cutting influences the condition and numbers of stock on the ground, the money spent has little or no chance of being recouped.

Perhaps over a longer term, the necessity of keeping bracken under control, regardless of the cost, would alter the above viewpoint. It is of interest to speculate what the position would have been on these 300 acres had no cutting been done at all and what the long term effect on stocking would have been.

2. A hill sheep farm in South Argyll

An area of bracken, previously uncut for over 20 years, was cut twice by scythe in 1949. The work was done by farm staff. The acreage cut per day was in the region of 1 acre per man. This gave an estimated (by farmer) cost of 20/- per cut acre or 40/- in the season. A 50% grant, without which no cutting would have been done, was received.

Farmer's Opinion

He considered that it was not worthwhile to continue as the bracken was as bad the following year.

Botanical Notes

The areas cut were all rather small, and results were masked by the growth of surrounding bracken into the cut areas. The uncut bracken was dense, 2'-6"-3'-0" at 40. One part had been cut by scythe in early June of 1952, and showed a reduction in height of 6", frequency remaining at 40. Another area had been single cut in the years 1949-1952, and in the main the bracken was reduced to 9"-12" at 10-12. The area cut in 1949 showed no difference between cut and uncut bracken.

Lightning had struck a hillside in 1935, and next year no bracken grew there. The bracken has not, even yet, grown in that area.

It is difficult to draw any definite conclusions from this example as the work was discontinued after the initial year. It is often the case that the number of fronds per square yard is greater in the year immediately after initial cutting - due to the plant trying to counteract the reduction in its food reserves caused by the previous year's cutting.

Certainly the net cost of cutting, at 20/- per acre, was expensive. On the other hand, since the work was being done by farm staff when spare time was available, the actual money spent would have been paid in any case. The question arises whether the labour could have been more profitably employed on other work. This farm would have been in a much more favourable position could a machine have been employed. Farm labour was available to operate it and the faster rate of working with a machine would have lowered the cost considerably. Also the only additional cost which could be attributed directly to bracken cutting would have been the operating costs of the machine. Unfortunately due to the topography, in the farmer's opinion a machine would not have been suitable.

3. A hill sheep farm in South Argyll

An area of bracken was double-cut by contract scythe in '47 and '48. The net cost per acre was 16/- per annum. This farm was one where the landlord contributed 50% of the cost. Due to Hill Farming Act commitments, cutting was discontinued after 1948, when the estate no longer contributed this share.
Botanical Notes

On cut areas of south-facing slopes, where the bracken had been 2'9" at 40, it was now 1'3"-1'9" at 21-31.

On north-facing slopes the uncut bracken was 2'6" at 40, and the cut bracken of 2'6" at 20-35.

At 8/- per acre per annum cost to the tenant this probably would have been a worthwhile case from the tenant's viewpoint had the estate continued to contribute towards the cost.

4. A hill sheep farm in North Argyll

Varying acreages of bracken had been cut from 1948 to 1952 inclusive. In 1948 the work was done by the farmer's own machines and by contract thereafter. The normal practice was a double cut each year. The net costs for the five years were 10/3, 11/9, 11/9, 12/6 and 13/6 per acre per annum.

The cut areas, although rough grazings, were enclosed below the hill dyke. The area was heavily grazed with sheep and cattle. The owner considered this cutting below the dyke worthwhile and would continue to cut - but probably on a reduced scale - on the low ground even if no grant were available.

On the hill proper, however, he did not consider that bracken cutting was worthwhile, and it is with bracken cutting on the hill that this report is mainly concerned.

Botanical Notes

In one part, cut bracken was 1'0"-2'0" at 10-15; in a second part it was 1'6" at 14-18. Uncut bracken for both parts was 3'0" at 40.

Some considerations against bracken cutting

When considering evidence about the efficiency of bracken control and indeed throughout the report, it must be remembered that, since the investigation was mainly concerned with farms on which bracken cutting was being or had been recently carried out, on the majority of farms visited it presumably had been already decided that cutting was effective and worthwhile, otherwise they would not have been going ahead with a cutting scheme. Hence the evidence given here against bracken control is by no means full or representative. It would require a similar investigation over a similar number of farms where cutting was either discontinued or had never been started, after due consideration of the position.

By chance, a few of the farms visited had not cut bracken recently. Almost all of these had stopped cutting when Scheme C (work done by men and machines belonging to the D.O.A.S. see page 8) was discontinued. The reasons put forward for not continuing are summarised in the following paragraphs.

1. Lack of labour, both regular and casual. All the regular farm staff were needed for sheep handlings and low ground work, such as hay, at the time when bracken was at the optimum stage for cutting. Casual labour was scarce and particularly for such work. That a scarcity of labour is an important factor on the national scale is borne out by figures from the annual reports of the D.O.A.S. In 1952 for example, out of 480 proposed schemes about 130 fell through mainly due to labour difficulties.

2. The topography of the ground. The steep and rough nature of some slopes precluded the use of their own machines.

Further reasons for not tackling bracken control were expressed by different people interviewed during the survey.

3. The large amount of capital which is required if a worthwhile acreage is to be tackled. The important fact being that, although there is a fifty per cent grant, the gross amount has to be found first. This
4. An attitude of indifference. Although, naturally enough, an individual will not say that such an attitude is peculiar to himself, nevertheless this opinion was stated on occasion during conversations with farmers who were cutting.

The first two reasons are partially outwith the control of the individual farmer.

The third reason can be viewed in a different light. In a time of competitive prosperity and high taxation, money ploughed back into farm improvements would not only be eligible for tax relief but would be an investment against possible future recessions. Bracken cutting in cases where tax was already being paid, would only cost the difference between its net actual cost and the tax payable had the cost not been incurred.

In the writer's experience the fourth reason may be valid and indeed, it perhaps plays a more important part than is often realised. Where a farm is badly infested with bracken and even although the occupier is aware that something should be done, the question arises who is going to do it and what share of the cost should be borne by landlord, tenant and State.

Bound up with this attitude is the short term view that bracken cutting is too expensive. Case studies of farms which found it profitable and a general dissemination of the results of such studies, might go part of the way in correcting this attitude, which unfortunately, is rather widespread and not entirely confined to farmers.
SUMMARY OF REPORT

This report is the result of a study, suggested by the Agricultural Research Council, of bracken cutting programmes being undertaken on farms. The investigation was carried out jointly by the Botany and Economics Departments of the College. Some sixty farms, scattered throughout the province, were visited in the summer of 1953.

Part 1. Cost of Bracken Cutting

As far as possible, costs were obtained for the seasons '50 to '53 inclusive. Except where otherwise stated, the costs given are the gross cost (i.e. before deducting grant) of cutting one acre of bracken twice per season.

Where farmers used their own equipment and staff, the costs cover wages, including employer's share of insurance, and the running costs of machinery. These costs do not include a share of depreciation or repair bills as these items are not eligible for the cutting grant. (Page 2)

Where contractors were employed, the contract rate for cutting one acre twice per season was the figure used.

Over the past three seasons, '51 to '53, the average annual gross cost of cutting one acre twice per season was:

(Table 1, page 3)

<table>
<thead>
<tr>
<th>Method</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>with self-propelled machine</td>
<td>16/-</td>
</tr>
<tr>
<td>with tractor outfits</td>
<td>16/-</td>
</tr>
<tr>
<td>by contract scythe</td>
<td>25/-</td>
</tr>
<tr>
<td>by contract machine</td>
<td>26/-</td>
</tr>
</tbody>
</table>

Although contract charges were approximately 10/- higher per acre, (reasons for this higher level of costs are given on page 4) some 80% of the acreage covered by the report was done by contractors. The main reasons for this are threefold, viz. the nature of the ground, the scarcity of both regular and casual labour on farms and the more urgent tasks of sheep handlings and low-ground work coinciding with the best time for cutting bracken. (Pages 4 and 5).

In 1952, the season for which most costs were available, 76% of the acreage was cut by hand scythes, 15% by self-propelled machines and 11% by tractor outfits. (Page 4)

Omitting the bracken areas cut on the Bucclouch Estates (the acreage of which is excluded from the above percentages), the majority of the acreage covered by the survey was on farms in Argyll and West Porthshire. Also, almost without exception, the farms were carrying a pure Blackface stock.

In the discussion on the advantages and disadvantages of cutting by farm staff or by contract (Pages 4 and 5), it must be stressed that a diminution in the amount of bracken cut by contract is not being advocated. On the contrary, the extent of bracken infested land is such that there is ample scope for both methods. The main points are that, firstly, on suitable land self-owned machines or tractor outfits are cheaper and, secondly, that a larger proportion cut by farmers would release contract labour - already scarce - for other areas. Particularly is this so where, at present, bracken capable of being cut by self-propelled machine is being handled by contract scythe.

By courtesy of the estate factor, detailed costs of bracken cutting over several thousand acres on Bucclouch Estates were made available. The cutting was done by self-propelled machines (supplemented by hand scythes) owned and operated by the Estates. The land owners and tenants shared the net cost equally. (Page 5)
After putting the costs on a comparable basis with the costs of self-propelled machines on other farms, the Estate costs were:

1951 - 13/4d, 1952 - 14/10d, 1953 - 17/- per acre twice cut.

(Table II, page 7).

A brief description of the different schemes of Government assistance towards the cutting of bracken is given on pages 8 and 9. All the programmes reviewed in this report were carried out under Scheme "B". Under this scheme, a proportion not greater than 50% of the gross cost is refunded. The programme must be approved by the Department of Agriculture for Scotland and the bracken must be treated twice per season. Normally this grant will only be paid for three successive years on the same area. A single cut in the third and fourth years may be eligible at the discretion of the D.O.A.S. (Page 9)

Scheme "B" has played and is playing a vital part in the control of bracken and its withdrawal would lead to an immediate and considerable contraction in the acreage cut with, eventually, a resulting drop in output from hill grazings.

Part 2. Botanical Observations

Bracken infested land in Scotland covers, it is estimated, some 8-10% of the rough grazing acreage.

The use of scythes or one of the various types of machines has a varying effect on the bracken fronds, depending on their mode of action. (Page 10)

The underlying principle of all bracken cutting is to remove the food-producing part of the plant, i.e. the fronds, so that over a period of years the underground stem, or rhizome, is starved. (Page 10)

It is the rhizome which, by its growth in length and branching, is responsible for almost all the spread of bracken.

Results of bracken cutting in 52 areas are given. (Pages 12-15)

These results indicated that, in the first year of cutting, frond height was, on the average, almost halved, whereas frequency was only reduced by a quarter. Over four years, height was reduced to a quarter of the original, while frequency was reduced to a half. (Table III)

The results also indicated that there was little difference between the effects of scythe or machine on height or frequency. (Table IV)

Cases were met with where liming and/or manuring would appear to have been very beneficial, especially where sward was already present, but these factors would bear further investigation. The sward possibly benefits more from the additions than does the bracken, since the roots of the bracken are mainly well down in the soil. (Table V)

Also, there was not enough data to show at what stage in a cutting programme lime or manures should be applied to obtain the best results.

The time of cutting is also an important factor, the best time to cut being about the last fortnight of June. Cutting before this date is more beneficial than cutting after this date. Cutting for the first time after the end of July is very unlikely to give worthwhile results. (Page 20)

From the experience of the farmers visited, and from results seen in the field, a cutting programme suggests itself, consisting of double cutting for three years, single cutting for one or two years, and no cutting for four to five years. (Page 22)

This programme will not normally eradicate bracken, but should reduce even a heavy growth on average soil to a stage where it does not have a detrimental effect on the sward below.
Part 3. Is Bracken-Cutting Worthwhile?

Due to the many variable factors involved, the measurement of the economic benefits of bracken cutting is very difficult. It does not lend itself to accurate mathematical measurement. Also, due to the lack of previous investigation in this field, many arbitrary assumptions have had to be made. As far as possible, the arguments were weighted unfavourably against bracken cutting in order to counteract any over-statement of the benefits derived. Consequently, the methods used in this part of the report are put forward more as an approach to the problem of measurement rather than as a general answer to it.

That bracken cutting is expensive cannot be denied, but it does not necessarily follow that it is un-economic. (Page 23)

The majority of farmers in the survey were of the opinion that bracken cutting was worthwhile, indeed essential in some cases. The economics of bracken control must be judged from the following standpoint; viz. the effect that bracken is having on the stock-carrying capacity over a period of years. (Page 23)

The farms in the survey fall into three distinct categories.

Case I Where bracken cutting prevented an ultimate decrease in flock numbers. (Pages 23 to 27)

Case II Where bracken cutting led directly to an increase in flock numbers. (Pages 27 to 34)

Case III Where bracken cutting maintained the present flock numbers. (Pages 34 to 40)

Provided that:-

(i) The present-day relationship of sheep and wool prices to cutting costs remains the same or improves.

(ii) The inherent stock-carrying capacity of the grazing is not too low, i.e. not more than 4 acres per ewe and preferably 3 acres or less.

(iii) The actual work is done thoroughly and at the optimum stage of growth for cutting.

(iv) The benefit to the grazing lasts for at least as long as the normal breeding life (on the hill) of a ewe.

(v) The farm management is such that at least average profits are being made with the existing stock.

then it would appear, at least for the six farms in Case I and the six farms in Case II, that bracken cutting would be a profitable proposition, taking a long-term view.

Of the 23 farms in Case III, 12 farmers and also the tenants on Buccleuch Estates were of the opinion that bracken cutting was financially worthwhile, 6 farmers were doubtful while the remaining 4 were sure it was not worthwhile under their particular circumstances.

With regard to the Buccleuch Estates, there can be little doubt that, where the landowners are sharing the cost equally with the tenants, bracken cutting is a worthwhile long-term investment, particularly to the tenants. (Pages 5 and 35)

It must be emphasised that, since the report was mainly concerned with farms where bracken cutting was being carried out, the evidence against bracken cutting is by no means full or representative.
The main reasons for not cutting bracken were:

(i) Lack of labour, both regular and casual.

(ii) The topography of the ground precluded the use of farm-owned machines.

(iii) The large amount of working capital which is required if a worthwhile acreage is to be tackled by contract.

(iv) An attitude of indifference engendered partly by doubts as to who should bear the cost - landlord, tenant or State - and partly by a lack of knowledge of the economic benefits to be derived from successful cutting programmes.
The Effects of a Cutting Programme

Level 1: Maximum growth of which the bracken is capable, i.e. growth before any cutting took place.

Level 2: Level at which bracken growth interferes with sward or grazing.

Level 3: Level at which bracken growth has no appreciable effect on sward or grazing.

Level 4: Level of complete extermination of bracken growth.

Height A: A measure of the initial effort required to reduce the bracken growth to Level 3.

Height B: A measure of the effort required at intervals to reduce the bracken growth to Level 3.

Note that this Appendix refers to a hypothetical average case.
APPENDIX II

1. Decrease in Frond Frequency and Height
   as a result of Cutting Treatment

These figures all refer to the same area being treated by the same machine in consecutive years. They are taken from a report submitted to the College Governors in 1943.°

<table>
<thead>
<tr>
<th>Machine Type</th>
<th>1934</th>
<th>1935</th>
<th>1936</th>
<th>1937</th>
<th>1938</th>
<th>1939</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slashing (1)</td>
<td>-</td>
<td>41</td>
<td>25</td>
<td>20</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>Slashing (2)</td>
<td>4.0</td>
<td>?</td>
<td>16</td>
<td>14</td>
<td>27</td>
<td>-</td>
</tr>
<tr>
<td>Bruising</td>
<td>73</td>
<td>?</td>
<td>60</td>
<td>?</td>
<td>48</td>
<td>54</td>
</tr>
<tr>
<td>Bruising</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>75</td>
<td>53</td>
<td>48</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Machine Type</th>
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<th>1935</th>
<th>1936</th>
<th>1937</th>
<th>1938</th>
<th>1939</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slashing (1)</td>
<td>-</td>
<td>30</td>
<td>25</td>
<td>15</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Slashing (2)</td>
<td>33</td>
<td>?</td>
<td>24</td>
<td>?</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>Bruising</td>
<td>4.2</td>
<td>?</td>
<td>30</td>
<td>?</td>
<td>21</td>
<td>18</td>
</tr>
<tr>
<td>Bruising</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>44</td>
<td>36</td>
<td>30</td>
</tr>
</tbody>
</table>

- ..... No Treatment.
? ..... Counts not obtained.

2. Common and Botanical Names of Plants mentioned in Text

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Botanical Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bent Grass</td>
<td>Agrostis spp.</td>
</tr>
<tr>
<td>Blueberry</td>
<td>Vaccinium myrtillus</td>
</tr>
<tr>
<td>Braekhen</td>
<td>Pteridium aquilinum</td>
</tr>
<tr>
<td>Creeping Soft Grass</td>
<td>Holcus mollis</td>
</tr>
<tr>
<td>Docks</td>
<td>Rumex spp.</td>
</tr>
<tr>
<td>Fescues</td>
<td>Festuca rubra and ovina</td>
</tr>
<tr>
<td>Frorin</td>
<td>Agrostis alba var. stolonifera</td>
</tr>
<tr>
<td>Juniper</td>
<td>Juniperus communis</td>
</tr>
<tr>
<td>Male Fern</td>
<td>Dryopteris filix-mas</td>
</tr>
<tr>
<td>Nettles</td>
<td>Urtica dioica</td>
</tr>
<tr>
<td>Sphagnum Moss</td>
<td>Sphagnum spp.</td>
</tr>
<tr>
<td>Sweet Vernal Grass</td>
<td>Anthoxanthum odoratum</td>
</tr>
<tr>
<td>Thistles</td>
<td>Cirsium spp.</td>
</tr>
<tr>
<td>Tormentil</td>
<td>Potentilla tormentilla</td>
</tr>
</tbody>
</table>

° "Bracken" Report to College Governors, 1943.
### APPENDIX III

**Survey Results in Tabular Form**

<table>
<thead>
<tr>
<th>Ref. No.</th>
<th>Out By</th>
<th>Years</th>
<th>Uncut</th>
<th>Cut</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A1</td>
<td>Sc</td>
<td>D</td>
<td>2'16&quot; at 10-15</td>
<td>1'16&quot; at 7-12</td>
<td>Damp</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4'10&quot; at 10-15</td>
<td>1'16&quot; at 7-12</td>
<td>Dry</td>
</tr>
<tr>
<td>1A2</td>
<td>Sc</td>
<td>D</td>
<td>2'16&quot; at 30</td>
<td>1'3&quot; at 20</td>
<td>No heather</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2'16&quot; at 30</td>
<td>1'3&quot; at 30</td>
<td>with heather</td>
</tr>
<tr>
<td></td>
<td>Se</td>
<td>D</td>
<td>2'16&quot; at 25</td>
<td>1'0&quot; at 10</td>
<td>No heather</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3'10&quot; at 40</td>
<td>2'6&quot; at 40</td>
<td></td>
</tr>
<tr>
<td>1A3</td>
<td>Sm</td>
<td>D</td>
<td>2'10&quot; at 25</td>
<td>1'10&quot; at 15</td>
<td></td>
</tr>
<tr>
<td>1A4</td>
<td>Sc</td>
<td>D</td>
<td>-</td>
<td>No visible difference</td>
<td></td>
</tr>
<tr>
<td>1B1</td>
<td>Sc</td>
<td>S</td>
<td>2'16&quot; at 35</td>
<td>2'13&quot; at 35</td>
<td></td>
</tr>
<tr>
<td>2A1</td>
<td>Cm</td>
<td>D</td>
<td>3'16&quot; at 45</td>
<td>1'16&quot; at 15-20</td>
<td>Lime + slag</td>
</tr>
<tr>
<td></td>
<td>Sm</td>
<td>D</td>
<td>4'10&quot; at 45</td>
<td>1'10&quot; at 10-15</td>
<td></td>
</tr>
<tr>
<td>2A2</td>
<td>Sm</td>
<td>D</td>
<td>3'10&quot; at 20</td>
<td>6&quot; at 15-20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sm</td>
<td>D</td>
<td>1'16&quot; at 20-25</td>
<td>9&quot; at 15-18</td>
<td></td>
</tr>
<tr>
<td>2A3</td>
<td>Sm</td>
<td>D</td>
<td>3'10&quot; at 45</td>
<td>1'16&quot; at 25</td>
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<td>2'16&quot; at 40</td>
<td>1'16&quot; at 25</td>
<td>South facing</td>
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<tr>
<td>2A5</td>
<td>Sc</td>
<td>D</td>
<td>3'16&quot; at 30-40</td>
<td>1'10&quot; at 10-15</td>
<td>Missed fronds</td>
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<td>Sm</td>
<td>D</td>
<td>3'16&quot; at 30-40</td>
<td>1'16&quot; at 15-20</td>
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<tr>
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<td>D</td>
<td>1'10&quot; at 50 to 2'13&quot; at 20-25</td>
<td>1'13&quot; at 10</td>
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<td>D</td>
<td>D</td>
<td>4'10&quot; at 30-40</td>
<td>1'19&quot; at 30-40</td>
<td>Sheep fank</td>
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<td>.2B1</td>
<td>Sm</td>
<td>S</td>
<td>2'19&quot; at 40-50</td>
<td>1'13&quot; at 40</td>
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<td>3A1</td>
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<td>3'16&quot; at 20</td>
<td>2'16&quot; at 30-40</td>
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<td>1'16&quot; at 25-30</td>
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<td>D</td>
<td>2'16&quot; at 30-35</td>
<td>1'16&quot; at 20-25</td>
<td>Dry</td>
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<td>2'16&quot; at 30-35</td>
<td>1'16&quot; at 5-10</td>
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<td>D</td>
<td>3'10&quot;-4'0&quot; at 3'5&quot;</td>
<td>1'19&quot; at 10-25</td>
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<td></td>
<td>Sc</td>
<td>D</td>
<td>3'10&quot; at 35-50</td>
<td>1'10&quot; at 10</td>
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<td>D</td>
<td>2'19&quot; at 40</td>
<td>1'10&quot;-1'16&quot; at 40-45</td>
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<tr>
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<td>Sm</td>
<td>D</td>
<td>3'10&quot; at 40</td>
<td>1'16&quot; at 10-15</td>
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<td>2'0&quot; at 20-25</td>
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<td>3'0&quot; at 40</td>
<td>9&quot; at 5-10</td>
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<td>3'0&quot; at 20</td>
<td>1'0&quot; at 8-10</td>
<td>9&quot; at 5</td>
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<td>442</td>
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<td>3'0&quot; at 30</td>
<td>9&quot;-1'0&quot; at 15</td>
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<td>D D D D</td>
<td>4'0&quot; at 25</td>
<td>5&quot;-9&quot; at 15-20</td>
<td>1'0&quot; at 10</td>
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<td>451</td>
<td>Sc</td>
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<td>2'5&quot; at 40</td>
<td>9&quot;-1'0&quot; at 10</td>
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<td>3'6&quot; at 40</td>
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<td>2'0&quot; at 30</td>
<td>6&quot;-9&quot; at 4-8</td>
<td>Lime in '49</td>
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<td>2'0&quot; at 30</td>
<td>1'0&quot; at 20</td>
<td>No lime</td>
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<td>2'0&quot; at 40-45</td>
<td>1'0&quot; at 12-15</td>
<td>Steep</td>
<td></td>
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<tr>
<td>643</td>
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<td>S S S S S</td>
<td>2'6&quot;-3'0&quot; at 30</td>
<td>9&quot; at 4-8</td>
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<td>10</td>
<td>Sm</td>
<td>'43-'52 inclusive</td>
<td>2'5&quot;-3'0&quot; at 35</td>
<td>6&quot; at 5-10</td>
<td>Easily cut</td>
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<td>2'6&quot;-3'0&quot; at 35</td>
<td>1'6&quot; at 15</td>
<td>Difficult</td>
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Sc...Scythe D...Double Cut H...Height
Sm...Slashing Machine S...Single Cut P...Frequency
Cm...Cutting Machine ...No cut