

WEST DONEGAL RESOURCE SURVEY

Part 2—Some Aspects of Production—Crops, Livestock and Fisheries

An Foras Talúntais



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FOREWORD

The continuing decline in population and the various physical, economic and social problems that beset many of our western counties have concerned people at all levels for more than a century now. Various studies of the problems have been conducted from time to time, remedies have been proposed and solutions sought and different approaches have been tried. Considerable national effort and finances are being devoted in various ways in an attempt to overcome the problems but these areas are still largely underdeveloped. The economic, social and cultural well-being of the people of these areas and of the entire nation stands to benefit from any development that can be achieved. Some of the most adverse conditions obtaining in the whole western region of Ireland are those to be found in West Donegal - an area poorly endowed in physical resources and reflecting all the ills of a high rate of emigration, an adverse population structure, an underdeveloped agriculture, low income levels and several other rural problems.

Against this background, the Council of An Foras Taluntais decided that the complex situation prevailing in West Donegal should be examined and appraised in a systematic, scientific manner and, having thoroughly analysed the findings and within the context of modern knowledge and techniques, some models for the agricultural development of the area should be established.

While there was a certain background of experience and information on such problems as emigration and farm resources and income this knowledge was of a general nature, the position in this respect being akin to that for many other areas of the country. There was no precise or co-ordinated information on such matters as the nature, distribution and the best use of different types of land, on present and potential levels of productivity, on norms for grassland output and animal production, on farm incomes, on educational levels or on the social background in the local farming community.

It was felt then that the way in which we, as an agricultural research organisation, could best contribute would be through a comprehensive survey of the agricultural resources of the area. Of course, agricultural improvement is only one of the means of improving living standards in the area. No matter how well developed, agriculture can only support a proportion of the population. Development in agriculture must go along with expansion in tourism, fishing, industry and other enterprises. The findings of the survey, then, will be used not only as a basis for agricultural development but will also be correlated with those of surveys by other organisations to create an integrated programme of community and general area development.

The carrying out of a sufficiently comprehensive resource survey presented a formidable task demanding the collective efforts of people in a wide variety of disciplines covering the physical, economic and human behavioural aspects. The experience gained on methodology and organisation in the course of a previous resource survey of West Cork was of great value. The report of the present survey will go further than that of West Cork by preparing working plans or operational models, within current

economic considerations which would form the basis of future agricultural development of West Donegal and of areas with similar problems in the West of Ireland. Surveys such as this are a prerequisite for optimum use of land resources within a framework of economic and social development. While we appreciate that the knowledge provided in the Survey Report is in certain respects incomplete, the primary objectives of the survey in providing a blueprint for the development of the land and the betterment of the people using the land have been largely achieved. It is hoped that the information provided will serve its purpose as a basis for guiding developments towards the future well-being of the entire community.

It is a pleasure to be associated with the highly merited acknowledgement given below to those within An Foras Taluntais and the many outside who co-operated with us in this project. Finally, may I commend the efforts of the Working Party who embarked on and completed this task with such dedication and enthusiasm.

T. Walsh,
Director.

PREFACE

The more pronounced rural problems in Ireland are to be found in the western counties. However, the western region is far from homogeneous in the quality of its resources and far from uniform in its rural problems. West Donegal is amongst the most poorly endowed areas in physical resources and one of the most extreme in rural problems.

In order to make a thorough, scientific and systematic appraisal of the situation in West Donegal a comprehensive resource survey was undertaken by An Foras Taluntais (The Agricultural Institute). The survey commenced in 1965 and the field investigations were generally completed by the end of 1967. A Working Party drawn from research staff of the Soils, Plant Sciences, Horticulture and Forestry, Animal Sciences, Animal Husbandry and Dairying and Rural Economy Divisions of the Institute was primarily responsible for the survey. Co-operating agencies at State and local level included: Department of Agriculture and Fisheries, Department of Lands (Forestry Division and Land Commission), Central Statistics Office, Meteorological Office, Geological Survey, Bord Iascaigh Mhara, Gaeltarra Eireann, Co. Donegal Agricultural Advisory Services, Irish Sugar Company (Errigal Co-Op.) and Muintir na Tire and other non-statutory bodies. While the main onus for the operation of the resource survey has rested on the working party they in turn have been able to draw on the research resources of the Institute as a whole and to consult local and State bodies and personnel engaged in the area and other outside specialists.

The procedure followed in conducting this survey was based largely on experience with a similar type of survey of West Cork some years previously. Most of the findings were derived by five methods:

- (a) complete surveys in the field, *e.g.*, soils, ecology, animal diseases;
- (b) farm surveys on a random selection of different-sized farms in the area;
- (c) field experiments, *e.g.*, crop productivity - grassland, horticulture;
- (d) questionnaires to farmers, local groups and others;
- (e) use of existing knowledge on the area, *e.g.*, climatic records, population and other statistics.

With the emphasis on compiling factual information on the physical, economic and social factors of production as a basis for decision-making and planning and with the lack or inadequacy of such information on many facets, survey and experimental projects were necessary. These research procedures were aimed at getting the answers to local problems in their local environment. During the survey the need for further research, mostly of a long-term nature, into certain aspects was brought to light.

The principal aims of the survey were:

1. to provide basic, factual information in a systematic manner on the physical, human and economic resources of this underdeveloped area;
2. to ascertain to what extent and by what means the area can provide a good living for a more stable population through agricultural development.

The Resource Survey was confined to the Glenties Rural District of West Donegal. The area comprises approximately 411 square miles (263,000 acres). The Atlantic Ocean forms the southern and western boundaries of the region. The coastline is rugged and deeply indented in places. Some islands occur off the coast; of these Aran Island is by far the biggest. The area has a number of small towns and villages, the most important being Killybegs, Glenties, Ardara and Dunglow.

The findings of the West Donegal Resource Survey are published in four parts covering broadly different aspects of the Survey findings:

Part I Soils and Other Physical Resources.

Part II Some Aspects of Production - Crops, Livestock and Fisheries.

Part III Economic, Demographic and Sociological Aspects.

Part IV Summary, Conclusions and Some Development Proposals for Agriculture.

For their co-operation and assistance in the work reported here the West Donegal Resource Survey Working Party is grateful to the County Agricultural and Horticultural Advisory Officers and in particular Mr. D. O'Donnell, C.A.O.; Rev. Fr. J. McDyer, Glencolumbkille; the officers of the Department of Agriculture and Fisheries in the area, including those of the Land Project, the Parish Agricultural Advisory Agents and Mr. C. Goulding and Mr. D. Browne of the Horticultural Section; the personnel of Errigal Co-Op. and the local officers of the Forestry Division, Department of Lands.

Special thanks are due to the local people and particularly to the farmers who facilitated the different surveys and experiments carried out in the area and without whose co-operation the Resource Survey would not have been possible. Here also the excellent support of the various non-statutory rural organisations in the area is acknowledged.

Grateful acknowledgment is also due to the Department of Agriculture and Fisheries (particularly to Dr. H. Spain, Chief Inspector, and to personnel of the Horticultural Section, the Veterinary Services Section, the Fisheries Division, the Land Project and the Farm Buildings and Congested Districts Offices); to the Department of Lands (both Forestry and Land Commission); to the Directors of the Meteorological Service, the Central Statistics Office and the Ordnance Survey; and to Bord Iascaigh Mhara personnel.

The Working Party appreciates the continued interest, stimulation and guidance of the Director, Dr. T. Walsh, and the excellent collaboration of fellow research workers in An Foras Taluntais, not only those making direct contribution but also those who provided analyses or gave help in other ways. In this regard particular thanks are due to Mr. M. Brannick, and other colleagues in the Rural Economy Division who conducted the farm surveys and to those in the same Division who processed the findings. Finally thanks are due to those who assisted in the preparation of the report and especially Mr. B. Gilsenan for his editorial work, Mr. T. Kendrick for drawings, Miss A. Davin for typing facilities and Miss O. Daly for general help.

Grateful acknowledgment is made to all those mentioned here and to others who helped.

Pierce Ryan
Chairman, Working Party.

An Foras Taluntais,
March, 1969.

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CROP PRODUCTION

by

M. NEENAN*

INTRODUCTION

In the economic production of crops, the farmer to a large extent is competing with other farmers inside and outside the country. To be in business with any hope of success, therefore, his balance between yields and production costs must be comparable with those of his competitors. Soil types vary in their potential to produce crops; hence the growers with the better soils have a decided advantage. In most tillage crops the costs of production are either constant or decrease with increasing acreage. This is mainly due to the greater mechanisation which is possible when crops are grown on a large scale.

Compared with the main tillage areas of Ireland, West Donegal has many disadvantages for arable cropping. These are discussed in detail in the forthcoming section on 'Horticulture'. The adverse factors affecting horticultural crops would apply to an even greater extent to arable farm crops, because the margin per acre to the grower is considerably less.

MAIN FACTORS ADVERSELY AFFECTING CROP PRODUCTION

Nature of soils

In West Donegal, the acreage of suitable tillage land is extremely limited and occurs in small disconnected pockets. Even the best soils here do not compare favourably with those of the better tillage areas of the country. Rugged topography with steep slopes and shallow soil depth with rock outcrop further limit the use of some of the better mineral soils for arable cropping. The coastal sandy soils have problems of erosion, seasonal moisture deficit and exposure to wind and salt spray. The vast expanses of peat are raw, wet, difficult, and costly to reclaim and operate. The general lime and nutrient status is very low but this can be treated.

There is scarcely a farmer in the area with sufficient suitable land to make tillage his main enterprise. This means that worthwhile investment in tillage machinery is economically unjustified. The alternative is the hiring or sharing of machinery and with the scattered nature of the tillage areas this is not very practicable. Experience in other parts of the country has shown that for cereal crops this arrangement is not very satisfactory. Moreover, the growing of tillage crops presupposes the existence of intake points, drying and other facilities in the area. It seems unlikely, having regard to the potential of the soil resources, that private industry would be prepared to invest the capital required.

*Crop Husbandry Dept., Plant Sciences and Crop Husbandry Division, An Foras Taliintais.

Climate

The climate of West Donegal has many disadvantages for arable cropping and particularly for cereal growing. The area is exposed, and rainfall is high by standards in the main tillage areas of the country. Winds are frequent and sometimes of considerable force. The otherwise general mildness of the area is offset by the shortness of the frost-free period (late June to early September). The meteorological records show that duration of bright sunshine is considerably less than elsewhere in the country. In terms of climate, therefore, West Donegal compares unfavourably with the main tillage areas in the country.

Size and shape of fields

Tillage farming inside and outside the country has become almost completely mechanised. Therefore, it is difficult to produce at competitive prices without a considerable degree of mechanisation. Because of its high capital cost, machinery must be operated with maximum efficiency. In West Donegal, the size and shape of most of the fields militate against the most efficient use of machinery. For example, the size of field has a very considerable bearing on the time taken to carry out a particular operation. The percentage time lost in turning machinery in fields of various lengths as determined by a study in the United Kingdom, is shown in Table 1 -¹ The time varies greatly with field length, and can constitute a sizeable proportion of working time especially as speed of travel increases. The average length of field in West Donegal is approximately 120 yards, compared with three or more times that length in the Carlow-Kildare region.

TABLE 1—Percentage of working time lost in turning machinery in fields of different lengths¹

Speed of travel	Turning time of 0.20 min/ turn				Turning time of 0.60 min/turn			
	100 yd run	250 yd run	500 yd run	750 yd run	100 yd run	250 yd run	500 yd run	750 yd run
1 mph	5.5	2.3	1.2	0.75	15.0	6.5	3.5	2.5
2 mph	10.0	4.5	2.4	1.5	27.0	12.5	6.5	4.5
3 mph	15.0	6.5	3.5	2.5	35.0	17.5	9.5	6.5

The times required for turning various machines under favourable conditions in ploughing, cultivating, drilling and combine harvesting are 0.32, 0.22, 0.21 and 0.32 minutes respectively.

Further factors which adversely affect the efficiency of mechanical field operations are the rugged nature of the terrain, the steep slopes and the rock outcrops. Peaty soils, although otherwise suitable for tillage, are unable to carry the weight of heavy machinery for a large part of the year.

Lack of facilities

There is a general lack of facilities for tillage farming in the area. Farms at present are very poorly equipped in regard to fencing, machinery, farm roads and buildings,

all of which are essential to the economic production and handling of crops. To remedy this situation would require a considerable injection of capital.

CROP POSSIBILITIES

Cash crops

Cereals: Studies by An Foras Taluntais throughout the country show that on good soils under efficient methods of production, nett returns from cereals are of the order of £15 to £30 per acre. The higher returns come from wheat and malting barley. The economic production of these two crops, due to the adverse factors cited earlier, would be most difficult if not impossible in West Donegal. Besides, such crops are grown mostly in the vicinity of major intake points and this trend towards zoning is likely to be intensified. Cf the commonly grown cereals, only two, oats and feeding barley, are possible in West Donegal. On the better soils of the country the nett returns from feeding barley are not more than £15 per acre so that in West Donegal £10 per acre is as much as might be expected. The growing of oats is scarcely profitable in Ireland at present and the acreage is declining rapidly. Considering the low returns even on good soils, and the limited acreage of suitable soils available in the survey area, it would seem that cereals could not be expected to make a worthwhile contribution to the economy of the region.

Root crops: Sugar-beet production is largely zoned in relation to the existing factories, but this apart, soil and climatic conditions in West Donegal are not particularly favourable for the production of this crop. This leaves only potatoes and vegetables. Both are crops which can be grown without elaborate mechanical equipment, and they are capable of a high nett margin (£40 or more) per acre. With potatoes the disadvantage is that a large surplus of ware potatoes already exists in other parts of the country and even elsewhere in County Donegal. If, however, a suitable outlet could be developed, there is scope for expansion of this crop on the reclaimed peats or on the coastal sands. At present, there is a starch factory in County Donegal, but at the potato prices offered to growers, (£7 per ton), only small quantities are supplied. If this factory could be geared to the production of some food product based on potatoes, then possibly a higher price could be paid to the grower. At present, more than one-third of all potatoes grown in the United States are processed. The proportion in Ireland is probably less than 5 %. Statistics show that there is more than sufficient ware potatoes being produced in East Donegal to maintain a factory, but such a factory outside the immediate region could still serve West Donegal.

Notwithstanding these possibilities, it must be accepted that because of the adverse soil and climatic conditions, large scale potato production in West Donegal would still be at a disadvantage compared to other areas in the country.

Industrial crops: The possibilities for the production of industrial crops such as fibre flax, linseed, hemp, and oil crops (for pharmaceutical purposes) have been considered. The adverse factors outlined earlier would place the survey area at a decided disadvantage compared with other parts of Ireland for the production of these highly specialised crops.

Fodder crops

The production of fodder crops is often subsidiary to the production of cash crops, and as such the latter carry part of the overheads on machinery and equipment. The

general lack of cash crops in the survey area would, at best, make the growing of fodder crops a doubtful proposition.

SUMMARY CONCLUSIONS

The survey area has a number of decided disadvantages for the production of tillage crops. Hence the possibilities for cash or even fodder crops will continue to be limited, and arable cropping need not be expected to contribute substantially to the farm income of the region.

HEALTH SURVEY OF OAT CROPS

by

P. C. CUNNINGHAM*

Thirty-two oat crops on 24 randomly selected farms in West Donegal were examined for disease in the 1965 season. The survey was carried out at the end of August. The majority of crops were still quite green and this particular stage of growth was suitable for crop vigour evaluation and disease diagnosis. Samples were taken back to the laboratory for confirmation of field diagnosis. Most attention was concentrated on diseases which appeared to be a problem or potential problem.

CROP VIGOUR

Nine of the 32 crops were considered good and only five of these very good. Inadequate nutrition appeared to be the greatest limiting factor in more than 20 crops; no fertiliser was used on the majority of crops. Even the better crops seldom received fertiliser but mostly followed a fertilised potato crop. In this area it is common practice for oats and potatoes to alternate as a rotation for 20 years or more. When fertiliser is applied it is generally the potato crop preceding the cereal that receives it. All the crops examined except the five very good ones would have benefited from a dressing of nitrogen together with phosphate and potash fertilisers.

The second major limiting factor to higher yields was uncontrolled weeds. Weeds were competing vigorously with the oat crop in 17 cases and to a lesser extent were probably inhibiting yields in practically all the crops examined. Redshank (*Polygonum persicaria*) was most abundant and in some cases tended to completely smother the cereal. Chemical control of weeds was not practiced.

In many instances the reason given for the very restricted rotation of oats and potatoes, was that hand cultivation necessitated confining the tillage to a small area and was easier to operate under continuous tillage. It is obvious from the relative attention given to fertiliser application and weed control in both crops that the potato crop is considered far more important than the oats.

DISEASE STATUS OF CROPS

The following diseases of the oat crop in order of importance were present: take-all caused by *Ophiobolus graminis* var. *avenae*, blast of florets attributed mainly to Barley Yellow Dwarf Virus, and covered smut caused by *Ustilago kollerii*. Diseases occurring to a lesser extent were brown straw caused by *Leptosphaeria avenaria*, leaf spot by *Pyrenophora avenae*, halo blight by *Pseudomonas coronafaciens*, eyespot by *Cercospora herpotrichoides* and sharp eyespot caused by *Rhizoctonia solani*.

*Plant Pathology Dept., Plant Sciences and Crop Husbandry Division, An Foras Taliintais.

Take-all

Take-all was the most serious disease problem which depressed yields. It was intensified by constant cropping of the same site with oats, inadequate nutrient status and failure to control weeds. The disease was noticeably worse where oat cropping was most intensive. Twenty of the 32 fields examined showed obvious symptoms and seven of these showed severe stunting and whiteheads.

Blast

Blast, which gives rise to non-fertile florets, is largely attributed to Barley Yellow Dwarf Virus, though the writer believes that the condition can result from frost injury, take-all infection or other stress on the crop at a certain stage of growth. In most fields, however, the condition was accompanied by pigmentation of the plants which strongly suggests virus infection. The condition was quite prevalent in nine fields.

Covered smut

Loose smut (*Ustilago avenae*) was not found while covered smut (*Ustilago kolleri*) was recorded in 10 crops. In four of these crops more than 5 % of ears were diseased. Generally the condition was worse where the farmer planted his own seed from a previous crop.

Other diseases

Halo blight was found in five crops, brown straw infection in three, while two fields had plants infected with eyespot and one with sharp eyespot.

It may be concluded from the survey that at the present low level of husbandry practices disease control is only of secondary importance. Nutrition and management must first be improved to give worthwhile yields and then disease control will become significant.

HORTICULTURE

by

P. A. GALLAGHER, MARIA PRENDIVILLE AND D. W. ROBINSON*

SOILS

Soil suitability

The classification of the soils of the survey area and their use-range and suitability for agricultural purposes have been discussed in Part I of the Resource Survey Report.

Only 3 % of the soils of the survey area or roughly 8,000 acres are considered to have a moderately wide use-range; largely, these soils are deemed to be moderately to poorly suitable for tillage cropping, moderately suitable for pasture and suitable for forestry. They are well- to moderately well-drained friable mineral soils comprising (a) Brown Earths and Brown Podzolics, and (b) stabilised sea-sand and sand-influenced soils. In the former, however, local factors such as rugged topography, shallow soils and rockiness restrict the use of the soils for arable cropping; for instance some 2,300 acres have scattered rock out-crops in excess of 2 % of the soil area and 1,000 of these have outcrops in excess of 10%. Although wind erosion, surface deposition of sand and a seasonal soil moisture deficit are common drawbacks within the 2,500 acres of stabilised sands, nevertheless they are the most suitable of the mineral soils for general horticulture and particularly for vegetable production. The acreage would be quite sufficient to service a local vegetable processing factory but these soils are scattered along the coast, are often remote, inaccessible and poorly serviced by roads, and in places exposed to wind and salt spray.

Organic soils, mostly unreclaimed, raw blanket peats, occupy 63 % of the survey area. A further 22 % of the area is occupied by organic-mineral (but mostly organic) soil complexes. Cultivated or reclaimed peats have been mapped to the extent of 8,800 acres in the "lowland" and 5,300 acres in the "highland". These organic soils have been classified as limited in use-range and capability and generally unsuitable for horticulture as drainage is poor and difficult to improve. The remaining 12% of the survey area are totally unsuitable mineral soils together with shifting sand-dunes, salt marshes and lakes.

In 1961, Gardiner and Ryan (1) examined the soils of 128 sites (approximately 160 acres) proposed in the Carrick-Glencolumbkille area for vegetable production to supply a processing plant; they classified the sites into seven categories (Table 1).

The first three soils of peat origin constituted 80% of all the sites surveyed. This is a fair reflection of the constitution of the soils in the entire survey area where roughly the same percentage has been classified as organic soils. It also indicates that tillage was undertaken in the Glencolumbkille area mainly on organic soils.

*Horticulture and Forestry Division, An Foras Taliintais.

TABLE 1—Classification of soils available for vegetable growing in the Glencolumbkille area

Type of soil	No. of sites	% of all sites
<i>Organic soils</i>		
a) Raw peats.	37	28.8
b) Peaty loams (partly mineralised).	37	28.8
c) Organic loams (more mineralised).	29	22.7
<i>Mineral soils</i>		
d) Sands (coarse and fine).	2	1.6
e) Loams and clay loams derived from mixed but mainly micaschist drift. . . . .	.8	6.3
f) Sandy loams derived from gneiss materials. . . . .	.13	10.2
g) Alluvial soils.	2	1.6
Total. . . . .	.128	100.0

The suggested sites were further classified on the basis of suitability for vegetable production into four groups, namely (a) suitable, (b) mainly suitable, (c) partly suitable, and (d) unsuitable (Table 2).

TABLE 2—Classification of soils available for vegetable growing into various suitability classes

Suitability class	No. of sites	% of all sites
a) suitable.	5	3.9
b) mainly suitable.	34	26.6
c) partly suitable.	43	33.6
d) unsuitable.	46	35.9
Total. . . . .	.128	100.0

Only a very small proportion of the sites was considered suitable for vegetable production. Those included in Class (b) were considered as mainly suitable but only by reference to soils available in the Glencolumbkille area and not by reference to soils of the country generally. Gardiner and Ryan (1) pointed out that in other areas where better quality soils are more plentiful the soils in Class (b) would largely be downgraded to the point of exclusion, in which case Classes (c) and (d) would not merit any consideration for vegetable production. Hence, the soils in this area would be considered as largely unsuitable for vegetable production.

Drainage

As described in the section on climate (Part 1) this is a high rainfall area. Average annual rainfall has been shown to vary from 1,140 mm (57 in.) to 2,500 mm or more (100 in.) and the greater proportion occurs in the July to December period. The wet conditions during the time when most crops are being harvested are shown by the

1964 figures when 72.6 inches of rain were recorded at Carrick, with 10, 8.5, 7.5 and 11 inches recorded for September, October, November and December respectively. Average monthly rainfall figures for Carrick (1951-1964) show that 7.0, 7.3, 7.2 and 9.1 inches of rain fell in the months referred to which is not very much less than the figures reported for 1964.

In 1964, vegetable crops grown for processing in the Glencolumbkille area were badly affected by the waterlogged condition of the soil(2). Canker, which affected the parsnip crop, was aggravated by the wet conditions. Eleven acres of late cabbage and four acres of Savoy cabbage deteriorated so badly as not to be worth harvesting. Celery, although doing well to the end of October, deteriorated rapidly afterwards with soft rot. Twelve acres of carrots could not be harvested owing to the waterlogged condition of the soil. Thus, out of a total of 172 acres of vegetables, 27 acres were completely lost and 14 acres of parsnip and Savoy cabbage produced poor yields, due to wet soil conditions. Hence, to produce good crops and to harvest them under desirable conditions, the drainage must be good enough to deal with heavy rainfall.

Burke (3) in drainage experiments on blanket peat at Glenamoy, Co. Mayo, has shown that although the watertable and the moisture percent of the peat can be lowered, adequate drainage of blanket peat is extremely difficult. To attain this, drains need to be placed at intervals of 15 feet or less compared with the more usual 20- to 40-yard intervals in drainage schemes on mineral soils. Furthermore, Burke has shown that in January after 28.9 mm of rain the watertable within 6 feet of the edge of the drain was 9.7 inches below the surface and dropped after 10 days to 13.0 inches. In July, after 34.3 mm of rain, the watertable dropped from 6.5 to 18.5 inches below the surface over a 10-day period. The persistence of the high watertable, even with this intensive drainage reflects the extremely poor drainage characteristics of this peat material.

Soil fertility

Lime and nutrient levels of soils are very low in the area (see section on Soils, Part I). For instance the pH of the surface 6 inches of raw blanket peat is 4.3 to 4.8. Phosphorus and potassium levels are very low. Peat contains 1.4 to 1.8% nitrogen but most of this is organically bound and not available for plant uptake. Therefore liberal dressings of nitrogen, phosphorus and potassium fertiliser are required to maximise crop production. Blanket peat is deficient in most trace elements including copper, cobalt, molybdenum and boron.

However, although this medium is extremely deficient in lime and nutrients the status of these can be raised to a satisfactory level by the use of optimum quantities of lime and fertilisers. The soil fertility appraisal of the area (discussed earlier in the Soils section) where roughly one in every three samples was from a tillage area, shows the extremely low levels of lime and nutrients prevailing in the soils of the region. Samples from the Carrick area, taken in 1964 by the Horticultural Advisory Officer attached to the vegetable processing factory at Meenanery, show a distinct contrast following the use of lime and fertilisers (Table 3). These samples were taken from soils on which vegetable crops had been or were to be grown.

The results show that whereas the soils of the area are naturally low in lime and nutrients the status of these can be raised satisfactorily. In addition, the nutrition of vegetable crops on peat demands particular attention to nitrogen application and the inadequate levels of essential trace elements must be remedied by appropriate dressings.

TABLE 3—The distribution (percent) of samples into low, medium and high categories of lime, phosphorus and potassium status for unmanured versus manured soils

Category	Lime status		Phosphorus status		Potassium status	
	W.D.R.S.* area	Carrick area	W.D.R.S. area	Carrick area	W.D.R.S. area	Carrick area
Low	61	4	70	2	10	0
Medium	32	47	22	33	45	22
High	7	49	8	65	45	78

*West Donegal Resource Survey.

CLIMATE

Rainfall

The effects of the heavy annual rainfall and poor drainage on the harvesting of most crops have already been discussed.

Wind exposure and salt spray

Winds of gale force (Beaufort scale, Force 8 or more) occur more frequently in West Donegal than on the south and east coasts.¹ There are few calm days and the area is generally windswept. This would severely limit the range of fruit and vegetable crops that could be grown. The wind direction in order of frequency is from the south, west, north, east, south-west and north-west. The winds from the sea can be particularly damaging as they are often salt-laden. This is clearly seen in some chemical analyses of

TABLE 4—Levels of sodium and chlorine in rainwater at various times of the year (mg/l)¹

Year	Month	Sodium		Chlorine	
		Malin Head ²	Birr ³	Malin Head	Birr
1966	July	10.8	1.6	19.2	1.9
	Aug.	11.3	1.5	19.5	0.6
	Sept.	16.0	2.8	18.3	2.8
	Nov.	88.6	11.6	155.8	20.2
	Dec.	65.0	13.7	112.4	24.1
1967	Jan.	18.0	2.6	30.1	4.3
	Feb.	20.7	4.0	41.8	13.3

Source: Meteorological Records, Department of Transport and Power.

²N. W. Donegal Atlantic Coast.
Central Plain of Ireland.

rainfall which show that the deposition of Na and Cl in Malin Head is many times greater than in Birr (Table 4). The figures for Malin Head were also generally higher than for the meteorological stations at Belmullet and Valentia.

Salt damage is often evident in crops after high winds and this factor further limits the usefulness of the area for horticultural crops and particularly of the unsheltered sandy or sand influenced soils along the coast that are subject to the full effects of wind exposure and salt spray damage.

Frost

As discussed in the section on climate (Part I) the area has a more severe frost problem than many other parts of the country. In West Cork, for instance, the number of frost days per year is 25 diminishing to 10 at the coast; in Tullamore it is 50, whereas in the Glenties area it is 103. Besides, the frost-free period in any year is very restricted. Places such as Ardara and Glencolumbkille, because of their nearness to the coast, would be somewhat more favourable than Glenties but even here late spring and autumn frosts are a hazard.

There are no records of soil temperatures but they are probably low until very late in the season due to the high moisture content of the soils. Growth would be late and the soils for the most part suitable only for late sown crops.

Sunshine

The number of hours of bright sunshine over the year is lower than in most other areas of the country. The main difference is from July to December which coincides with the particularly heavy rainfall over this period in the Glenties region.

Summary

The climate, in association with the exposed nature of the area and its adverse soil conditions, is amongst the least suitable in the country for many horticultural crops.

CROP HUSBANDRY

The generally unfavourable soil, climatic and other physical characteristics of the area impose particular difficulties in various aspects of crop production.

Weed control

A survey carried out in 1964/65 showed that weeds are a major problem in crop production in West Donegal. The most prevalent weed species in vegetable plots in the Glencolumbkille area were, chickweed (*Stellaria media*) and redshank (*Polygonum persicaria*) and species such as annual meadowgrass (*Poa annua*), groundsel (*Senecio vulgaris*), fat hen (*Chenopodium album*) and corn marigold (*Chrysanthemum segetum*) were also abundant in places.

The weed problem is greatly aggravated by the high rainfall which enables weeds to re-root quickly after cultivation or handweeding. In these circumstances the use of herbicides should be very valuable. Many modern herbicides are soil-acting, for example, simazine, and are more effective under wet than under dry conditions. Other herbicides like paraquat, act through the foliage only but are also effective under wet conditions.

Although the use of herbicides greatly facilitates crop production in high rainfall areas, their use in Donegal will be more difficult than in many other parts of the

country. The small uneven fields are not suitable for the efficient use of mechanical spraying equipment. Many soil-acting herbicides are rendered inactive by adsorption on soil colloids such as organic matter and clays and more especially the former. The degree to which this happens depends on the herbicide used and the soil type. Chemical weed control is easier on soils containing a low to moderate amount of organic matter, for example 2 to 5 % which is enough to act as a buffer and prevent crop damage from an accidental overdose of chemical. On the peat soils in Donegal where the organic matter content will be at least 30%, higher and more expensive doses of many of the herbicides will be necessary to obtain satisfactory control. It will also be more difficult to determine exactly the optimum dose of herbicide for specific areas because the dosage range will vary more on peat soils than on mineral soils.

Diseases and their control

Vegetables: The conditions prevailing in the survey area favour the development of many serious diseases of horticultural crops. Inadequate rotation of crops, due to the scarcity of suitable land for cultivation, leads to the build-up of disease organisms in the soil. Without proper rotation diseases such as club root are particularly hard to eradicate. High atmospheric humidity accelerates the development of most foliar diseases and poorly drained soil favours the development of many diseases caused by soil-borne disease organisms.

The effect of inadequate rotation was shown clearly by a survey of club root of cabbage crops in the Glencolumbkille area in 1964. It was found that 55% of the crops examined were infected with club root, 35% being severely attacked. The severity of the disease was found to be closely related to frequent growing of cruciferous crops and particularly to the locating of the cabbage seed beds in small kitchen gardens with long histories of cabbage growing. Root and stem rots caused by the fungi *Sclerotinia* and *Rhizoctonia* spp. affect celery, carrots and potatoes in the area and appear to be related to successive growing of these susceptible crops. Other diseases which become serious under a system of short rotations include downy mildews of peas and onions, ring spot and light leaf spot of brassicas and white rot of onions.

High atmospheric humidity is favourable to the development of many diseases affecting the over-ground parts of plants. Notable examples are leaf spot of celery and ring-spot of brassicas which have been particularly severe in the Glencolumbkille area. Other diseases favoured by these conditions include the downy mildews of peas and onions, leaf and pod spot of peas, halo blight and anthracnose of French beans, and grey mould of French beans, onions and peas.

Poorly drained soil increases the severity of a number of diseases. This has been noted in the Glencolumbkille area in the severity of club root and *Phytophthora* root rot of brassicas, parsnip canker and bacterial soft rots of carrots, celery and brassicas.

Satisfactory control measures are not available for most of the diseases that have been mentioned, unless the conditions favouring disease can be rectified. A cabbage crop may be grown with some success in land infested with club root if the transplants are dipped in a protective calomel suspension before transplanting. Similarly, onions may be protected from white rot by pelleting the seed with calomel. However, these methods are expensive and do not reduce the level of club root or white rot inoculum in the soil. Celery leaf spot can be controlled by fungicidal applications but under conditions of high rainfall, very frequent applications are necessary which increase the cost of production. Growing the new resistant variety, Avonresister, may help to control parsnip canker but it seems that good yields of this variety can be obtained only with a very high standard of management.

Each of the vegetable crops which might be grown are liable to severe attacks by one or more diseases which are specially favoured by conditions in the area. A few of these diseases can be controlled to some extent by the use of fungicides or resistant varieties; effective control measures for the remainder are not available. Therefore, diseases must be regarded as a major obstacle to the successful production of vegetable crops in the area.

Top fruit and soft fruit: The growing of top fruit or soft fruit in this area would be more difficult and more costly than in more suitable areas of the country. The major fruit pathogens which cause foliage, flower and fruit diseases are either favoured by high rainfall, high humidity and wet soils or follow injury by wind or frost or both. Well-timed sprays of the correct fungicides applied with suitable spray machinery enable skilled growers in more favoured areas to achieve a high degree of disease control. To achieve a similar degree of control in the survey area is more difficult and because a higher number of sprays will be needed fruit growing will be less economic.

Varieties

Vegetable crop yields obtained in the area (Table 7) suggest that if future yields are to be economical growing conditions would need to be changed or the varieties improved by selection and breeding. A selection and breeding programme would have to be initiated to produce varieties that would give high yields under adverse conditions. These varieties would have to be quick maturing, resistant to frost and to disease under cool wet conditions and tolerant of wet soils and salt spray damage. One or probably two of these characters are already possessed by certain of the vegetables grown, e.g. quick maturing cabbage such as Rapidity, and celery which is more adaptable than most crops to wet soil conditions and is more tolerant of salt spray damage. To breed and select varieties of vegetables with all the suitable characteristics would be almost impossible; if it were possible the cost would be prohibitive. The project would require at least two full-time plant breeders and other help, as well as adequate glasshouse and laboratory facilities. The programme would take at least ten years and even then the chances of success seem remote; Therefore, it seems most unlikely that horticultural production could be resuscitated to any real extent by the introduction of new varieties adaptable to the conditions of the area.

Fertiliser usage

The use of fertilisers would present no real problems except that heavier than normal dressings of nitrogen would be required to produce maximum yield. This supplemental nitrogen could be applied as a top-dressing, which may be the most efficient way of supplying all the nitrogen in an area of high rainfall. Costs of spreading fertiliser would tend to be slightly higher than on soil areas more suitable to mechanised application.

Mechanisation and tillage tradition

Most farm crops in the area are sown and harvested by hand. The work is hard and the returns are low. With the exception of celery, horticultural crops grown for processing give small returns and are not likely to be an attractive proposition. There are no machines available in the area for most of the tasks involved. The lack of interest in tillage and the poor availability of machinery is shown by the distribution of vegetable crop acreages in the Carrick area in 1963. In that year 134 acres of vegetables

were grown for processing of which 72 were produced by Errigal Co-Operative Society itself. Even on the 62 acres, produced by private growers, a large part of the work was carried out by the Society's machinery and personnel (2).

Size of cropping area

Records from the Glenties area (Central Statistics Office), show that in 1960, 1.16% of the area was used for cropping of which 91.4% comprised oats and potatoes. This cropping is primarily planned to supply potatoes for home consumption and some grain and straw for winter feeding of stock.

A survey of a random sample of farms stratified into District Electoral Divisions showed that the average area of land used by each grower for cropping was 1.28 acres (Table 5). Most of this was used to produce potatoes and oats. There were 4.07 acres for hay per farm, some of which may be suitable for subsequent use as tillage ground. However, in many instances the area used for tillage was the best drained part and the area used for hay was generally more poorly drained with occasional rock outcrops. A distinctive feature of the area is the patchwork pattern of extremely small plots of land used for crop production. Quite apart from the fact that many of these are unsuitable for tillage due to inherently poor soil conditions, the sizes of the areas available for vegetable crop production are quite unsuitable for mechanised methods of production and harvesting.

TABLE 5—Average acreage of cropped land and that used for hay in a random sample of farms stratified into District Electoral Divisions

District electoral division	Total number of farms	Average acreage	
		All tillage crops	All tillage crops and hay
Ardara	21	0.99	5.82
Inniskeel	17	0.70	5.14
Crowkeeragh	20	1.03	5.51
Glencolumbkille	10	0.85	5.05
Glenaheen	26	1.14	4.21
Lettermacaward	22	1.66	4.68
Maghery	30	1.26	3.03
Rutland	14	0.88	1.92
Graffy	35	0.85	5.19
Maas	20	1.65	6.96
Killybegs	20	0.88	7.65
Tursceelta	14	0.64	7.28
All areas	249	1.28	5.35

With advances in the husbandry of horticultural crops, particularly in weed control and in mechanisation, there has been a growing trend to transfer these crops from a market garden system to a place in farm rotation. In 'Horticulture in Britain, Part I, Vegetables' (H.M.S.O., London, 1966) the distribution of the acreage of various crops is shown by analysis of size of crop. Except for a few salad crops, *e.g.*, lettuce, salad

onions and radishes, most vegetable crops are grown extensively as part of a farm rotation. In the production of carrots, roughly 90% of the crop is grown in lots of 5 acres or greater, 43 % of the total acreage is grown in 50-acre lots or greater and 25 % in lots of 100 acres or greater. Peas are considered a crop for large scale production and 61 % of the total acreage was produced in 50-acre lots or greater. Most of the cauliflowers produced (76%) are grown in lots of 5 acres or greater with more than 50% of the crop produced in the 5 to 30-acre range. Even with celery, very little of the total crop (11%) was grown in less than 5-acre lots and most was grown in lots of 10 to 100 acres.

Prices for vegetables and fruit crops, particularly those grown for processing are marginal. To make their inclusion into a farm system worthwhile the acreage grown must be fairly substantial and costs of production must be kept to a minimum. Costs of producing a crop of carrots would probably be similar to those of producing a crop of sugar beet, namely £60 to £80 per acre, assuming that harvesting was mechanised. To meet these original costs, yields of carrots would have to be at least 7 tons per acre (at £10 per ton) and would have to be considerably in excess of this to make the growing of this vegetable an attractive proposition. From a commercial point of view then small areas of vegetables can hardly be expected to compete favourably and large-scale inclusion of vegetables in the farm rotation of the area would be very difficult.

The small acreages available for tillage also present considerable problems in providing for a rotation which will keep the land disease-free whilst at the same time confining the cropping as near as possible to a processing factory. The scattered distribution of the small areas of land used for cropping and the need for strict rotation means that crops would have to be grown at considerable distances from the processing factory, thus increasing the cost of production still further.

HORTICULTURAL PRODUCTION AND POTENTIAL

Production

In a survey of a random sample of 249 farms in the area, horticultural crops were grown on only six and on these the acreage was extremely small. The horticultural industry in the area is very limited despite several attempts to promote this activity. The Department of Agriculture's soft and top fruit schemes resulted in some planting of these fruits but the plantations have failed, primarily because of the unfavourable climate. However, a fresh attempt was made in 1961 when a vegetable processing factory was established in Carrick. The acreage of vegetables grown for this project is given in Table 6.

Except for celery, where the acreage has expanded, the vegetable acreage has fluctuated and generally declined steadily since 1963. The reduction in acreage of most crops has been due to poor yields and associated poor nett returns (Table 7). Celery has been a marked exception in that both yields and quality were good. Cabbage has also been reasonably successful in some cases but the average yields were low although the yield from the best eight growers was 16.9 tons giving a nett return of £37 per acre. However, this compares unfavourably with the high yields (30 tons per acre) obtained in the Carlow and Mallow areas.

TABLE 6—Acreage of crops grown for the Errigal Co-Operative between 1962 and 1968¹

Crop	1962	1963	1964	1965	1966	1967	1968
Potatoes	33	36	42	20	30	4	—
Swedes	—	3	13	—	20	25*	25*
Beetroot	2	3	—	—	—	5	—
Parsnips	—	2	5	10	10	6*	—
Celery	4	9	13	22	22	23	22
Leeks	1	1	—	—	—	—	—
Savoy cabbage	45	23	13	25	—	—	—
Summer and autumn cabbage ...	10	27	57	10	10	8	12
Carrots	40	20	29	20	8	—	—
Broad beans	—	10	—	—	—	—	—
Total	135	134	172	107	100	71	59

Source: O'Toole, W., Personal communication, 1968.

*Grown in E. Donegal.

The poor yields for most crops are undoubtedly due to the unsuitability of the soils and climate of the area. Celery differs from other vegetables in that it can produce high yields under fairly wet conditions. However, even the yields of celery are not as good as those obtained in the Ballinasloe and Skibbereen areas where yields of 40 tons per acre are obtained, whereas in 1966 the average yield of the 17 best growers out of 66 in West Donegal was 31.5 tons per acre. The acreage of vegetables in 1968 was reduced

TABLE 7—Average yields (tons per acre) of various vegetable crops in the Carrick area of South West Donegal as compared with average yields obtained from good soils in more suitable areas in Ireland and in England.

Crops	S. W. Donegal						Ireland ¹		England*	
	1963	1964	1965	1966	1967	1968	Average yield	Obtainable yield	Average yield	£'s per ton
Cabbage	—	11.4	11.0	9.8	12.9	14.5	15	20	12.6	10.2
Celery	8.4	11.6	10.0	19.0	17.7	15.5	17	25	16.0*	—
Carrots	—	5.3 ^s	8.0	9.0	—	—	9	16	12.8	12.8
Parsnips	—	6.0	5.8	4.8	4.0	—	9	12	9.4	19.5
Swedes	—	13.0	—	6.0	—	—	29 ^s	—	—	—
Potatoes	—	—	6.5	n.a.	8.5	—	12	17	—	—
Savoy	—	7.5	—	—	—	—	10	13	8.3	12.3

(Obtainable yield = Average yield of top 33 % of growers)

¹Source: O'Toole, W., *Biats*, 19(8): 523-525, 1965.

*Source: 'Horticulture in Britain, Part 1, Vegetables', H.M.S.O., London, 1966.

^sdoes not include 12 acres not harvested.

^oincludes trench celery.

^oE. Donegal, 1967.

to less than one-third of that grown in 1964 and nearly half of the 1968 crops, namely 25 acres of swedes, was grown in East Donegal (Table 6). Hence in 1968 only some 34 acres of vegetables were grown in the vicinity of the processing factory compared with 172 in 1964.

Potential

Vegetable crops: The difficulties of vegetable growing in West Donegal have been discussed. High incidence of frost, high rainfall and poor soil drainage, the fragmented acreage of suitable soils, exposure and salt spray damage - all these factors severely limit the range of vegetables which can be grown.

Brassicae and other leaf vegetables including celery and onions: Crops such as Brussels Sprouts, winter cauliflower, winter and spring cabbage and cauliflower could not be grown successfully in the area because of frosts and waterlogged soil. Spinach and lettuce would not thrive in the poorly drained soils and would be particularly sensitive to leaf diseases which would readily develop in the high rainfall and humidity prevailing. Onions need well drained and sheltered sites and it is likely that onions grown in the area would tend to produce thick necks, would be more subject to leaf and bulb diseases and would be difficult to dry and store well.

In addition to celery, late summer and autumn cabbage, and possibly autumn cauliflower could be grown in the area, but even for these brassica crops a well-drained site is required. The lack of shelter and the effects of salt spray will further limit the yield potential of these crops. Disease control could be a further problem, especially leaf spot on celery and ring spot on cabbage, both of which would be favoured by the highly humid conditions of the area.

Root vegetables: Crops such as carrots, beetroot and parsnips require well drained soils for high yields. Poorly drained soils would limit the yield potential of these crops but the main problems would be encountered at harvesting because of the very heavy rainfall from September to December. The various root rots, such as canker in parsnips would be aggravated by the extremely wet soil conditions.

Leguminous vegetables: Leguminous crops require well drained soils and favourable climatic conditions. French beans are particularly sensitive to exposure and would not thrive in this area. Peas would be subject to serious leaf and pod diseases due to the humidity and would likely be damaged by salt spray.

Soft fruits

The main soft fruits grown in Ireland are strawberries, blackcurrants, raspberries and gooseberries. The principal problems faced by growers in the existing soft fruit areas are:

1. The perishable nature of the fruit (strawberries, raspberries, blackcurrants) necessitating very rapid marketing or processing.
2. Frost injury (blackcurrants and gooseberries).
3. Diseases, viz *Botrytis* (strawberries), leafspot and mildew (blackcurrants and gooseberries).
4. Wind exposure, which affects raspberries and blackcurrants, even in relatively favoured districts.

All these problems may be expected to be particularly severe in the survey area. Raspberries, blackcurrants and strawberries are very perishable and rapidly spoil if not quickly consumed or processed. Fruit grown in the survey area could not be processed successfully because of the distance from existing factories and there is too little suitable soil in the area to justify the establishment of a factory there.

With production on a smaller scale for the fresh market, efficient and rapid transport is essential along with speedy and skilful picking and packing. Efficient marketing would be particularly vital in this area because the high relative humidity would predispose the harvested crop to attack by fruit rotting organisms. The absence of any large consuming centre in the vicinity and inadequate transport facilities to other areas would seriously hamper soft fruit production for the fresh market. Even in favourable areas for soft fruit production, growers are dependent on good seasons to balance the occasional poor ones.

Blackcurrants and gooseberries: Even assuming that other factors were not limiting, the high incidence of frost and wind would seriously hamper the consistent cropping of blackcurrants and gooseberries. Costs of production would be higher than in other parts of the country. More frequent spraying would be required to give acceptable disease control, because of the favourable conditions for the development of plant pathogens and the ease with which the fungicides would be washed from the foliage by rain. Wind exposure would severely impair growth, reduce fruit setting and hamper crop spraying. The damage caused by wind would be particularly severe because of frequent high salt content.

Although blackcurrants are more tolerant of impeded drainage than other soft fruits, conditions approaching waterlogging in the soil are disastrous. With the exception of a few isolated areas, soil conditions would be generally unsuitable even for blackcurrants. The difficulties of blackcurrant production in the Survey area are demonstrated by a blackcurrant growing scheme started by the Department of Agriculture in 1957. Under this scheme, eight ½-acre plots of blackcurrant bushes were planted in September 1957, in the Glencolumbkille, Glenties and Gortahork areas. The plants cropped for the first time in 1959 but yield was small due to frost, sea-spray and wind damage. Frost and wind again reduced the crop in 1960. In 1961 when the bushes should have produced yields equivalent to 40 cwt per acre, frost and harsh winds again damaged the crop and yields ranged from 1 to 8 cwt per acre. The plots were eventually abandoned without giving an economic return in any season.

Raspberries: This crop is extremely sensitive to wind exposure and impeded drainage and these factors would make the profitable cultivation of raspberries impossible in the Survey area.

Strawberries: Strawberries are less wind sensitive than most soft fruits and it is now possible to control *Botrytis* by spraying and red core root-rot (on land that is fairly well drained) by the use of tolerant varieties. Nevertheless, the survey area would not be suitable for profitable, large-scale strawberry production at normal market prices because of the risk of salt spray injury and the very limited area of suitable soils. Weeds are a greater problem in strawberries than in bush and cane-fruits. This problem has largely been overcome in the strawberry growing areas of the country by the use of the soil acting herbicides, simazine and lenacil. These herbicides are less effective on peaty soils because of adsorption by organic matter. Consequently weed control in straw-

berries on peat soils would still rely heavily on cultivation, a difficult and expensive operation especially under high rainfall conditions.

While normal commercial production of strawberries for processing or for the fresh market would not be feasible in the area, small farm plots to supply the tourist industry may be a proposition. In most varieties, however, the bulk of the fruit ripens before the second week of July, when the main holiday season begins, so that later varieties, such as Rearguard, would probably be more valuable than the earlier ripening varieties, such as Cambridge Favourite and Vigour. Ever-bearing strawberries, for example Red Rich, might be worthy of trial provided that the new measures for the control of *Botrytis* are effective under the conditions of soil and climate in West Donegal.

Orchard fruits

Orchard fruits in Ireland consist of plums, pears and apples. Plums and pears can only be grown successfully in the best areas in the country under highly skilled management and it is doubtful if they will continue to be produced commercially anywhere in Ireland under conditions of freer trade.

Successful apple production is also very dependent on favourable natural conditions and serious financial loss often occurs if any one factor, such as site, soil or climate is unsuitable. Apple growing in Ireland is tending to develop in the south and east of the country, which have a more suitable climate with higher summer temperatures and solar radiation. This trend is supported by studies by Blanpied and O'Kennedy (4) which suggest that low sunlight and night temperatures during the growing season are two factors that limit apple growth.

Many features of the climate of West Donegal will militate against successful apple production. Temperatures during the growing period are among the lowest in the country. Control of apple scab and other fungal diseases are difficult because of the very heavy rainfall and high relative humidity. Spring and autumn gales reduce fruit set, retard growth and cause crop loss near harvest time. Throughout most of the area orchards will suffer damage by exposure to wind-borne salt and spring frosts would also be a considerable hazard.

Many recent studies have shown that there is little place in the future for the non-specialist fruit grower, financial success and technical perfection being closely linked. Consequently, viable orchard units in the future are expected to be at least 20 acres in size. Because of the scarcity of suitable land and the difficulties imposed by the climate, commercial apple growing in the survey area would be impracticable.

Glasshouse crops

This area would have no marked advantage for tomato growing over other existing glasshouse areas. Winter temperatures are slightly higher than in Dublin but this would be offset by higher winds in West Donegal so that little, if any, saving in heating costs would be expected. Winter temperatures in Donegal are not as high as in Cork and solar radiation is less than in most other parts of the country.

Existing glasshouse growers are being forced to modernise rapidly in face of free trade conditions. The Survey team on the Glasshouse Industry (1966) reported that at the present level of production most of the existing growers would be unable to compete in free trade conditions. For many the potentially high degree of profitability was unattainable because of uneconomic operations. It is now considered that an economic unit of glass will not be smaller than \ acre and would preferably be over

1 acre. The cost of erecting glasshouses at present varies from £15,000 to £25,000 per acre. Investment of this order is only likely to be made in areas with the most suitable climate and convenient to markets. Consequently, the expected development in Ireland is likely to occur along the east and south coasts which are nearer the main consuming centres in England and Ireland and where conditions are more favourable. Nevertheless, from a growing point of view, good crops of early tomatoes have been produced at Gortahork, Fintown and Ballybofey in County Donegal. A small glasshouse industry may well become established near the Northern Ireland market but in this case any development in Donegal is more likely to occur in the eastern part of the county than in the west. To meet the requirements of scale, a producers' co-operative, on similar lines to that established at Causeway, Kerry would probably offer the best possibilities of success.

The development of modern tomato growing in West Donegal on an extensive scale cannot be recommended mainly because of the need for very high capital investment, for well-developed supporting services, for zoning crop production in the future, for nearness to markets and for highly skilled labour in this form of horticulture.

Mushrooms

A scheme such as exists in Northern Ireland where compost is prepared by specialist composters and sold to growers for peak heating and cropping might be considered in a mushroom growing project in West Donegal. The remoteness of the area, however, both from sources of horse manure or straw and from markets would reduce the profitability of such an enterprise considerably. The perishability of mushrooms would restrict the possibilities of sale on the British market. Canned mushrooms are not likely to be profitable in the future with the rapid increase of cheap supplies from Taiwan on the international markets.

The logical positioning of such a mushroom-growing enterprise would be where horse manure supplies are available and also close to the British markets, *e.g.* in the Kildare-Meath area. However, with a large capital investment, first class management and specialist advice, mushroom growing might be profitable in the short term, but long term prospects would seem to be poor.

Nursery stock production

Some genera of shrubs grow particularly well on well-drained acid soils in mild districts with high rainfall and relatively low sunshine, but only where there is very good shelter from wind, especially sea-wind. It is unfortunate that the West Donegal area is particularly windswept because at Mulroy, in the same county is an example of what can be grown where conditions are favourable. The Mulroy district is well wooded and is additionally sheltered by an extensive mountain area to the south west. The shore of this winding sea inlet enjoys mild, moist conditions without the ill-effects of salt-carrying winds off the ocean. Here there is a well known rhododendron garden where many uncommon and valuable species thrive. A small trade in these shrubs and in camellias has been initiated.

However, large areas of West Donegal are scheduled as Black Scab areas (First Schedule) which in addition to the scarcity of suitable soils in sheltered locations, would preclude the possibility of developing a nursery stock industry in the area.

Beekeeping

The possibility of beekeeping as a worthwhile occupation has been considered. The main factors against successful beekeeping in such areas are high rainfall, low summer temperatures, high winds and the absence of a varied flora giving nectar sources from spring to autumn. The heather could undoubtedly give heavy yields in good seasons, but difficulties would arise in maintaining the bees at good strength throughout the remainder of the year. This could be done by a skilful and experienced beekeeper though even for him it is unlikely to be financially rewarding. Experience in West Donegal and in North West Mayo (Peatland Research Station) has been very discouraging.

Although not of benefit to local inhabitants, the heather crop might be exploited more by beekeepers from other districts when the normal sources of nectar elsewhere (*e.g.*, clover) were finished.

SUMMARY AND CONCLUSIONS

The development of horticulture as a commercial enterprise in the area can hardly be justified on economic grounds or on conditions of technical efficiency. The whole trend of horticultural production in Europe is towards the kind of development that is already the norm in America, *i.e.* mechanised systems on crops covering 5 to 20 acres or more. Prices paid for horticultural crops are more likely to decrease than to increase and field horticulture can no longer be considered as a high income enterprise and the prerogative of the small farmer. Entry into some form of expanded economic community such as the E.E.C., with developments in efficient, international bulk transport of horticultural produce and with demands of large retail organisations for uniform produce and continuity of supply will intensify the problems of the small grower in marginal areas, remote from the main markets.

In summary, the main shortcomings of the area for commercial field horticulture would be:

1. The extremely limited and scattered acreage of suitable soils making satisfactory crop rotation very difficult.
2. Poor drainage characteristics of the cultivated peat soils and the very high cost of providing only fairly adequate drainage.
3. The small size of the cultivated fields, rendering efficient mechanisation difficult.
4. The adverse climatic conditions, exposure and salt spray damage.
5. The lack of a tillage tradition and interest in horticultural crops and therefore the lack of the appropriate skills.
6. The comparative economic disadvantage to growers in the survey area where production costs are higher, potential yields are lower and transport and marketing more expensive than in the more favourable areas of the country.

Glasshouse cropping can be considered on a small scale. In this sphere of development, however, the highly mechanised, £-acre production unit is considered to be the minimum size. The cost of modern glasshouses is too high for most growers in the survey area, and the remoteness of the area from current market outlets would further militate against this development. Mushroom production might also be considered since the main adverse factors *viz.* poor soil and climatic conditions, would not significantly affect this crop. However, the large capital investment required, the need

for skilled management, the absence of local supplies of horse manure and straw and the distance from markets would reduce the long-term prospects for this crop.

In this appraisal, horticulture has been examined solely from an economic standpoint, which is the only important consideration for a commercial enterprise. The social and educational implications of developing horticulture have not been assessed.

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GRASSLAND

1. Production

by

M. RYAN AND W. E. MURPHY*

INTRODUCTION

Due to the nature of the local terrain, soils and climate, farming in West Donegal is based almost exclusively on a grassland-livestock economy. Therefore any increase in farm income will primarily depend on increasing animal output which in turn depends on improving both yield and quality of grass. This will involve the efficient use of lime and fertilisers and better grassland management together with more intensive stocking.

The nature and quality of West Donegal grasslands on the mineral soils and blanket peats are discussed in the section: "Grassland—3. Botanical composition, ecology and management". Pastures on mineral soils comprise approximately 13% of the survey area or about 33,000 acres; blanket peat and organic soils, carrying rough grazings, comprise approximately 85% or 224,000 acres of the survey area (1). In order to obtain quantitative data on grassland output short-term fertiliser trials were laid down on pastures and meadows on mineral and organic soils and on recently surface-seeded pastures on blanket peat.

PASTURE PRODUCTION ON MINERAL SOILS

Potential

An experiment using the wire-cage technique (2) was laid down on a number of pastures on a range of mineral soil "types" in 1965 and continued through 1966, 1967 and 1968. Treatments (cwt/acre) consisted of 8 calcium ammonium nitrate, 4 superphosphate, 2 muriate of potash applied yearly. The soils were limed according to requirement at the commencement. In 1967 as it was possible to take one cut more than in previous years, the calcium ammonium nitrate treatment was raised to 10 cwt per acre.

The experiment provided information on earliness and seasonality of production and on the influence of lime, fertilisers and soil-pasture type on herbage yields. The control and highest yields obtained on the pastures on different soil types are given in Table 1; because of variations in the time of application of the lime, the 1965 results are not included.

*Grassland Nutrition and Ecology Department, Soils Division, An Foras Taliintais.

TABLE 1—Control and maximum dry matter yields (lb/acre) in relation to treatment and soil type 1966/67/68

Soil type ¹	Control			Maximum		
	1966	1967	1968	1966	1967	1968
Grey-Brown Podzolic	9,604	7,554	8,575	13,240 (NKL)	13,113 (NPL)	14,178 (NPL)
Brown Podzolic	2,962	2,576	2,297	11,155 (NPK)	10,983 (NPL)	11,530 (NPKL)
Acid Brown Earth	9,406	7,450	7,673	14,932 (NPKL)	10,572 (NPL)	11,408 (NPL)
Gley	3,640	4,583	5,120	7,961 (NPKL)	9,051 (NPKL)	10,835 (NPL)

*Due to its very limited occurrence the grey-brown podzolic soil is not shown on the published Soil Map of West Donegal. The brown podzolic, acid brown earth and gley soils are represented respectively by units 2, 1 and 26 on Soil Map.

The pattern of yields on the control plots is similar for the 3 years (Table 1). Control yields in the region of 7,500 to 9,500 lb dry matter per acre on the acid brown earth and grey-brown podzolic soils are reasonably high and reflect a fairly satisfactory initial nutrient status in these soils. Control yields on grey-brown podzolic soils in County Limerick, *i.e.* Patrickswell and Elton Series were of the order of 5,000 to 6,500 lb dry matter per acre (3) and in County Wexford ranged from 5,000 to 7,000 lb (4). The brown podzolic soil yielded poorly on the control plots each year and was inferior to the others including the gley soil. Low lime and nutrient status and poor botanical composition - the sward contained 21 % weeds - are mainly responsible.

Fertiliser treatment narrows the gap between yields on the different soils (Table I). Maximum yields of 13,000 to almost 15,000 lb of dry matter per acre are quite high; comparable yields obtained on the Patrickswell and Elton soils in Co. Limerick were 11,000 to 12,500 lb per acre (3). The grey brown podzolic and acid brown earth soils gave the highest overall yields for the 3 years, averaging approximately 13,000 and 12,000 lb dry matter per acre respectively and they were followed by the brown podzolic and gley soils yielding somewhat in excess of 11,000 and 9,000 lb per acre respectively. By far the most significant yield response to lime and fertiliser is on the brown podzolic soils.

Allowing that a pasture production level of 10,000 lb dry matter provides the annual feed requirement for a milch cow giving 650 gallons of milk at a stocking rate of 1.2 acres per cow, the potential of these mineral soils is at least as good as that of comparable soils in other areas of the country.

Response to fertilisers

It is notable that in 1966 various combinations of lime, phosphorus and potassium together with nitrogen were needed to obtain maximum yields. In 1967 and 1968, however, additional potassium was generally unnecessary for this purpose due probably to a build-up of soil potassium together with recycling induced by the grazing animals. The need for nitrogen application to boost pasture yields towards a maximum is shown by its presence in all the treatments giving highest yields. The importance of lime and phosphorus is second only to nitrogen as shown by their inclusion in all but one of the treatments giving maximum yields over the 3 years.

Chemical composition of herbage

Apart from the effect of fertilisers in boosting dry matter yields, these amendments substantially changed the chemical composition of the herbage right from the commencement of the experiment (Table 2). Preferred levels of N, P and K in herbage for the requirements of grazing animals or as a reflection of optimal production conditions are 3.5; > 0.35; > 2.0%, respectively (5). The difference between these optimum levels and those in the herbage of some of the control plots, *e.g.*, on the brown podzolic soil, is substantial. The satisfactory plant phosphorus level in the control plot of the grey brown podzolic soil reflects previous manuring and explains the absence of P in the treatment giving maximum yield in 1966 (Table 1).

TABLE 2—Chemical composition of herbage on control and NPKL plots at 1st cut 1966 (percentage of dry matter)

Soil type	Control			NPKL treatment		
	N	P	K	N	P	K
Grey Brown Podzolic	2.8	0.43	3.0	3.4	0.58	4.3
Brown Podzolic	2.8	0.28	1.5	2.6	0.42	2.9
Acid Brown Earth	2.3	0.29	2.0	3.7	0.36	3.2
Gley	2.3	0.34	2.9	2.4	0.43	2.6

Early grass production

The 1967 data (Table 3), provide an indication of the potential quantity of grass on these mineral soils of West Donegal in early April, when adequately limed and manured and receiving 2 cwt nitrogen fertiliser on February 14. The control yields are included for comparison.

TABLE 3—Early-season production (lb DM/acre) April 11, 1967 on control and fertilised plots

Soil type	Control	NPK treatment
Grey Brown Podzolic	907	1300
Brown Podzolic	5	543
Acid Brown Earth	81	412
Gley	5	248

Early-season grass yields for comparable soils in other parts of the country receiving adequate lime, phosphorus and potassium with 3 cwt of nitrogen fertiliser applied in February-March ranged from 142 to 696 lb DM per acre in the first year of a more recent trial (Table 4).

Allowing for the fact that the West Donegal results (Table 3) are for the third year of the trial it is still obvious that the mineral soils here compare more than favourably with comparable soils in more southerly parts of the country in their ability to produce early grass. The value of these yield increases is quite appreciable considering that 112 lb dry matter is equivalent to 4 grazing days per cow. In an area usually so lacking

TABLE 4—Early-season production (lb DM/acre) April 1967 on control and NPKL treatments

Soil type	Location	Date N applied	Date cut	Control yield	NPKL yield
Grey Brown Podzolic	Co. Limerick	28/2	18/4	147	207
	Co. Meath	8/3	25/4	101	205
	Co. Meath	10/3	26/4	370	696
Brown Podzolic	Co. Carlow	3/3	19/4	zero	142
	Co. Carlow	3/3	20/4	64	441
	Co. Cork	28/2	19/4	123	493
Acid Brown Earth	Co. Waterford	3/3	17/4	32	210
	Co. Wexford	3/3	20/4	374	380
	Co. Cork	1/3	18/4	14	617
Gley	Co. Limerick	14/3	25/4	76	290
	Co. Limerick	14/3	26/4	417	548

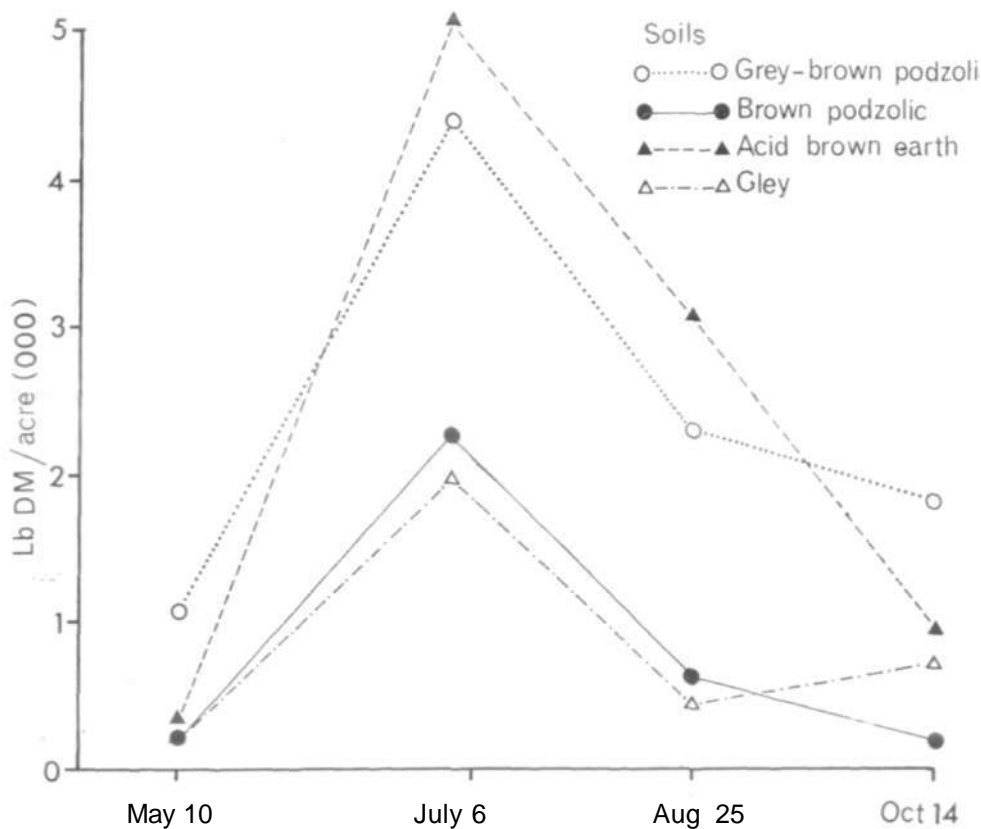


Fig. 1 - Seasonal distribution of control yields - West Donegal, 1966

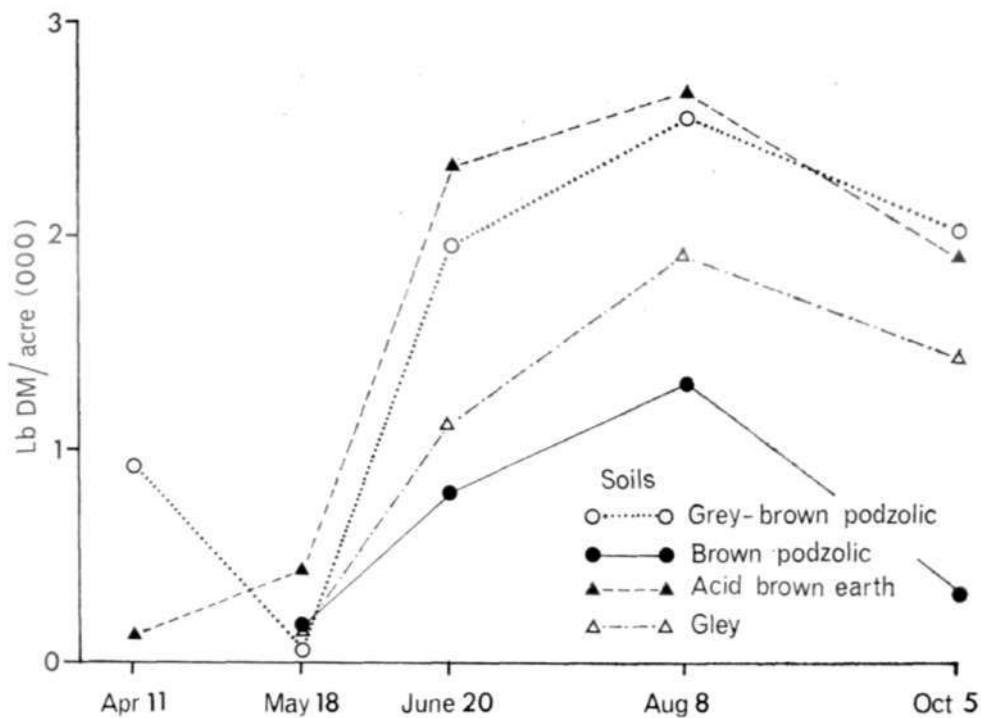


Fig. 2 - Seasonal distribution of control yields - West Donegal, 1967

in winter keep the value of early season grass to the spring calving cow or to other livestock hardly needs elaboration here. The early "bite" could play a vital role in reducing lamb mortality in the area if it were geared to coincide with the peak spring need in lambing ewes. The drier soils especially can be successfully used for early grass production: the wet gley soils present problems in effectively utilising the early growth.

Seasonal production

Control plots: In 1966 four harvests were taken on May 10, July 6, August 25 and October 14 respectively. As seen in Figure 1, highest yield on the control plots was obtained from the second or July harvest on all four soils. Although yields differed, the patterns of growth were similar for all soils for the first three harvests; there was a mixed pattern for the last harvest.

In 1967 five harvests were taken on April 11, May 18, June 20, August 8 and October 5 respectively. Figure 2 shows that the highest yield on all soils in this year occurred at the fourth or August harvest; here the peak was not as high as that achieved in July 1966. However, there was a better distribution of yield over the season in 1967; after the first cut, the patterns of distribution for all soils were similar. In both 1966 and 1967 the grey-brown podzolic and acid brown earth soils outyielded the brown podzolic and gley soils by a considerable margin over the greater part of the season. The pattern of production over the season and of yield differences between the soils in 1968 were very similar to those for the previous 2 years.

High yielding plots: On the treated plots giving the highest yield in 1966, (Fig. 3), peak production, as in the control plots, occurred at the second or July harvest. The pattern of yield decline after this date was variable. All soils gave a much more similar overall yield compared with the performance of the control plots in either 1966 or 1967.

In 1967, as with the control plots, the peak yield on the treated plots was less pronounced than in 1966 (Fig. 4); there was a better spread of yield over the mid-season. Peak yield occurred on three of the soils in August but was not much greater than the June yield on the grey-brown podzolic and gley soils. The highest yield on the brown podzolic soil occurred in June. Once again the similarity of the overall yields is notable compared with the disparity on the control plots. The 1968 results show trends more similar to those of 1966 than 1967 in that there is less of a spread of yield in mid-season and peak yield is in June-July rather than August except on the grey-brown podzolic soil. The differences in yield and in seasonal yield pattern for the different soils are in line with previous years.

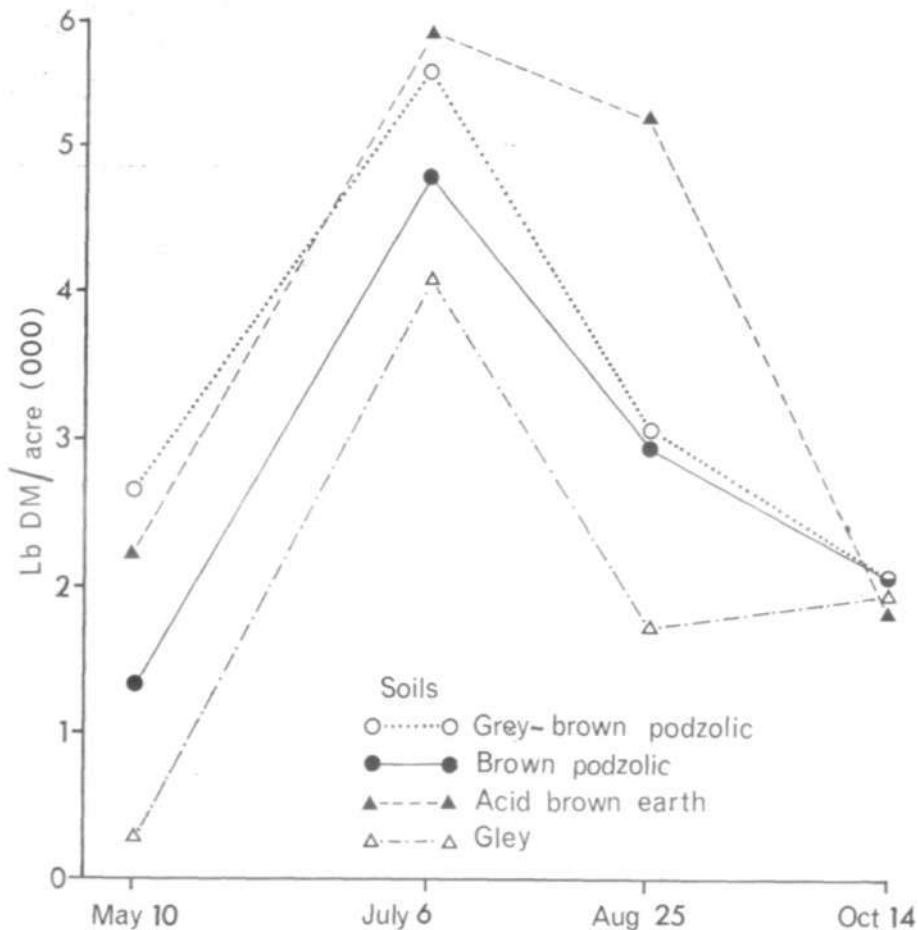


Fig. 3 - Seasonal distribution of maximum yields - West Donegal, 1966

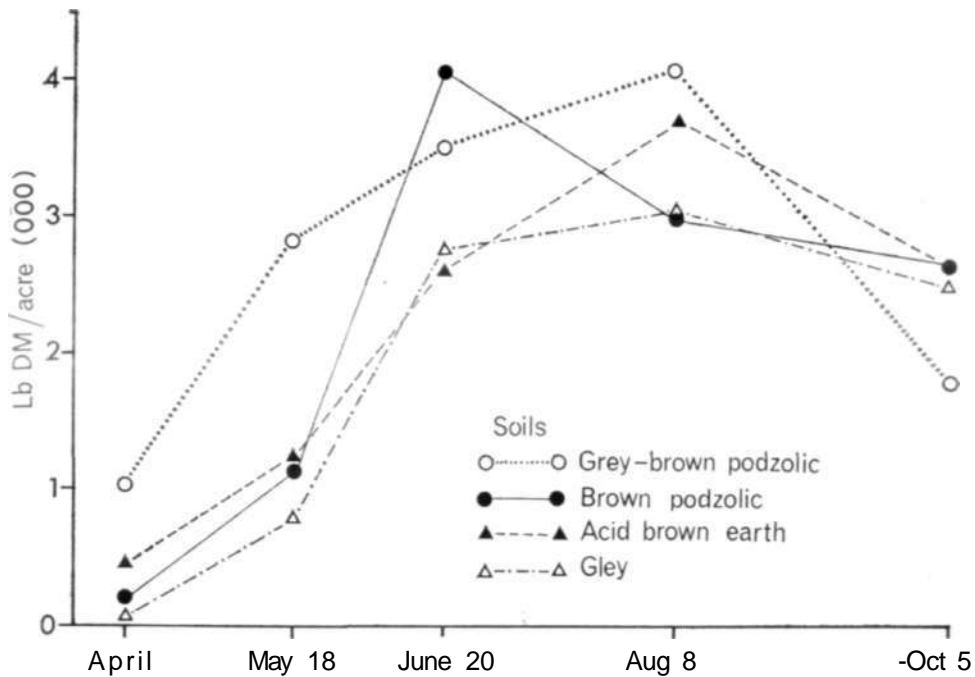


Fig. 4 - Seasonal distribution of maximum yields - West Donegal, 1967

The seasonal yield distribution and total yield for the control plots and for those giving highest yields for 1966 and 1967 are summarised in Table 5. The rate of production of dry matter per day in the intervals between harvests is shown in Table 6; the higher values shown compare favourably with values of 83 to 119 lb DM/acre/day reported by Brougham and Glenday for the Grassland Research Station at Hurley (6). The disparity between the unfertilised plots and those that are producing best yields is also highlighted.

PRODUCTION FROM WET MEADOWS

The results of the trial investigating the potential of West Donegal meadows which was located on three different sites showed that, with manuring, these meadows can be highly productive. The treatments comprised a lime dressing (calculated to bring soil pH to 6.8) in 1965 and a basal dressing (cwt/acre) of 4 superphosphate, 2 muriate of potash and 4 calcium ammonium nitrate - the latter split into two equal dressings - each year of the trial. The meadows were ungrazed before cutting in July.

Meadow yields

The yields of the control and highest yielding plots are shown in Table 7. The large responses to fertiliser treatments are obvious. Yields of 5,000 to 7,000 lb of dry matter per acre on the peat are equivalent to hay yields of 3.0 to 3.5 tons per acre on a 10% moisture basis; these are very satisfactory yields. The control yields that are less than 3,000 lb of dry matter per acre are not satisfactory and at best are equivalent to 1.5 tons hay per acre. Surprisingly, maximum yield on the gley soil in 1967, although low by relation to the other soils, was attained without the use of nitrogen; presumably, there was a high release of N from soil reserves in that year.

TABLE 5—Seasonal yield distribution and total yields (lb DM/acre) for control and highest producing plots - West Donegal, 1966-67

	Grey Brown Podzolic				Brown Podzolic				Acid Brown Earth				Gley			
	1966		1967		1966		1967		1966		1967		1966		1967	
	Con- trol	Max	Con- trol	Max	Con- trol	Max	Con- trol	Max	Con- trol	Max	Con- trol	Max	Con- trol	Max	Con- trol	Max
Cut 1	1,079	2,644	908	1,003	186	1,350		203	321	2,191	181	446	209	262		42
2	4,384	5,462	57	2,789	1,966	4,765	148	1,152	5,051	5,783	412	1,214	2,253	4,067	90	784
3	2,298	3,051	1,967	3,491	603	2,961	792	4,032	3,061	5,161	2,332	2,603	449	1,713	1,111	2,738
4	1,843	2,083	2,610	4,066	207	2,079	1,327	2,987	973	1,797	2,725	3,688	728	1,919	1,931	3,011
5			2,012	1,764			319	2,609			1,900	2,621			1,451	2,476
Total	9,604	13,240	7,554	13,113	2,962	11,155	2,576	10,983	9,406	14,932	7,450	10,572	3,640	7,961	4,583	9,051

TABLE 6—Yield of dry matter (lb/acre/day) occurring between harvests - West Donegal, 1966-67

Harvest interval	Grey Brown Podzolic				Brown Podzolic				Acid Brown Earth				Gley			
	1966		1967		1966		1967		1966		1967		1966		1967	
	Con- trol	Max	Con- trol	Max	Con- trol	Max	Con- trol	Max	Con- trol	Max	Con- trol	Max	Con- trol	Max	Con- trol	Max
1st-2nd	76.9	95.8	1.5	75.4	34.5	83.4	4.0	31.1	88.6	101.6	11.1	32.8	39.5	71.3	2.4	21.2
2nd-3rd	45.9	60.1	59.6	105.7	12.1	59.3	24.0	122.2	61.2	103.2	70.7	78.8	8.9	34.3	33.6	83.0
3rd-4th	36.8	40.2	53.3	83.0	4.1	41.6	27.1	60.4	19.4	35.9	55.5	75.2	14.6	38.4	39.3	61.3
4th-5th			34.7	30.4			5.5	44.5			32.8	45.2			25.0	42.7

TABLE 7—Control and highest yields (lb DM/acre) on meadows, 1966-1968

Soil type ¹	Control			Highest		
	1966	1967	1968	1966	1967	1968
Gley	2,766	1,973	1,814	4,771 (NPKL)	3,263 (PKL)	4,664 (NPK)
Peat	2,486	1,830	1,616	7,325 (NPK)	6,967 (NPK)	4,895 (NPKL)
Degraded Brown Earth	3,718	4,092	2,858	5,656 (NKL)	5,664 (NKL)	5,770 (NPKL)

¹The gley, peat and degraded brown earth are represented by units 4, 10 and 7 respectively on Soil Map.

Chemical composition of herbage

Continuous mowing of grassland constitutes a severe drain on nutrient reserves in soils. Many meadows in West Donegal, such as those used in the experiment, are wet by nature and are little grazed, if at all. Many of them are not treated with fertiliser or farmyard manure. Such management severely depletes nutrient reserves in the soil which is reflected in the quality of the herbage. Table 8 shows the unsatisfactory levels of P and K in the third successive hay crop where it is untreated compared with the levels where the meadow is limed and fertilised.

TABLE 8—Chemical composition of hay from control and NPKL plots, 1967 (percentage of dry matter)

Soil type	Control			NPKL		
	N	P	K	N	P	K
Gley	2.1	0.26	1.0	2.8	0.42	1.9
Peat	2.0	0.16	1.4	1.9	0.33	2.4
Degraded Brown Earth	2.3	0.27	1.4	2.0	0.38	2.4

PASTURE PRODUCTION ON PEATS

In 1967 the potential production of recently sown, surface-seeded pastures on blanket peat was measured on three sites. Each site was limed to requirement and a basal dressing of 4 cwt superphosphate, 2 cwt muriate of potash and 10 lb copper sulphate was applied per acre. The plots were located on, A) wet flattish peat, 3 ft deep, elevation 450 ft O.D., B) dry flattish peat, 3 ft deep, elevation 250 ft O.D., C) dry peat on a fairly steep slope, 3 ft deep, elevation 300 ft O.D.

Table 9 shows the annual total yields of dry matter obtained without the use of artificial nitrogen - it is usual to rely on clover for nitrogen supply in this type of pasture.

TABLE 9—Annual yields¹ (lb DM/acre) on peats, 1967

Site	Plot replication			Mean of replications
	1	2	3	
A	4,578	3,284	2,286	3,383
B	2,709	2,981	3,453	2,941
C	2,842	4,367	2,191	3,133

¹These yields are the totals of three harvests on site B and two harvests each on sites A and C.

These total annual yields may appear low but when it is considered that establishment of good grass species was below optimum on all sites, they compare favourably with yields of 3,000 to 4,000 lb dry matter per acre obtained on a 3-year-old surface-seeded sward on peat at Glenamoy, Co. Mayo (7). Work at Glenamoy has shown that the potential production of good swards, without using artificial nitrogen, is 7,000 lb dry matter per acre (8).

The establishment of productive pasture and especially its efficient utilisation is problematic on peats and particularly on those that are wet. Generally, where undrained, these peats cannot support heavy animals or machinery. Drainage is costly but vital to allow a worthwhile grazing season and to make the land trafficable for the spreading of fertilisers and for other operations. Without constant additions of fertilisers, these newly seeded peats rapidly revert to their former state, *i.e.*, low-producing rough grazings containing mainly indigenous species. Intensification, where possible, must also take into account problems of fluke-infestation in animals.

CONCLUSIONS

Present production of pastures and meadows on many mineral soils in West Donegal is low. However, this can be substantially improved by the use of lime and fertilisers. The most general causes of poor production are low native soil pH and nutrient levels together with the low usage of lime and fertilisers. Mineral soils on the elevated and oftentimes steeply sloping areas that have a grass cover have a high potential but fertiliser application is a great problem here. Aerial top-dressing may be a suitable solution but the economics of this procedure have not, as yet, been established.

Low-producing, *Molinia-Callima* dominant swards on peats cover by far the greatest part of the survey area. There can be no doubt but that practically all of these rough-grazings except where they are badly eroded, too steep or too rocky, can be developed through established surface seeding techniques, but at the cost of fencing, drainage, supply and application of fertilisers and seeds. There are many acres of peat adjacent to roads which are quite suitable for surface seeding, and which could be fenced and improved immediately on a communal basis. Blocks of 10 to 15 acres each should be fenced and used to supply feed in the early spring period of the year when it is most needed. In our experience, farmers who have successfully done this, show proof of their appreciation of the "new value" of the bog by aiming to expand the sown area and exploit this relatively untapped reserve of land to the full.

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GRASSLAND

2. Potential for nitrogen fixation

by

C. L. MASTERSON*

In the surface seeding of peat with clover, the establishment of an effective association between the clover and its associated nodule bacteria (*Rhizobium trifolii*) is of prime importance. In West Donegal, these bacteria are undetectable in the blanket peat where clover is not present. On introducing clover, even without seed inoculation, a population of these bacteria is rapidly established and the young clover plants become profusely nodulated. The question remains, however, whether these bacteria are effective with their clover hosts in fixing nitrogen. To obtain information on this question, a survey was carried out of several peat areas which had been surface seeded with clover.

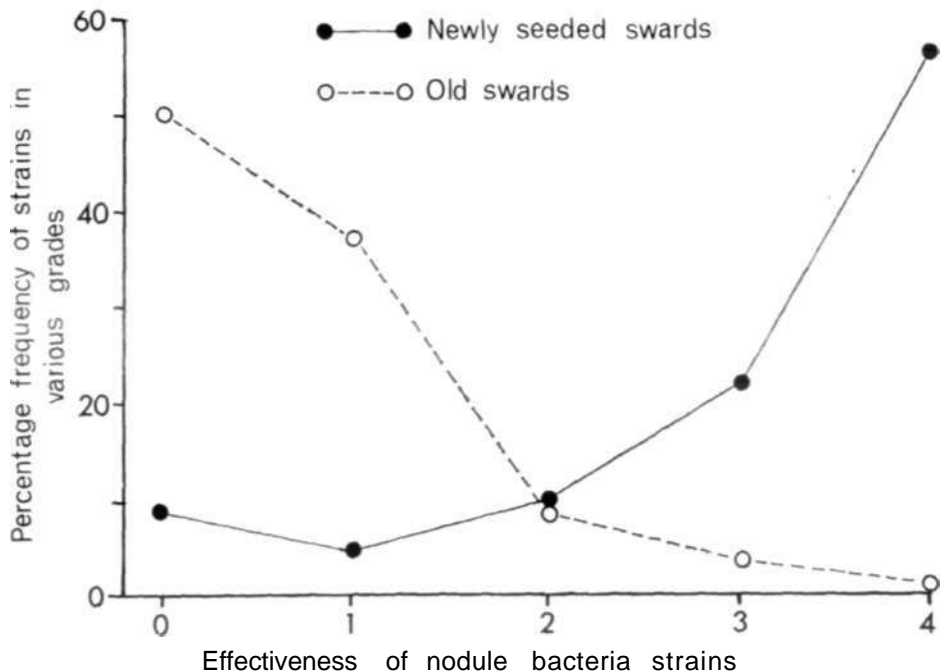


Fig 1. Effectiveness of clover nodule bacteria (*Rhizobium trifolii*) strains from swards on blanket peat in Co. Donegal.

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It was found that highly effective nodule bacteria populations became established in newly-seeded blanket peat. In contrast, areas in which clover had been growing for several years contained very ineffective populations of these bacteria. Some of these areas were situated on acid mineral soil or where there was a strong mineral soil influence due to the peat being very shallow. Figure 1 shows that in newly sown areas, over 75 % of the bacterial isolates examined were in the higher effectiveness categories, whereas over 85% of the isolates taken from the older areas were totally ineffective or nearly so.

In this survey, areas where the clover seed was inoculated were compared with those where no inoculation was carried out. The effectiveness of the nodule bacteria population was not influenced by inoculation.

It can be concluded that effective nodule bacteria predominate in blanket peat when it is surface-seeded with clover. Such clover would have a high nitrogen-fixing potential, as long as the soil is adequately supplied with lime, phosphorus, potassium and trace elements. It is apparent that the effectiveness of these bacteria decreases with time; the reason for this is not clear, but may be associated with inadequate use of lime and fertilisers on these swards.

GRASSLAND

3. Botanical composition, ecology and management

by

A. M. O'SULLIVAN*

INTRODUCTION

The Irish lowland grasslands are all man-made communities. They are often termed 'replacement communities' since they occupy the former sites of either woodland or bogland plant communities. A reconnaissance survey of the lowland grasslands of West Donegal was carried out during August, 1965 and part of June, 1966. The aim of this rapid survey was to describe and classify the grassland communities in the Resource Survey area.

This survey has revealed two major grassland 'types' in the area. These differ in their species composition which in turn is reflected in their separate ecology and usage. For convenience the two types will be referred to as 'wet grasslands' and 'dry grasslands'.

Grassland is utilised as pasture or meadow in West Donegal. Reseeded grasslands are rare. Where they occur they are of poor quality and revert after a few years to resemble the old grasslands on comparable soils. Grassland has the same localised distribution as the human population, being mainly confined to the lowland valleys and coastal areas. There are few meadows or pastures above the 400 feet (120 m) contour level. The survey area has a rugged and mainly mountainous landscape. Rainfall is high and constant, winds are frequent, moist and of considerable force at times and sunshine is limited. Large-scale bog development is a natural result. Much of the wet grassland is on reclaimed or partly cutover peat. If abandoned for some years the grassland character depreciates due to competition from the re-invading bog plants.

The grassland is used mostly in association with the adjoining bogland. A large proportion of both the wet and dry grasslands is mown annually for hay. The dry meadows are mown from the middle of July onwards; the wet meadows are rarely mown before the first week of August. In a very wet summer haymaking may continue into September. Much of the haymaking on individual farms is still done entirely with hand implements. The hay crop is reserved mostly to provide for the few cows and other cattle which are kept through the long winter.

During the summer the grazing animals feed on the nearby bogland which is unfenced and mostly under common ownership. Here the cattle must compete with small flocks of Scottish Blackface sheep for the available feed. The sheep live off the natural bog vegetation throughout the year getting little or no supplementary feeding over the winter.

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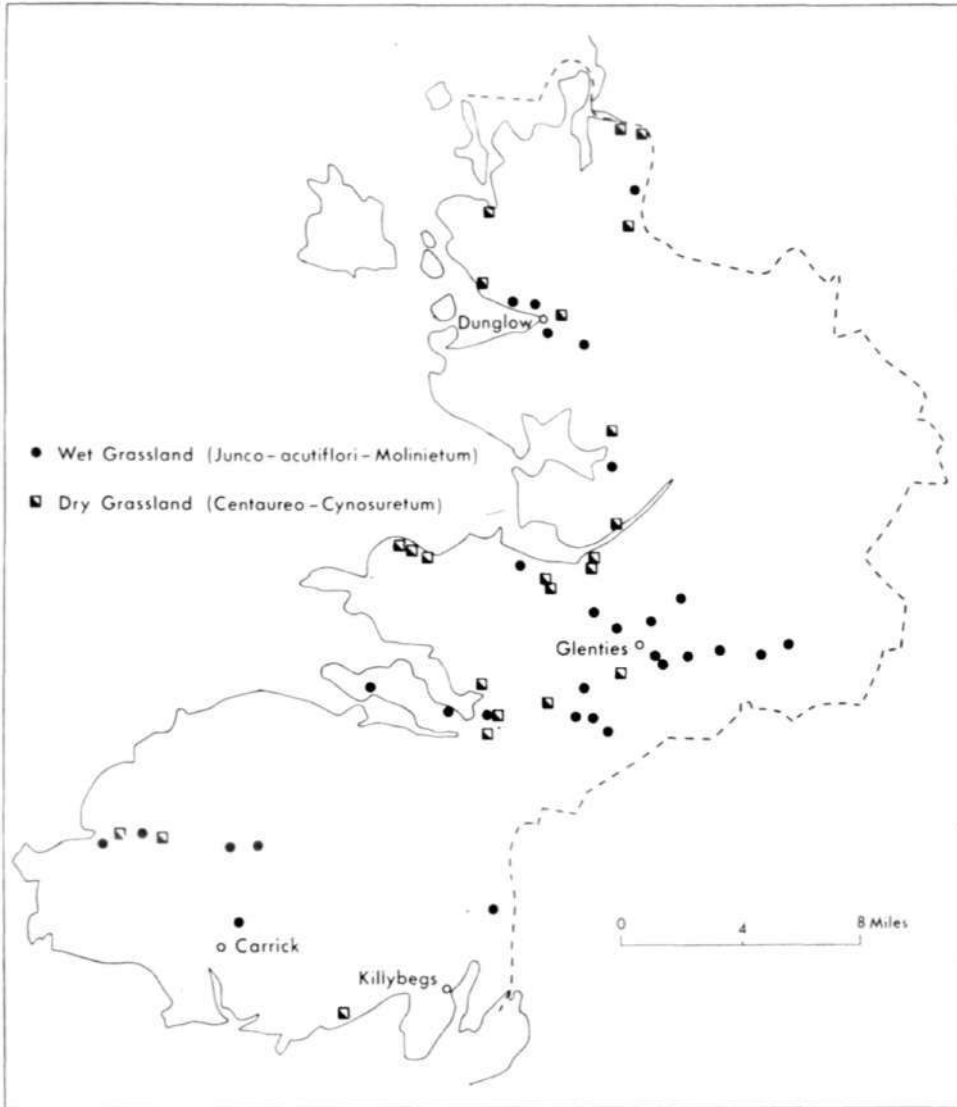


Fig. 1 - Location and type of grassland stands examined.

Some of the smallest and most irregularly-shaped fields in Ireland are in the survey area. The usual size range is $\frac{1}{10}$ to 1 acre ($\frac{1}{10}$ to $\frac{4}{10}$ hectare). On reclaimed or cutover peat the dividing ditches are usually strips of uncut peat. On mineral soils the fields are usually surrounded by stone walls.

THE FIELD SURVEY

Lists of species were compiled in homogeneous grassland swards throughout the study area. The locations of the stands examined are shown in Figure 1. At each stand - the concrete unit of vegetation in the field - all the species present were noted on a coded field card. A semi-quantitative estimate of the cover - abundance of each species, based on a plus to five (+ to 5) scale was made¹. In addition, the general environmental features of the habitat, the kind of management and the stage and vigour of growth were noted. The soil profile was described and soil samples collected for chemical analysis.

The 53 species lists and their associated field data were transferred onto 80-column IBM punch cards. The species lists were then compared, sorted and classified electronically using an IBM 1620 computer with a 40 K storage capacity. The lists were also tabulated electronically and those which resembled each other most closely were grouped in a table.

Two floristically distinct groups of species lists are apparent in this table (Table 1). One has a large number of moisture-loving species and is dominated by a variety of rush, sedge and moss species. Grasses and legumes are only of secondary importance. This community is given the general designation of 'wet grassland' since it occurs exclusively on poorly drained soils. The other group contains species which grow mainly in well drained situations. The dominating species are pasture grasses, clovers and plantains. This community is referred to as 'dry grassland'.

THE WET GRASSLANDS²

Botanical composition

Soils vary widely in their moisture status and this is reflected by the type of plants growing in a particular stand. The association between rush species and wet soils is well known; detailed examination of a large number of grassland stands and their underlying soils reveals other soil/plant relationships.

Out of the 53 grassland stands studied in detail, 30 belonged to the wet grassland group. Over 90 species were possible constituents of the sward but the average number of species occurring in an individual stand was 31; many species were present in only one or a few lists. Technical and cost considerations have precluded publication of a table showing the individual species lists. Instead these have been summarised and presented in the form of a Constancy Table (Table 1). The Roman numerals I-V are used as follows:

Constancy class **I** = 1—20%; **II**=21—40%; **III**=41—60%; **IV**=61—80%;
V=81—100%

¹This widely used scale is as follows: + =sparsely present (<1 %); 1 = 1—5% cover; 2=6—25%; 3=26—50%; 4 = 51—75%; 5=76—100%.

²*Junco - acutiflori - Molinietum.*

TABLE 1—Constancy table of grassland species-lists from West Donegal

Grassland type:	Wet	Dry
No. of species lists (stands) per column:	30	23
Average no. of species per stand:	31	30
Wet grassland species:		
<i>Juncus acutiflorus</i>	V 2 [^] *1	I 1
<i>Carex nigra</i>	IV +—2	I +—2
<i>Cirsium palustre</i>	IV +—1	II +—1
<i>Carex panicea</i> ...	III +—2	I +
<i>C. echinata</i>	III +—3	
<i>Sieglingia decumbens</i> ...	III 1—2	I +—1
<i>Succisa pratensis</i>	III +—2	I +
<i>Thuidium tamariscinum</i> ...	III 1—3	I +—2
<i>Dactylorhiza fuchsii</i>	II +	I +
<i>Potentilla erecta</i>	II +—2	I +
<i>Agrostis canina</i>	II 1—3	I 2
<i>Pedicularis sylvatica</i> ...	II +—2	
<i>Viola palustris ssp. juressi</i> ...	II +—2	
<i>Peltigera canina</i>	II +—1	I +—1
<i>Carex demissa</i> <i>C. lepidocarpa</i>	II +—1	
<i>Nardus stricta</i>	II 1—2	
<i>Molinia caerulea</i>	II +—2	
<i>Senecio aquaticus</i>	II +—2	I +
<i>Filipendula ulmaria</i>	II +—1	
<i>Angelica sylvestris</i>	II +—1	
<i>Ranunculus flammula</i>	II +—2	
<i>Lychnis flos cuculi</i>	II +—2	
<i>Carex ovalis</i>	II +—2	I +—2
Dry grassland species:		
<i>Centaurea nigra</i>	II +—2	V +—2
<i>Senecio jacobea</i>	i +	IV +—1
<i>Crepis capillaris</i>	i +	III +—1
<i>Cerastium vulgatum</i>	II +—1	IV +—1
<i>Lolium perenne</i>	i +	II +—2
<i>Bellis perennis</i> ...	i +	II +—2
<i>Poa trivialis</i>	i +—2	II +—3
<i>P. pratensis</i>	i 1	II —2
<i>Dactylis glomerata</i> ...		II +—1
<i>Taraxacum officinale</i> ...	i +	II +
<i>Chrysanthemum leucanthemum</i>		II +—1
<i>Heracleum sphondylium</i> ...		II +—1
<i>Vicia cracca</i>	i +—2	II +—1
<i>Lotus corniculatus</i>		II +—1
<i>Veronica chamaedrys</i>	i +	II +
Indifferent species:		
<i>Holcus lanatus</i> ...	V 1—2	V 1—3
<i>Rhytidadelphus squarrosus</i>	V \i	V +—3
<i>Plantago lanceolata</i> ...	IV +—2	V +—2
<i>Trifolium repens</i>	IV +—2	V 1—3
<i>Agrostis tenuis</i> ...	IV +—3	V 2 [^] \
<i>Anthoxanthum odoratum</i>	V 1—2	IV 1—3
<i>Prunella vulgaris</i> ...	IV +—2	IV -r—2
<i>Cynosurus cristatus</i>	IV +—2	IV +—2
<i>Hypochaeris radicata</i>	IV +—2	IV -r—2

<i>Trifolium pratense</i>	HI	+—2	V	+—3
<i>Ranunculus repens</i>	III	+—2	IV	+—2
<i>R. acris</i>	V	+—2	II	+—2
<i>Rumex acetosa</i>	III	+—2	V	+—2
<i>Rhinanthus minor</i>	III	+—1	III	+—2
<i>Festuca rubra</i>	III	+—2	III	+—2
<i>Leontodon autumnale</i>	III	+—2	III	+—2
<i>Mnium undulatum</i>	III	+—3	III	+—1
<i>Potentilla anglica</i>	IV	+—2	III	+—1
<i>Lophocolea bidentata</i>	III	1—2	III	+—2
<i>Acrocladium cuspidatum</i>	III	1—2	II	+—2
<i>Pseudoscleropodium purum</i>	III	1—3	II	+—2
<i>Juncus effusus</i>	III	—3	II	+—1
<i>Euphrasia spp.</i>	II	+—1	II	+—1
<i>Brachythecium rutabulum</i>	II	+—2	II	+—2
<i>Eurynchium praelongum</i>	II		II	+—1
<i>Trifolium dubium</i>	II	+—2	II	+—1

Species of lower constancy omitted.

^xRange of cover/abundance with which the species occurred in the total number of stands.

Table 1 shows that the wet grassland type is defined by over 20 species which are scarce or absent in the dry grassland type. The wet grassland sward is characteristically dominated by rushes. The rush with the highest constancy and vitality is *Juncus acutiflorus*, one of the jointed rushes. It gives the rush meadows of West Donegal their characteristic brownish-green appearance in summer. A number of grasses, sedges, herbs and mosses are present as minor constituents of the sward. Growth is of a stemmy rather than a leafy nature. Competition for light and space is thus not so great as in a leafy grass sward.

A number of plants in the sward are also commonly found in heaths and bogs and they include *Carax panicea* (carnation sedge), *C. echinata* (star sedge), *Sieglingia decumbens* (heath grass), *Succisa pratensis* (devil's bit), *Nardus stricta* (matgrass) and *Molinia caerulea* (purple moor-grass). The semi-natural character of the wet grasslands is also exemplified by the presence in a number of them of the common spotted orchid, *Dactylorchis fuchsii* and of the 'dog lichen' (*Peltigera canina*).

The wet grasslands have a considerable number of species in common with the dry grasslands. These are listed as 'indifferent species' in Table 1. If a broader spectrum of plant communities were being studied, however, many of these species could no longer be called indifferent. For instance, species such as *Holcus lanatus* (Yorkshire fog), *Plantago lanceolata* (plantain), *Trifolium repens* (white clover) and *T. pratense* (red clover) would emerge as characteristic species of the manured lowland grasslands. On the other hand, *Rhytidiadelphus squarrosus* (moss), *Agrostis tenuis* (bent-grass) and *Anthoxanthum odoratum* (sweet vernal grass) would retain their indifferent status since they occur also in heaths and woods.

High-yielding grasses like *Lolium perenne* (perennial ryegrass), *Poa trivialis* (rough-stalked meadow-grass) and *Dactylis glomerata* (cocksfoot) are rare or absent. They require fertile soil conditions and at least moderately good drainage to survive. However, *Holcus lanatus* (Yorkshire fog), *Agrostis tenuis* (bent-grass), *Cynosurus cristatus*

(crested dog's-tail) and *Trifolium repens* (white clover) are present in small amounts in practically all stands. These species increase markedly in abundance when fertilisers are applied. The presence of *Trifolium repens* (white clover) in even the poorest grasslands in West Donegal is remarkable since it is a legume with an optimum growth only where soil pH and nutrient status are adequate.

Distribution and ecology

Wet grasslands are widespread but local throughout the survey area (Fig. 1). They occur mainly in the vicinity of roads and around the edges of the extensive blanket bog, at altitudes between 100 and 400 feet (120 m), the average being 150 feet (45 m). They occupy much more gently sloping terrain than the dry grasslands, the average slope being 4 degrees.

Wet grassland communities most typically occur on partly reclaimed peat soils in West Donegal (Table 2) but occasionally also on heavy textured mineral gley soils. In both cases, the natural drainage is impeded to strongly impeded and in a number of instances a high water-table prevails also. The great majority of these peat and gley soils are typically stone-free, slowly permeable and continuously moist to wet. Evidence of poaching is rare at present since most stands are mown or only lightly grazed.

Wet grassland stands have a more inland distribution than the dry grasslands. Many of them occur in areas receiving 50 to 70 in. (1,250 to 1,750 mm) of rainfall annually. In such areas dry spells lasting more than a few days during the growing season are rare.

Hedge species

Hedge growth is characteristically poor in areas where wet grasslands are common. The ditches around wet grasslands in the mineral soil areas carry *Salix* spp. (willows). To a lesser extent, gorse and mountain ash (*Sorbus aucuparia*) also occur. Where peat ditches separate the fields *Osmunda regalis* (royal fern) and *Calluna vulgaris* (ling heather) are common hedge plants.

Management

The major proportion of the wet grasslands are meadowed annually; of the 30 stands studied 21 were in meadow and the remaining 9 in lightly grazed pasture. Growth starts late in the wet meadows and mowing does not commence until August. The mown sward is composed mainly of the stems of *Juncus acutiflorus* (jointed rush). Haymaking is usually difficult for want of suitable weather. Regrowth after mowing is slight and is usually grazed off before the end of the growing season in October. In winter the sward has a whitish appearance and mosses are very conspicuous.

Fertilisation and light liming of these wet grasslands greatly increases their productive capacity (see Grassland—1. Production). Fertilisers cause a major increase in the grass content of the sward at the expense of the rushes and sedges. Of the grasses, *Holcus lanatus* becomes the dominant species after manuring with nitrogen, phosphorus and potassium. The resulting leafy sward, however, is more difficult to mow and save, using the existing hand harvesting methods. Ground conditions in many of the wet meadows are too soft and the fields are too small for mechanised haymaking.

Improved drainage, enlarged fields and proper management practices are prerequisites to any worthwhile and longterm improvement of these wet grasslands. At present, poaching damage is rare since grazing is light and sporadic and mainly done

by young cattle. However, under intensive stocking it could become a real problem unless adequate precautions were taken.

THE DRY GRASSLANDS³

Botanical composition

The dry grasslands lack most of the moisture-demanding rush, sedge and herb species of the wet grasslands. They are also positively defined by a number of species typical of well-drained soils (Table 1). The most common and abundant of these are *Centaurea nigra* (knapweed), *Senecio jacobea* (ragwort), *Crepis capillaris* (smooth hawk's-beard) and *Cerastium vulgatum* (mouse-ear chickweed).

The average species number per stand is 30. About 95 different species were actually found in all the stands of this grassland type but 50 of them occurred in less than 20% of the stands. Of the 53 grassland stands originally described 23 belong to the dry grassland type.

Grasses usually occupy 80 to 90% of the herb layer. The usual sward dominants are *Agrostis tenuis* (bent-grass), *Poa trivialis* (Yorkshire fog) and *Anthoxanthum odoratum* (sweet vernal-grass). The good agricultural grasses are notably scarce. Both *Phleum pratense* (timothy) and *Alopecurus pratensis* (meadow foxtail) are absent altogether while *Lolium perenne* (perennial ryegrass), *Poa trivialis* (rough-stalked meadow-grass) and *Dactylis glomerata* (cocksfoot) occur sparingly. Similarly, many common weeds of fertile grasslands such as *Cirsium arvense* (creeping thistle), *Odontites verna* (red bartsia) and *Plantago major* (broad-leaved plantain) are rarely seen in the survey area.

Both the white and red clovers (*Trifolium repens* and *T. pratense*) are present in most stands of the community. Their effectiveness as nitrogen producers is however doubtful since the soil pH levels are very low (Table 3). Other occasionally occurring legumes include *Trifolium dubium* (yellow clover), *Lotus corniculatus* (birdsfoot trefoil) and *Vicia cracca* (tufted vetch).

The average ground cover of mosses in the moss layer of the sward is 40% rising to over 70% in individual stands. Most of this cover is made up of one moss, *Rhytidiadelphus squarrosus*.

Within the dry grassland group there are a number of sub-types or variants. These are recognised by slight differences in the botanical composition of individual lists. Regrouping the order of the lists and the order of the species in Table 1 leads to the 'crystalisation' of four variants (Table 4). These variants indicate minor differences in the ecology or management of the stands.

Distribution and ecology

The dry grassland communities have a pronounced coastal distribution (Fig. 1). They occur at altitudes between sea level and 300 feet (90 m), the average being 120 feet O.D. In general the dry grasslands in the survey area occupy mineral soils: Acid Brown Earths, Brown Podzolics, Regosols. These soils are derived from mixed drifts mainly of granite, schist, or gneiss origin. They are mostly shallow, rather stony, and usually well drained (Table 2). The topography in the mineral soil areas is usually rolling to hilly, so few of the stands of dry grassland are on level ground. The average slope of all the stands is 9 degrees.

³*Centaureo-Cynosuretum*, typical Sub-association, variant of *Rhytidiadelphus squarrosus*.

1 AMI 1 2 Summary of soil physical observations made at stands of wet and dry grassland types in West Donegal

	No. of samples	Wet grassland 30	Dry grassland 23
Texture	Light (sandy)		13
	Medium (loamy)	13	78
	Heavy (silty or clayey)	27	—
	Peaty	60	9
Permeability	Slow	90	13
	Moderate	10	87
	Rapid	—	—
Stoniness	Stonefree	87	39
	Slightly stony	13	57
	Stony	—	4
Drainage	1 i M		65
	Moderately free	3	22
	Impeded	13	13
	Strongly impeded	84	—
Ground-water level (Jul>)	At surface	3	—
	5—25 cm	—	4
	26—50 „	23	—
	51—75 „	10	4
	76—100 „	10	—
	over 100 „	54	92
Poaching	None	80	91
	Slight	13	9
	Moderate	7	—
	Severe	—	—

For each of the soil factors observed the number of stands associated with a particular factor are expressed as a percentage of the total number of stands examined in the particular grassland type.

TABLE 3—Mean soil test values (\pm SE in brackets) for pH, phosphorus, potassium, magnesium, manganese and organic carbon from grassland stands in West Donegal. Sampling depth 0-10 cm (0-4 in).

	pH	P (ppm)	K (ppm)	Mg (ppm)	Mn (ppm)	Org.C (%)	No. of samples
a) Mineral soils							
Wet grassland (<i>Junco-Afolinietum</i>)	5.2 (0.08)	2.3 (0.40)	60.4 (5.54)	47.9 (11.04)	3.6 (0.76)	6.8 (0.82)	10
Dry grassland (<i>Cent.-Cynosuict mn Typ.</i>)	5.6 (0.10)	3.2 (0.34)	81.9 (7.32)	86.8 (7.29)	3.7 (0.36)	6.6 (0.49)	18
Significance	*	NS	**	**	NS	NS	
b) Peat soils							
Wet grassland (<i>Jimco-Moliiietum</i>)	4.9 (0.07)	3.3 (0.32)	78.1 (5.41)	154.7 (8.47)	6.6 (1.04)	21.4 (1.38)	20
Dry grassland (<i>Cent.-Cynosureturn Typ</i>)	4.9 (0.12)	3.6 (1.12)	79.0 (7.01)	223.2 (53.50)	7.0 (2.07)	19.4 (2.70)	5

TABLE 4—Sub-types or variants within the dry grassland group

<i>Lolium perenne</i>		
<i>Poa annua</i>	Pasture	
<i>Veronica serpyllifolia</i>	Variant	
<i>Sagina procumbens</i>		
<i>Plantago major</i>		
2. <i>Rhinanthus minor</i>		
<i>Crepis capillaris</i>		
<i>Chrysanthemum leucanthemum</i>	(Dry) Meadow	
<i>Heracleum sphondylium</i>	Variant	
<i>Euphrasia officinalis</i> agg.		
<i>Veronica chamaedrys</i>		
3. <i>Sieglingia decumbens</i>		Heathy Variant
<i>Galium saxatile</i>		
4. <i>Juncus effusus</i>		Moist Variant
<i>Carex oralis</i>		
<i>Juncus articulatus</i>		

Four local patches of limestone occur in the survey area and stands of dry grassland are common at each. These patches are situated near Killybegs, Glencolumbkille, Portnoo and Maas respectively. Likewise local areas of well drained brown earth and brown podzolic soils occur on mixed glacial drift overlying the limestone at these places. The best stands of grassland in the survey area are those on the limestone at Portnoo. *Lolium perenne* (perennial ryegrass) is locally common here.

Two stands of the heathy variant (Table 4) were found on shallow, well drained peat. All stands of the moist variant were on humic gley soils or deep, reclaimed peats. Poaching was rare and confined to the moist variant.

The distribution of the dry grasslands roughly corresponds with the areas of lowest rainfall in the survey area. The coastal lowlands have an annual rainfall of 40 to 50 in. (1,000 to 1,250 mm) and probably have the most sunshine also.

Hedge species

The dry grassland fields are usually surrounded by stone walls or low ditches carrying poorly growing hedges of *Ulex europaeus* (gorse) and *Crataegus monogyna* (hawthorn). The prevalence of stone walls is usually indicative of shallow stony soils nearby. Where pasture management is poor the hedge plants encroach on the field, stifling the grassland species. The bracken fern, *Pteridium aquilinum*, is often a troublesome weed in this respect.

Management

The manner in which the dry grasslands are used is best illustrated by the land-use breakdown of the 23 stands studied in detail: old pasture, 13; old meadow, 9; new pasture, nil; new meadow, 1.

By comparison with the vast expanses of wet peats the area of dry soils is so small that they are used fairly intensively. However, little or no artificial fertilisers are

applied, main dependence being on farmyard manure. This is laboriously carted out and spread by hand in spring or autumn. Pastures have a characteristic mosaic of ungrazed and heavily grazed patches.

The dry meadows are usually mown about the middle of July. Most grasses have become fully mature by this time and the usual growth height is about 15 inches (37 cm). The sward is composed mainly of the flower stems of *Anthoxanthum odoratum* (sweet vernal grass), *Holcus lanatus* (Yorkshire fog) and *Agrostis tenuis* (bent-grass). This herbage has a high dry matter content and can be made into hay with a minimum of drying, but its feed value is inferior.

LIME AND NUTRIENT STATUS OF SOILS AT GRASSLAND STANDS

Soil samples collected at each stand during the field survey were analysed for pH, phosphorus, potassium, magnesium, manganese and carbon (Table 3). The results were grouped according to mineral and peat soils. Soils with a carbon content greater than 12% were regarded as peats. It is necessary to distinguish between mineral soils and peats as the extractant used in the analyses removes more of certain elements from the latter. Allowing for this, there is little difference in lime and nutrient status of the soils throughout the grasslands of the area; the general status reflects the inattention to liming and manuring.

COASTAL GRASSLANDS ON STABILISED DUNES

The survey region has a long, strongly indented coastline. In general there is a narrow coastal lowland which extends inland here and there. This coastal strip has many bays and inlets, the two largest being Gweebarra Bay and Loughros More Bay. Sand-dunes are mainly confined to the more sheltered parts of these bays.

The more recent dunes (those nearest the sea) are mainly dominated by marram grass, *Ammophila arenaria*. The older, more stabilised dunes are usually devoid of this grass and have a complete vegetation cover, a high percentage of which comprises the legume, *Lotus corniculatus* (bird's-foot trefoil). Many of the introduced species here are grassland plants such as *Poa pratensis* (smooth stalked meadow-grass), *Festuca pratensis* (meadow fescue) and *Trifolium repens* (white clover). Grazing by cattle has been mainly responsible for the entry of these species.

The soil survey has shown (Part I) that sand dunes cover approximately 1,040 sq km (2,622 acres) or 1 % of the survey area. As they offer shelter and dry lying-out conditions many dune areas are used as year-round cattle grazings. There is no information on the pasture dry matter output per acre on these dunes but it is undoubtedly low since grasses form such a small percentage of the total cover.

The nitrogen and potassium levels in these sandy soils are characteristically low, 0.1% and 36 ppm respectively. However, they are neutral to highly calcareous and the magnesium content is high. These soils also give very high soil test values for phosphorus (12-16 ppm), due to the high content of shell fragments rich in calcium-phosphate. The content of organic matter is low (1 to 2% org.C in the surface 10 cm).

SUMMARY

1. The grasslands of the survey area belong to two main types which have been given the general names of 'wet grassland' and 'dry grassland'.
2. The two grassland types differ in their floristic composition. The wet grasslands

- have a predominance of rush and sedge species and particularly dominant is *Juncus acutiflorus* (jointed rush). The dry grasslands mainly lack moisture-loving species and instead are dominated by pasture grasses, clovers and plantains.
3. The two grassland types also differ in the ecology of their habitats. The wet grasslands occur on poorly drained peat and gley soils. The dry grasslands occur mainly on well drained Acid Brown Earths, Brown Podzolics and Regosols.
 4. The dry grasslands have a pronounced coastal distribution. The wet grasslands have a more inland distribution. Few grassland stands occur at altitudes over 400 feet (120m)O.D.
 5. The dry grasslands are used both for meadow and pasture. The wet grasslands are mostly in permanent meadow.
 6. Local areas of poor grassland also occur on stabilised dune sands. These are often dominated by *Lotus corniculatus* (bird's-foot trefoil).

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APPENDIX

THE INDIGENOUS VEGETATION OF THE PEATS

by

A. M. O'SULLIVAN AND S. VAN DER SCHAAF*

The survey area is in an 'organic zone' with peat formation widespread. Because of the manner in which peat covers both the slopes and the flat areas it is referred to as 'blanket peat'. Peat occurs with equal regularity on the granite and quartzite, these rocks are naturally low in plant nutrients. Bog plants have a very low nutrient requirement which is satisfied mainly by the dissolved salts in the rainfall. Most of them also grow successfully in strongly acid (pH 3 to 4) situations and under water-logged conditions. When they die their remains accumulate to form peat.

The present vegetation cover represents a biotic climax influenced by centuries of low intensity grazing coupled with occasional burning and erosion. The plant remains of which the peat is composed indicate a gradual fall over the centuries in the abundance of the bogmoss (*Sphagnum*) and bog cotton (*Eriophorum*) species. Plants which occur on most of the peats, whatever their depth and topographic situation, include *Calluna vulgaris* (ling heather), *Molinia caerulea* (purple moor-grass), *Eriophorum angustifolium* (bog cotton) and *Trichoptwrum caespitosum* (deer sedge). The red bogmoss (*Sphagnum rubellum*) is one of the most common and abundant mosses.

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Typically common species of the deep, wet, lowland peats are *Schoenus nigricans* (black bog rush), *Myrica gale* (bog myrtle) and *Ryncospora alba* (white-beaked sedge). However, the most usual dominant species on all the deep and moderately deep peats is *Molinia*. The shallower and drier peats of the hill slopes are typically dominated by *Calluna* while *Juncus squarrosus* (heath rush) and *Erica cinerea* (bell heather) may also be locally abundant. The high level blanket bogs are usually also Ctf/w/73-dominant. Species peculiar to these upland bogs include *Empetrum nigrum* (crowberry) and *Vaccinium myrtillus* (bilberry).

A detailed account of the botanical composition, distribution and ecology of the peat vegetation will be published by Mr. van der Schaaf.

FORESTRY*

INTRODUCTION

State Forestry plantations in Glenties Rural District were commenced in 1953, and by September, 1968 a total of 4,909 acres had been planted and 454 acres were in preparation for planting during the following season. There were 321 acres reserve of plantable land in hand and negotiations were at various stages for a further 1,000 acres of suitable land.

Co-operative private enterprise planting has been carried out on 59 acres near Ardara since 1958. There are a few older small stands of timber in the area; these are mostly hardwoods.

SOILS AND CLIMATE

Of the 263,050 acres in the Glenties Rural District, organic soils, mostly unreclaimed, wet peats, occupy roughly 63% according to the soil survey findings reported in the 'Soils' section (Part I). Mineral soils, many of heavy texture and poor natural drainage, represent roughly 13% of the area and organic-mineral soil complexes a further 22%. Bedrock outcrop and associated shallow soils are a distinct feature of many parts. In terms of soil suitability for forestry, some 3% of the soils would be generally suitable, a further 4% would be moderately suitable and, discounting the sand dunes and lakes (3%), the remaining 90% would be generally unsuitable. Even where soils are suitable however, other environmental factors, principally exposure, may militate against successful forestry. The vast majority of the soils of the region are very infertile by nature. Apart from their physical shortcomings, gross shortages of lime and of both major and minor nutrients are widespread, *e.g.*, over 90% of the soils have very low levels of phosphorus.

As has been shown in the 'Climate' section (Part I), rainfall is high and frequent by national standards so that only the more permeable soils can cope with the excess of precipitation over evapotranspiration. The chief limiting factor in the environment, however, is exposure to winds, which occur throughout the year and are of considerable force at times. The prevailing winds are from the south and west; these are mild and moist. The occasional northerly winds have an intense chilling or 'blasting' effect, particularly on young plantations. Frosts, though not severe, are liable to occur in most months and spring frost damage is apparent in young plantations in some valleys north-east of Glenties.

Mostly because of soils and climate then, lands suitable for forestry tend to lie below 500 feet elevation; the limit falls to 100 feet near the west coast, but rises to 1,000 feet on a few well-protected east-facing slopes. On the open rocky plains north of Ardara, and around Dunglow a combination of wet raw peat and exposure limits

•Submitted by Forestry Division, Department of Lands.

TABLE 1—Yield (Hoppus cubic ft /acre) according to site rating

Site class	Species	Vol at 30 years		Vol at 50 years	
1	Sitka Spruce	2,110	(3,895) ¹	4,415	(8,485)
2	» >>	1,575	(2,800)	3,620	(6,705)
3	n »»	1,105	(1,820)	2,775	(4,915)
4	Pinus Contorta	1,700	(2,500)	—	—
5	m >>	1,000	(1,000)	—	—

¹Figures in brackets are for total yield including thinnings.

tree growth to small plots of reclaimed land. To the west of a line from Ardara to Killybegs, a horseshoe-shaped mountain barrier formed by Slieve Tooley and the crests of Crocknapeast, Crownarad, and Slieve League contains the Carrick district. In this area the peat is badly eroded and wind-blasted vegetation indicates severe exposure except in the most sheltered valleys. The locality north of Killybegs as far as Mulmosog Mountain and Carrickatlieve, the hill slopes east of Ardara and the valleys east and north from Glenties benefit from mountain shelter and these regions contain the most likely areas for future expansion of forestry.

SPECIES AND SITE QUALITY

So far in this region only two species of trees have been found suitable for extensive planting: Sitka spruce and a vigorous strain of *Pinus contorta*. However, Japanese and hybrid larch, *Abies procera (nobilis)*, Norway spruce, and Corsican pine can be used in limited favourable sites.

Assessment of the possibilities for forestry development in the region is based on the rate of height growth on the 2,876 acres planted between 1953 and 1961. These measurements were compared with age/height graphs derived from those of the British Forestry Commission¹ in the case of Sitka spruce and from the Provisional Yield Tables² compiled in Ireland for *Pinus contorta* (coastal).

From the measurements a five-stage scale of growth potential was prepared. This scale was applied by ocular estimation to all lands considered capable of growing stands of trees within the region (see accompanying map). For purposes of comparative study agricultural lands were included but lands where it was thought that severe exposure would give low-growing seasonal crops a special advantage over trees were omitted. As the effects of exposure on older plantations cannot be accurately assessed the potential productivities indicated are tentative.

Yield estimates expressed as standing volume and (in brackets) as total production including thinnings are shown in Table 1. In site classes 1, 2 and 3 output is quoted in terms of Sitka spruce at 30 years of age for pulpwood and 50 years for timber; these classes correspond with Yield Classes 200, 160 and 120 respectively of the Forest Management Tables. Yield Class may be defined in a simplified way as the maximum mean annual volume increment (expressed as Hoppus cubic feet per acre) of a planta-

¹"Forest Management Tables" British Forestry Commission Booklet No. 16, H.M.S.O., London, 1966.

²Joyce, P. M. and Gallagher, G. Provisional Yield Tables for *Pinus contorta* (coastal) in Ireland. Research Record No. 2. Govt. Publ. Office, Dublin, 1966.

tion irrespective of the age at which this culminates. In site classes 4 and 5 output is quoted in terms of *Pinus contorta* at 30 years of age for pulpwood; the health and increment of this species, in later years under adverse conditions, is still uncertain. The yield figures given in Table 1 correspond with Growth Classes II and III of the provisional Yield Tables of Joyce and Gallagher.

In all cases a 15% reduction in the yield estimate was allowed for unplanted areas such as roads and unstocked margins and since class 5 sites were found to have considerable rock outcrop and patches of rough unplantable peat, the allowance was increased to 30% for this type.

FORESTRY POTENTIAL IN THE AREA

A survey of existing State Forest plantations in the Glenties area revealed an approximate percentage distribution down the scale from class 1 to class 5 of 3:8:27 : 55:7. Classes 3 and 4 together make up 82% of the existing plantations. It is clear that little of class 1 land is likely to become available for future planting as only 2.3% of the total survey area falls into this class (Table 2).

TABLE 2—Acreage of the Glenties Rural District mapped in each site class

Site class	...	1	2	3	4	5	Unsuitable
Acres.	. . . . .	6,000	5,800	11,100	24,100	3,000	213,050

On all class 3 and on some class 4 sites, either Sitka spruce or *Pinus contorta* may be chosen for planting. A vigorous crop of pine, (Growth Class 1 of the Provisional Yield Table), may be expected to be of rough quality, so spruce has been chosen in preference where conditions allow. Spruce and pine have been mixed on some class 4 sites, with a view to producing a useful pulp crop yielding greater volume than spruce alone. It may be possible in future with additional fertiliser application to use a higher proportion of Sitka spruce.

All lands planted required intensive preparation by drainage, ploughing (or digging of mounds where ploughing was not possible) and application of fertiliser at the time of planting. The techniques used have been undergoing modification in recent years; in making the site assessments the most up-to-date methods of preparation and treatment were taken into account. These include the use of appropriate strains of *Pinus contorta* and additional manuring with ground mineral phosphate after some years of growth.

In class 4 and class 5 plantations, thinning is likely to cost more than it would be worth. Here the trees will probably be grown to an early maturity and harvested on a total yield basis, in so far as this proves practical. The yields should approximate to those presented (in brackets) in Table 1. Acquisition of class 5 sites will be limited to such areas as may be acquired in conjunction with lands of higher quality; there will be no planned policy of acquiring substantial areas of this class.

As far as possible, classes 1, 2 and 3 are likely to be tended as timber-producing areas with a rotation between 50 and 70 years. However, where these sites occur only as patches throughout an extensive area of pulpwood plantations which would be felled at an earlier age, then the shorter pulpwood rotation would probably apply throughout. Also if hurricane force winds, such as the great storm of September, 1961

were to occur more frequently than the climatic records suggest, shorter rotations would be necessary in order to reduce windblow risks.

The resources of available plantable land are unlikely to support any substantial timber industry within the area itself. However, industrial use of forest products must be considered in a wider geographical context, and it is reasonable to assume that markets will be available for such timber as can be produced. It is possible, too, that a local demand for fish boxes and other outlets may develop for which local timber could be used.

Employment has varied with the supply of land for planting and in September, 1966 there were 60 workers in the State plantations.

Shelter belts

Provision of shelter from wind is of great importance in this region. With belts of trees and shrubs the aim should be to provide fairly permeable screens which would reduce the wind force, without creating serious air turbulence. The shelter belt would need to have a long effective life.

Donegal Co. Council have been promoting farm planting for many years, mainly of belts of Sitka spruce and *Pinus contorta*. Buildings and yards have been protected to an encouraging extent, but relatively few farmers appear to have attempted to provide field shelter, or to have joined with neighbours in co-ordinated planting to benefit groups of holdings.

Spruce and pine give quick shelter but within 20 years they are liable to blow-over. It might be advisable to cut the tops when they reach a useful height - 20 to 30 feet over most of the district and as low as 12 feet in the most exposed places. In exposed localities farm trees should be trained and pruned to provide shelter rather than to produce timber. Planting of groves of trees and shrubs for animal refuge might also be considered as an improvement measure on some of the open hill grazings.

LIVESTOCK FARMING

by
V. E. VIAL*

INTRODUCTION

With few exceptions, the farms in the area of West Donegal covered by the survey are not farmed in the usual sense of the word. Holdings on the pockets of mineral soils between the peats and the rock outcrops are quite intensively farmed, but few of these holdings are large enough to yield a worthwhile income from fulltime farming. For the most part the land is not intensively farmed and very often is devoted to communal rough grazing mostly for sheep. As has been shown in Part I of this Resource Survey Report the soils here are generally of very inferior quality. On these vast tracts of marginal grazing lands with their poor, natural swards the output is very low and of poor quality.

Surveys of a random sample of 249 farms in the course of the Resource Survey in 1965-66 and of the farms of 15 townlands in and around Glencolumbkille in 1965 provided a good indication of the general pattern of farming. The majority of the small holdings consist of about 20 acres adjacent to the dwelling, and sub-divided into 2-3 fields, together with the grazing rights of a nearby bog or mountain. Typically, a section of the in-bye 'greenland' has been drained either with a network of open ditches, or by covered drains consisting of a layer of stones 6 inches thick covered to a depth of one foot with the peaty soil. Around this 20-acre block the annual 1/2-acre patch of potatoes is rotated. This is the most widely grown tillage crop in the area but only 9% of the farms grow more than one acre. Since the potato patch is seldom fenced, it means that the surrounding area of the field in ley - usually an unfertilised association of grasses, sedges and rushes - will not be grazed. This is generally cut for hay in late Summer and left in cocks for several weeks. Then it is carted off to be stored in a barn or stack close to the dwelling. More than half (58.5%) of the 249 holdings surveyed grew between 1/2 and 1 acre of oats.

The fields not devoted to tillage and meadowing are used to graze two or three cows and a few smaller cattle. Large bullocks are almost entirely absent. About one-fifth of the holdings keep an ass. Sheep are confined for most part to the hill and bog grazings.

Very often the hay is still mown by scythe and manure spread by ass and cart and by hand. The nature of the terrain and the open drains in the 'greenland' are not conducive to mechanised activities; neither would the size of enterprise and level of farm income in so many cases warrant the use of machinery (See Part III - Economic Structure of Agriculture).

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SHEEP AND CATTLE PRODUCTION

The main livestock enterprises in the survey area are sheep and cattle production. The sheep enterprise operates at very low efficiency. Scottish Blackface rams, usually leased to the farmers and mostly of high quality with good potential for growth and wool, are put out in November-December to mate with the Blackface ewes. Very few of these ewes are given flushing feed on the 'greenland', and the feet of neither ewes nor rams are attended to prior to mating. Raddling of the sires is not generally practiced.

On some holdings, the ewes are mustered off the commonage in January and given hay till lambing, but very few farmers provide grain supplements with the hay. Along the coastline, the 'greenland' is often so exposed to western gales, that it is questionable whether any reduction occurs in lamb losses by removing the sheep to this land. On the upland peats, rocky outcrops often provide shelter which is so vital in the early days of a lamb's life.

Lambing rate is 80-90% but survival rate is very poor, despite the late lambing date. It is common to hear of flocks which, by the following Christmas, have insufficient ewe lambs to maintain flock numbers. This in turn results in ewes of 7 and 8 years of age being kept when they are so debilitated that they frequently lamb only every second year and seldom have twins. These also lower the average wool clip to the present 3 lb per head.

Although there were 29,356 breeding sheep recorded in the survey area in 1965 (Agric. Enumeration, C.S.O.) the average flock size is small. On the 249 farms in the random sample of this survey the average for holdings with sheep was slightly less than 30 breeding ewes whilst in the survey of all farms in 15 townlands of Glencolumbkille the average size of breeding flock was 24.

Cattle in the area are mainly Aberdeen Angus or crossbreds of Aberdeen Angus-Shorthorn or Hereford-Shorthorn. Total cattle in the survey area in 1965 numbered 17,141 (Agric. Enumeration, C.S.O.) of which 6,654 were cows and heifers-in-calf, 5,028 young cattle under 1-year-old, 3,262 under 2-years-old, 2,171 over 2-years-old and the remainder were bulls. However, on the random sample of 249 farms in the Resource Survey the average for total livestock units of cattle was only 3.3 on the under 30-acre farms, 5.4 on the 30 to 50-acre farms, 5.9 on the 50 to 103-acre farms and 6.5 on the over 100-acre farms. The average herd for all-size farms was approximately 5.0 livestock units¹ composed of 2 to 3 cows and the remainder mainly calves and cattle under 2-years-old.

As will be seen from the following section on nutrition most of the conserved fodder is fed to the cattle and very little to sheep. The relative economic efficiency of both sheep and cattle is discussed in Part III - Economic Structure of Agriculture. The local marketing system for sheep and cattle is examined in Part III - Marketing. The main sources of income from sheep are from the sale of (a) wethers as 2-year-olds (or older in very poor and exposed areas), as 1-year-olds and as wether lambs (in the more fertile areas); (b) wool - average ewe fleece of 3 lb but up to 5 lb on non-lactating ewes and on wethers; (c) a very small number of farmers sometimes sell 2-year-old ewes for breeding in "flying flocks" in lowland areas. As shown in Part III, the average sheep enterprise in the area is so inefficient that returns are very low and almost half of the income per flock is derived from the sale of wool. Cattle are sold mainly as calves and yearlings. Marketing of either sheep or cattle is not well organised.

¹livestock unit is defined as the "average" 10£ cwt cow or its equivalent in other stock (See E. A. Attwood and J. F. Heavey, *Ir. J. agric. Res* 3, 249, 1964).

PIG AND POULTRY PRODUCTION

One might imagine that with the scarcity of good soils there would be a concentration on farmyard enterprises such as pigs and poultry in the Survey Area. This is not the case, however.

There are very few pigs throughout the area although recently some have been introduced into Glencolumbkille district. According to the C.S.O. Agricultural Enumeration, there were 135 pigs in the survey area in 1965 and only 61 in 1960. Most of the farmers in the random 249 farms surveyed kept no pigs.

Some of the reasons for the small number of pigs are as follows:

- (a) The high cost of feedstuffs in West Donegal. Table I shows the large regional variation in local price per cwt of feedstuffs and it must be borne in mind that there would be additional costs from Letterkenny (the closest centre quoted in Table 1) to the far west of the survey area. On these prices, a farmer in Mallow can feed the litters of 5 sows to bacon weight for £125 less than his counterpart in Letterkenny.
- (b) The decline in locally grown feed. The potato acreage has declined drastically in the survey area over the past 20 years and so has cereal cropping which is reduced to some 800 acres of oats. There is a small acreage of green crops but there is really no alternative source of energy feed to replace the potato. Furthermore, there is no regular supply of alternative feedstuffs such as hotel swill.
- (c) The lack of suitable housing for either rearing or fattening pigs. There are scarcely any piggeries of acceptable standard apart from some "pilot" ones recently erected in the Glencolumbkille area. Without cereal growing there is no real source of bedding which might improve matters in the existing stone pigsties.
- (d) The lack of a bacon factory in the survey area. Letterkenny is the nearest and there would be very high costs associated with the transport of small, irregular lots of finished pigs.

TABLE 1—Retail prices of animal feedstuffs (shillings/pence per cwt) at various centres

	Letterkenny	Mallow	Kilkenny	Macroom
Ground barley.	36/3	29/-	32/-	32/6
Soyabean meal.	50/-	48/-	50/-	52/6
Pig fattening meal.	39/-	34/-	35/6	35/9
Sow and weaner meal.	41/-	36/-	39/-	37/9

Source: Department of Agriculture and Fisheries, December 1968.

Poultry, once kept in much larger numbers in the area, has declined rapidly in recent years - from a total of 126,661 in 1949 to 51,572 in 1965 (Agric. Enumeration, C.S.O.). The produce is mostly for local consumption.

FARM BUILDINGS²

Farm buildings, in a specialised sense, scarcely exist in the survey area. A limited number of cowhouses have been built under the Farm Buildings Scheme but most of the buildings on farms are conversions of obsolete or abandoned dwellings. Very few farms have Dutch barns for hay or any type of silo. Cattle, when housed, are tied up for 150-160 days and dried bracken is the most customary bedding material.

In the townlands around Glencolumbkille there is one communal dipping bath for sheep, erected with the help of a grant from the Department of Agriculture. There is no shearing shed equipped with a slatted floor for penning sheep overnight, and very few farms have anything but the most rudimentary facilities for working with sheep.

Except for a small number of new houses recently erected in the Glencolumbkille area under a special scheme, pig housing is non-existent.

Few farms have water laid on for farmyard uses. No system peculiar to the area has been evolved for the construction of farm roads and access to commonage is in most cases by bog roads laid down for the haulage of turf.

²This section has been contributed by P. Tuite, Farm Buildings Department, Rural Economy Division, An Foras Taliintais.

ANIMAL FEEDING

by

R. B. MCCARRICK*

INTRODUCTION

Information on livestock and feed resources in the West Donegal area was collected in the course of a survey of 249 farms, by the Rural Economy Division in 1965-1966. Three farms kept sheep as the sole livestock enterprise, 121 kept cattle only and the remaining 125 kept both cattle and sheep. Within districts, farms were categorised according to size, *viz.*, 0-30, 30-50, 50-100 and greater than 100 acres. A broad breakdown of land into three types, *viz.*, mountain, hill and lowland was made. Summary information from the survey is given in Table 1.

CATTLE FARMS

In general, the number of cows per farm did not vary much with size, land quality or district. All farms carried approximately two to four cows (Table 1). The bigger farms carried increased numbers of additional drystock. Potatoes, which average less than half an acre per farm, are used mainly for human consumption. About one-third of an acre per farm is devoted to oats (Table 1) and the hay crop is the main home produced source of winter keep for cattle. The acreage devoted to hay varies from a mean of 2.4 acres on the under 30-acre farms to a mean of 9.6 acres on the over 100-acre farms but the average for all farms is 3.3 acres (Table 1).

Hay quality in general is poor but similar in feeding value to that analysed by Sheehan *et al* (1) on poorly managed swards in Mayo, by Wilson *et al* in Meath (2) and by McCarrick (3, 4) for various farming systems throughout Ireland. Analyses of some 250 samples of hay, taken at random in the area, showed a crude protein range from 5 to 15.5% in the dry matter with a mean value around 9%. This hay would have a starch equivalent value of approximately 37 on a dry matter basis. As most of the hay comes from old meadows and is harvested late in the season the digestibility is low.

The mainstay of the winter feed is hay of inferior quality. The other sources are the produce of the limited acreage of oats and some purchased feed. Almost all of the purchased feed consists of concentrates, the average purchased per farm is 11.9 cwt per annum (Table 1). On the average farm in the area with a dry matter yield of 35

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cwt of hay and 25 cwt of oats per acre, the winter feed reserves for livestock would be as follows (lb starch equivalent):

3.3 acres of hay @ 35 cwt DM/acre @ 37 % starch equivalent		4,786
0.3 acres oats @25 cwt DM/acre @ 60% starch equivalent	=	504
11.9 cwt purchased concentrates (<i>a</i> 12% starch equivalent	=	960
		6,250

The cattle overwintered on the average farm represent approximately 5.4 livestock units (Table 1). Assuming a 150-day winter, available feed might be distributed as follows (lb starch equivalent):

Maintenance @ 7 lb starch equivalent/day/livestock unit	=	5,670
Balance for production (6,250—5,670)	=	580
	=	0.72 lb. per livestock unit/day
Expected liveweight gain (<i>a</i> 2.25 lb starch equivalent/lb gain	=	0.3 lb/day

The feed available, therefore, is sufficient for maintenance and small weight gains in the animals wintered. This level of feeding however would be less than adequate for pregnant cows or for cattle intended for sale at the end of a subsequent grazing season. It would be very much below the requirements for lactating cows or for dry-stock intended for sale during the first half of the following grazing season. If some cows are lactating during the winter or if some cattle are being prepared for sale early in the new season then it is likely that the remaining animals are seriously underfed.

For cattle intended for grazing during the subsequent summer the following minimum winter rates of liveweight gain (lb/day) would be desirable: dry pregnant cows, 0.75; cattle 1 year and older, 0.75; weanlings, 0.5. To obtain these liveweight gains an additional 3 lb barley or its equivalent per day would be required by cows and older cattle and 1 lb by the weanlings. To achieve these minimum growth rates an additional 19 cwt of barley equivalent would be required on the average farm each winter.

However, it is a doubtful economic proposition to keep dry cattle in these areas beyond the age of 1 year. Besides, it would be most desirable to sell dry cattle in the spring and early summer months. If this were to be achieved, a liveweight gain of 1.5 lb/day should be the winter target. The extra feed requirements to meet this target would involve feeding an additional 5 lb barley or its equivalent per day to weanlings and 9 lb extra per day to older cattle. This would mean an additional 59 cwt of barley equivalent per farm to obtain moderate fattening. Only a limited amount of feed is obtained from grazing by outwintered animals. An advantage of the improved winter feed programme would be to allow for considerable increases in stocking rates since animals would be sold at earlier ages.

CATTLE - SHEEP FARMS

Cattle populations on farms where sheep were also kept were almost identical in numbers and type according to farm size and land category (Table 2) as those already described for farms containing cattle only (Table 1). Winter feeds available were

TABLE 2—Livestock wintered and feeds available on farms carrying cattle and sheep in the survey area

Size category (acres)	No. of farms	Mean area of farms (acres)	Cattle on farms				Sheep on farms		Acreage under crops				Purchased feed		
			Cows	Under 1 year old	1-2 year old	Over 2 year old	No. of sheep	No. of lambs	Oats	Pota- toes	Hay	Other	Concen- trates (cwt)	Bulky feed (ton)	
S	Mountain														
	0- 30	18	19.1	2.3	2.2	0.8	0.4	23.9	10.5	0.3	0.4	3.6	—	12.3	0.4
	30- 50	14	42.7	3.1	2.4	1.5	0.3	35.3	15.5	0.3	0.3	4.1	—	21.9	0.1
	50-100	26	75.8	2.9	2.9	1.2	0.6	24.6	11.7	0.3	0.4	4.5	—	14.4	0.1
	100 plus	27	268.8	2.9	1.9	1.8	0.2	56.3	25.6	0.3	0.3	4.6	—	16.2	0.4
	All sizes	85	119.6	2.8	2.3	1.4	0.4	36.3	16.5	0.3	0.4	4.3	—	15.7	0.3
	Hill														
	0- 30	7	19.9	1.7	2.1	1.3	—	20.7	8.1	0.1	0.3	4.0	—	9.2	0.3
	30- 50	5	43.0	4.4	5.0	2.8	2.0	43.4	24.8	0.5	0.7	7.8	—	32.6	—
	50-100	5	80.9	2.6	2.6	1.6	0.8	23.6	18.8	0.2	0.7	6.2	—	20.0	0.1
	100 plus	5	156.5	3.0	3.6	2.0	1.6	28.2	16.2	0.2	0.3	4.8	—	9.6	—
	All sizes	22	70.0	2.8	3.2	1.9	1.0	28.2	16.2	0.3	0.4	5.5	—	17.0	0.1
	Lowland														
	0- 30	6	12.7	3.8	2.7	1.8	0.3	14.2	3.8	0.6	0.5	2.8	0.2	16.8	0.4
	All sizes	6	12.7	3.8	2.7	1.8	0.3	14.2	3.8	0.6	0.5	2.8	0.2	16.8	0.4
	All land types														
	0- 30	31	18.0	2.5	2.3	1.1	0.3	21.3	8.7	0.3	0.4	3.5	—	12.5	0.4
	30- 50	19	42.8	3.5	3.1	1.8	0.7	37.4	17.9	0.3	0.4	5.1	—	24.7	—
50-100	31	76.6	2.9	2.8	1.3	0.6	24.4	12.8	0.3	0.4	4.8	—	15.3	—	
100 plus	32	251.2	2.9	2.2	1.8	0.4	51.9	24.1	0.3	0.3	4.7	—	15.1	—	
All sizes	113	104.3	2.9	2.5	1.5	0.5	33.5	15.7	0.3	0.4	4.4	—	16.0	—	

evaluated as follows (lb starch equivalent):

4.4 acres of hay @ 35 cwt DM/acre @ 37% starch equivalent	6,382
0.3 acres of oats (a 25 cwt DM/acre @ 60% starch equivalent	504
16 cwt purchased concentrates @ 72% starch equivalent	1,290
	8,176

Assuming that all this feed supply is fed only to cattle over a 150-day winter the apportionment between maintenance and production might be as follows (lb starch equivalent):

Maintenance of 5.4 livestock units of cattle @ 7 lb starch equivalent/day/livestock unit	=	5,670
Balance for production	=	2,506
	=	3.1 per livestock unit/day
Expected liveweight gain @ 2.25 lb starch equivalent/lb gain	=	1.4 lb/day.

This level of winter nutrition is more than adequate for the minimum nutritional requirements of dry cattle including dry cows and is almost sufficient for moderate fattening of dry stock. If the sheep on these farms were fed from the same reserves, then the nutritional requirements of the total livestock would not be adequately satisfied. From the information available, the sheep in this area do not get supplementary winter feed in any form. Instead they are required to graze the hills during the winter. The quality and quantity of hill grazing is very poor and would be unlikely to satisfy even maintenance requirements of the animals.

The survey showed that winter mortality in ewes and hogget lambs in the area is very high; on average 13 and 33% respectively of the animals placed on the hill in the autumn of 1965 died (Table 3). Mortality rates were high on all farms and did not vary substantially with either size of farm or district in the survey area. Lambing percentage in surviving ewes was also low (approximately 85 lambs per 100 ewes). Weaning percentage at about 65 indicates high post-natal mortality in lambs. As a result of these losses farmers tend to sell only about 30 sheep per 100 ewes mated. The low fertility and heavy losses are most likely a direct result of the poor winter nutrition of the sheep. It is difficult to see how the level of nutrition can be improved

TABLE 3—Birth rates and post-natal mortality of sheep and cattle

Farm size category (acres)	Per 100 ewes mated		No. of sales	Per 100 sheep wintered		Per 100 cows wintered	
	Lambs born	Lambs weaned		Ewe deaths during winter	Hogget deaths during winter	Calves born	Calves died
0- 30	77.4	59.1	30.6	10.0	29.4	85.2	6.1
30- 50	89.4	67.0	31.6	8.6	39.2	82.8	5.1
50-100	90.3	69.3	28.9	15.5	34.3	79.3	2.7
100 plus	82.5	56.3	30.6	15.1	34.0	71.2	6.7
Mean	84.3	61.7	30.2	13.5	33.1	80.4	5.2

sufficiently if the ewes are left on the hills during winter. If over-wintered in the lowlands, adequate feeding could be provided from hay or silage or both together with some concentrates. Approximately 200 lb hay or 800 lb grass silage supplemented with 30 to 40 lb concentrates should provide adequately for a pregnant mountain-type ewe during a 100-day winter. To reduce the mortality in hoggets they could be overwintered on somewhat smaller quantities of hay or silage than the ewes and an additional 1 lb concentrates per day would probably provide a small liveweight gain (1 lb liveweight gain per week approximately).

By contrast with sheep, the fertility and mortality situation for cattle in the area is not so serious. Approximately 80 calves are born per 100 cows (Table 3) compared with 92 per 100 as average for the country. Calf deaths in the area are less than 5% which is slightly better than the average for the country.

SUMMARY

The two greatest limiting factors in livestock production in West Donegal are the extremely low stocking rates and the poor feed situation. In the latter instance the most serious shortfall is in winter and spring when supplies are grossly inadequate especially for the requirements of growing and lactating animals. To improve the standard of nutrition of the present very low stock numbers and to cater for much-needed intensification of stocking, grassland production must be increased and improved conservation practices for hay and silage introduced.

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ANIMAL HEALTH

by

B. J. G. KELLY* AND D. B. R. POOLE**

BACKGROUND

This report is based on field investigations by the local officers of the Department of Agriculture and Fisheries and the District Veterinary Office, Raphoe, into animal husbandry and disease problems in the area included in the Glencolumbkille hill-farming experiment, and on information obtained from veterinary surgeons and farmers in the broader area of the Glenties Rural District. It is backed by a limited amount of laboratory investigation undertaken by the Veterinary Research Laboratory of the Department of Agriculture and Fisheries and by the Field Investigations Department of An Foras Taluntais.

The main farming enterprises in the survey area are hill-sheep and cattle production. There are few pigs, with the exception of those recently introduced in the Glencolumbkille district. Poultry are kept for domestic and local supply.

The breeds of cattle kept, the average size and composition of herds and the standard of nutrition have been discussed in the two previous sections. Artificial insemination is widely used but there are still some licensed bulls. In the more exposed areas cattle are often housed for 6 months of the year and frequently the only winter feed is poor quality hay. Nevertheless the health of the cattle which are indigenous to the area appears to be no worse than the norm for the country. Parasitic diseases in conjunction with nutritional deficiencies are more significant than specific bacterial diseases.

There has been a general increase in sheep numbers in this area in recent years. However, the flock size is much too small in most cases to give a viable enterprise. In Glencolumbkille the range is from 10 to 300 sheep but 92% of the flocks have less than 100 breeding ewes. These figures would appear to be fairly typical for the survey area in general as shown by a flock size of about 30 quoted as average in the previous sections.

HEALTH AND MANAGEMENT OF SHEEP

For the maintenance of health and vitality in hill sheep, flock management and husbandry are so important that they are difficult to discuss apart. Specific diseases can be controlled by vaccination but parasitism, nutritional deficiencies and environmental hazards are the main causes of loss and constitute real problems in the economics of hill farming.

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Sheep in the area are almost exclusively of the Scottish Blackface breed. Attempts to introduce other breeds have met with success only in exceptional circumstances. Flock owners in general are satisfied with the Blackface breed and an improvement in strain without loss of hardiness or foraging ability is the general aim. Rams introduced through the Sheep Breeding Schemes of the Department of Agriculture and Fisheries and the County Committee of Agriculture, while possessing the necessary genetic qualities, are not sufficiently conditioned to the mountain environment. They require special attention during their first winter of service, a factor which is not sufficiently appreciated by the flock owners. Ewes are culled at about 7 years of age because of loss of vitality. Worn or broken teeth are not a problem. Losses from natural causes and culling due to infertility lessen the possibility of culling for quality improvement.

The overall lambing rate at around 80 to 90%, though low, is not as bad as might be expected considering the adverse conditions. The ewe/ram ratio is generally satisfactory, especially in the smaller flocks, and the co-operative use of rams is practised. The ram is often tethered or housed at night and run during the day on a trailing rope. Ewes are occasionally taken to the lowlands for tupping and this has the added advantage of a flushing effect on the ewes. Where the ewes are allowed free range, the fertility rate is lowered. Even daily gathering of the flock tends to increase the numbers of ewes tupped. Twin pregnancies are rare. Abortion is uncommon and is usually caused by rough handling, chasing by dogs or severe hardship. There are no specific diseases of reproduction recognised in the area.

Lambs are born from late March onwards. In a bad year many are weak and have difficulty in suckling or even standing. The ewe may be seriously under-nourished with resulting poor lactation, and her mothering instinct is poor under these conditions. Losses can be heavy where little is provided for extra nourishment and shelter.

In some cases the ewes are brought to the lowland for lambing, but hand feeding in late pregnancy and early lactation is practised only in exceptional cases. It is a common practice to bring weak ewes and lambs to the hay-stack for shelter and nourishment. Here sometimes supplementary bottle feeding is given to the lambs. After the first few days of life lambs normally are able to contend with the dangers of the terrain. From then on the main hazards are tick infestation and bad weather. The dry north or north-east wind, so welcome in other parts of the country in spring, is feared by the hill sheep farmers in this area not only for its effect on young lambs but also for the effect on the growth of grass which is badly needed by the lactating ewes. During the first two months of life many losses occur. Specific diseases play a secondary role to the combined effects of malnutrition and environmental hazards.

Lambs are weaned between late July and the end of August. Only from the more fertile areas are lambs sold in their first year. Sometimes they are kept on lowland grazing in autumn and winter, but on overstocked holdings they go back to the mountain or to rented winter grazing in sheltered inland areas or mild areas close to the sea.

Losses in lambs, wethers and ewes are heavy in this area mainly from the following causes, in order of importance:

a) *Drowning and other accidents*

Drowning occurs at small river crossings and in water holes which form naturally in the course of small riverlets on sloping peaty terrain and are often concealed by vegetation or by snow. Grey crows, which have increased considerably in numbers in recent years, cause mortality in young lambs already weakened or disabled by hard-

ship or disease and in ewes physically distressed by prolonged lambing or by becoming cast. This has increased the overall animal loss by an estimated 4 to 5 %. In coastal areas seagulls are as destructive as grey crows. Little attempt is made to control or eradicate the grey crows and the sheep carcasses are almost invariably left unburied and so provide carrion for these vermin. An intensive campaign against foxes was waged in south-west Donegal some years ago and the area was almost completely freed of this pest. With the relaxation of efforts, however, losses of young lambs have again been occurring in secluded areas in recent years and skeletal remains have been found around occupied fox earths.

b) *Malnutrition and weather hardship*

The latter part of winter and early spring is the period of greatest stress from malnutrition and even starvation. It is at this time that the hardness of these hill flocks is really tested.

c) *Internal parasites*

In combination with (b) internal parasites are accountable for most losses not only directly but also as predisposing factors to losses through drowning and other accidents.

d) *Bacterial and viral diseases*

These diseases cause relatively little direct loss compared with the foregoing factors.

SOME HEALTH PROBLEMS AFFECTING CATTLE AND SHEEP

Conditions which are especially associated with grazing, *i.e.*, parasitism and irregularities of mineral nutrition (either from deficiency or imbalance) are dealt with jointly for cattle and sheep.

Internal parasites

Liver fluke: With its high rainfall conditions the survey area is one of high fluke risk and wherever cattle or sheep are grazed fluke incidence appears to be universal. The disease in sheep is usually in its chronic form, mortality is never high but much unthriftiness and lack of vitality is caused; this is aggravated by the marginal nutritional status at which many flocks are maintained. Flock owners, in many cases, do not fully appreciate the importance of routine dosing. Intervals between dosing during the winter are too long and no attempt is made to attack the parasite at any other stage of its life cycle, either by grazing management or by strategic anthelmintic treatment. Ideally, sheep should be dosed in October and dosing repeated at monthly intervals until lambing.

This is the most important parasitic disease of cattle in the area. Nearly all cattle are affected sub-clinically on farms where clinical cases are occasionally observed. Routine dosing keeps the disease under some control but sometimes where treatment has been given only once or twice during the winter, laboratory tests confirmed the continued existence of the infection. Young cattle are not so severely affected, as these are kept mostly in the lowland areas and get the individual attention which is possible on the small holdings.

Any general programme of improved pasture output with increased stocking rates, particularly on peat soils, will almost certainly aggravate the liver fluke problem and may increase it to catastrophic proportions unless adequate precautions are taken.

Nematode parasites (gastro-intestinal roundworms): The absence of stock rotation on pasture and a wet, mild climate are ideal for a high level of internal parasitic infestation. When this is associated with low nutritional status, parasitic diseases are a constant threat to animal health.

Cattle throughout the area are affected to some degree, but principally the younger stock. Significant worm egg counts have been recorded in the older animals but in the absence of clinical symptoms, no treatment is given. This results in a further build-up of parasitic infection. The greatest economic loss results from unthriftiness and occasional scouring. Treatment, based on experience and good results, is often given routinely once or twice annually.

In sheep, this is a more serious problem in lowland flocks where grazing of fat lambs is more intensive, but quite heavy infestation can occur in hill flocks, especially in sheep under one year. Older sheep have a degree of immunity but this is liable to break down in the face of nutritional deficiency or other stress, as for example at lambing time. The usual species of roundworm have been found in this area, including *Nematodirus* species. When lambs are 6 weeks of age they and the ewes should be dosed.

The threat from roundworms is not as serious as that from liver fluke, although high mortality in wethers and hoggets can be encountered. Intercurrent infections of fluke and worms are common. While many remedies aim at combined treatment, separate medication and expert advice are really necessary. In general, each flock owner has evolved his own system of dosing, mainly by trial and error but this is often wasteful and many losses which are accepted as inevitable could be avoided.

Hoose: Lung worm infection is a serious problem in some regions where calf rearing is practised. Most calves are born in spring and put out on grass during their first summer. These pastures are used year after year and a carry-over of parasites occurs. Modern drugs and veterinary attention have helped in recent years to control this disease. The existence of lungworms in sheep from the area has been confirmed in the laboratory, but farmers are not generally aware of the condition.

External parasites

Tick infestation: Ticks (*Ixodes ricinus*) are mainly of importance because of the diseases which they transmit but heavy tick infestation *per se* causes severe irritation and anaemia in young lambs. Dipping of these lambs is difficult. In West Donegal, the rough and inaccessible terrain is ideal for tick survival and a permanent reservoir of infection remains in these insect vectors. As the ticks exist on many other species besides cattle and sheep, their complete eradication by dipping or spraying is not possible. However, with the use of long-acting dips a substantial reduction in the tick population of a hill-grazing flock can be achieved. Ticks have been observed on sheep in Donegal even throughout the winter. Following an intensive programme of dipping it is probable that most sheep would only become infested once or twice each year. The long tick-free intervals, however, can allow immunity to some of the tick borne virus diseases, notably 'louping ill', to wane. Thus, a marked reduction in ticks can be associated with an increased incidence of clinical louping ill.

Mineral deficiencies

Extensive soil analyses discussed in Part I of the Resource Survey Report, indicate the very low nutrient status of the great majority of soils of the area. The analytical results which are of particular relevance to animal nutrition are discussed here.

Major elements: More than 90% of the random soil samples were very low in phosphorus, to the point where aphosphorosis would be expected in grazing stock. Bog lameness in cows, with depraved appetite, due to phosphorus deficiency is still evident in some localities but with the wider use of phosphatic fertilisers, and the provision of mineral supplements in winter and early spring, the incidence of this has decreased in recent years, and the condition should disappear in due course.

Infertility due to the deficiency or imbalance of major elements is much less evident in recent years. Grass tetany in cattle is only rarely diagnosed. However, with an extended grazing season following the re-seeding of reclaimed areas and the greater use of fertilisers some increase in incidence would be expected. Current control measures would successfully combat this. Grass tetany has been recognised in ewes but appears to be rare. The possibility of calcium shortage in some of the hill pastures must be considered.

Trace elements: The peat soils, which account for about three-quarters of the total area, and certain of the mineral soils are low in trace elements such as cobalt, copper, manganese and molybdenum.

Cobalt deficiency in soils and herbage is known to be widespread in the survey area, but under present low-intensity farming, may be noticed only in a mild or sub-clinical form in livestock. With increased use of lime, the re-seeding of hill pastures and especially of heather pastures, together with increased stocking rate, cobalt deficiency could become a major problem, particularly in sheep.

At the present time, 'pine' due to cobalt deficiency, as distinct from unthriftiness due to malnutrition or parasitism, is encountered in some flocks particularly on commonage grazings. In certain instances 'affected areas' have been recognised traditionally and changing the flock, especially lambs, to a 'healthy' area is a strict practice. The change is one of the recognised advantages of wintering the young sheep away from the home farm, and in renting summer grazing in better areas. Pine occasionally develops in hitherto unaffected areas and causes considerable unthriftiness and even deaths before its existence is recognised. The complication with parasitism is not always easily detected. Treatment of sheep in the form of drenching is almost universal throughout the area but most farmers are not aware of the more effective and lasting result possible from top dressing of the sward with cobaltised superphosphate.

The incidence of ill-thrift in cattle attributable to cobalt deficiency is low, but in areas where pining in sheep is a problem it is reasonable to assume sub-clinical effects in calves. Cattle which have become unthrifty after a period spent on some of the offshore islands show immediate improvement on return to parts of the mainland. Cobalt deficiency is regarded as the main factor involved. As stated earlier in the case of sheep, intensification including improved pasture production, increased stocking rates, the extension of the grazing season and a greater reliance on home produced fodder, would tend to increase disorders of this type unless the necessary preventative measures are taken.

In a survey of blood copper levels in animals in Glencolumbkille, approximately 20% of the samples showed mild hypocupraemia. There is, however, little evidence of the effect on the performance of the sheep. Swayback has not so far been confirmed but its existence is suspected. Copper shortage may affect wool growth and quality. Induced copper deficiency in calves is unlikely to occur, as molybdenum levels especially in the peat soils have been shown to be very low. However, overliming of isolated heavy mineral soils in the area could lead to excessively high concentrations of molybdenum in pasture. In addition, on the calcareous sandy sea-board soils the

possibility exists of absolute copper shortage, concurrent with cobalt deficiency, occurring in cattle; however, cattle are not generally confined to these areas for long periods.

DISEASES AND OTHER CONDITIONS OF CATTLE

There are no specific cattle diseases of exceptional importance in the area. The incidence of those diseases under Department of Agriculture and Fisheries Control and Eradication Schemes is negligible.

A milk ring-test survey of *Brucellosis* was undertaken in 1964, and revealed a low incidence of the disease in the smaller herds in south west Donegal. In 1966 the Department of Agriculture and Fisheries Eradication Scheme was initiated in the county, and by 1968 the county became the first accredited area in the country. This means that cattle can go directly into accredited herds in Northern Ireland without further tests. It will also enhance the value of breeding stock from the area as replacements in other parts of Ireland during the further progress of the Scheme.

Louping ill is increasing in incidence in areas where the disease is prevalent in sheep. There is no effective vaccine against this disease in cattle. Mastitis occurs in isolated cases only. Hand milking, together with the very small herd size limits the spread of this disease.

Digestive upsets are often caused by faulty diet. Most calves are bucket fed and the usual difficulties associated with this type of rearing are found. The feeding of cold milk at long intervals appears to be associated with many of these problems. Digestive disorders occur in older cattle in late winter when they have been fed on poor quality hay. At this time losses occur from starvation but these are usually associated with parasitic diseases.

Most herds are affected by the 'three-day scour' approximately every 1 to 3 years. It usually causes only a temporary set-back. Acetonaemia is rarely seen, and the incidence of milk fever is very low compared to dairying areas in other parts of the country. Trichomoniasis, which had been frequently associated with infertility, appears to have been eradicated. Dysentery, due to coccidiosis is confined to certain regions and symptoms are so obvious that veterinary help is immediately requested.

Cattle introduced into the area or transferred over a considerable distance within the area, show acute symptoms of redwater. This is a good example of immunity in an indigenous cattle population. The extensive campaign against warble fly has almost completely eradicated this parasite from West Donegal. Lice are still a problem in the larger herds and cause further unthriftiness in animals which are affected by malnutrition or chronic diseases: this is not generally appreciated by herd owners.

DISEASES AND OTHER CONDITIONS OF SHEEP

Braxy is the most common bacterial disease in sheep in the area but losses are kept to a reasonable level by routine vaccination of all lambs in the autumn. Some deaths still occur despite vaccination or during the second winter of life, but as veterinary diagnosis is not sought the assessment of losses is difficult.

Pulpy kidney and lamb dysentery are significant only on a few of the better managed pastures. Single losses do occur elsewhere but only in the more productive areas is

vaccination considered economical. These diseases could become a greater problem as husbandry improves, and the wider use of vaccines, particularly multiple cover vaccines, would be necessary to combat them.

The most important tick-borne diseases affecting sheep in the area are louping ill and tick pyaemia. Louping ill appears to be widespread although some localities are free of it despite the presence of ticks. In other areas the strain of virus appears to be of high virulence. Vaccination of susceptible flocks is carried out at the same age as for braxy. Incidence is high in rams and other freshly introduced stock. Some indigenous flocks which show a higher incidence than normal need a second booster vaccination but this is not widely practised. Tick pyaemia outbreaks vary depending on weather conditions (especially wind) and the aspect of the hill grazing. The disease may cause serious losses; it is estimated that 5 to 7% of the lambs born in this area die of tick pyaemia. Recovered lambs are often stunted and unthrifty. No vaccination is available but better control is possible with improved husbandry and recently introduced dips. Some farmers have found early use of antibiotics to be effective.

Amongst the other conditions affecting sheep, photosensitisation during the bright sunny spells in June, resulting from the ingestion of certain plants, causes severe discomfort and even deaths from secondary infection. The incidence varies considerably between districts. In the worst areas 15% of the lambs may be affected and 1 to 2% of all deaths in lambs can be attributed to this cause. Orf is widespread but usually only 5 to 10% of any flock is affected. Considerable unthriftiness is caused and most farmers are unaware of available control measures by vaccination. They have found that the application of a copper sulphate solution or gammatox dip is an effective treatment.

Ophthalmia occurs sporadically. Most affected animals recover but temporary blindness caused by this condition predisposes sheep to accidents. Footrot is uncommon on rocky hill grazings but has been introduced on some holdings by an infected carrier and appears difficult to eradicate under prevailing conditions. Intestinal tapeworm infection receives little notice and no treatment is given. Copper sulphate is used in some regions as a general anthelmintic. Compared with other sheep farming areas the number of cases of gid or head staggers is small and confined to definite localities. No special treatment is given to dogs which harbour the adult stage of the tape worm which causes gid.

Dipping throughout the area is carried out three to four times annually to combat external parasites. The weatherproofing properties of the winter dips are of real benefit and act as an incentive to the regular and thorough dipping of the flocks. The sheep ked has been eradicated and sheep scab has not been seen in West Donegal for many years. In winter, lice are sometimes found on unthrifty sheep in a few localities. Maggot fly strike is controlled by residual action dips. One dipping shortly after shearing is generally sufficient for the blow-fly season.

A stress syndrome in newly-introduced rams is so commonly encountered and so consistent in its course as to merit description as a specific clinical entity. Rams reared on a high protein diet, steamed up for show purposes and then abruptly introduced to conditions of mountain hardship, within a short time begin to show a progressive series of symptoms which is almost irreversible. Special care which is required for these rams during their first winter in the mountain flock is rarely provided except by those who purchase their own rams either entirely or with the aid of the subsidy of the County Committee of Agriculture.

Pneumonia and chills also occur but these are amenable to treatment.

OTHER ANIMAL DISEASES

Pigs

Pig production, once an important contribution to the economy of the area, has for a long time been virtually ignored. Only in very recent times has any attempt been made to revive this industry. Disease incidence and health problems encountered so far in Glencolumbkille are no different to those to be expected in a controlled environment in any location.

Equities

Although horses and ponies are reducing in number all the time there are just over 200 left in the area. The decline in numbers has kept abreast of the rest of the country. Donkeys also have become scarce and are now used only for pack-loading or harrowing. Indiscriminate breeding has lowered the standard of conformation considerably but hardiness is still retained and there are no health problems.

Dogs

Treatment against tapeworms is given only on farms where the connection between gid in sheep and the final stage of the tapeworm in the dog is understood, or where dogs are obviously carrying some species of tapeworm. Virus diseases occur in sporadic outbreaks, and farmers with useful dogs are becoming more aware of the desirability of veterinary attention in the control and prevention of these and other diseases in the dog. The value of a well-bred and properly trained sheep dog in saving time and manpower and in the quiet efficiency of good shepherding is only rarely appreciated by farmers in the area.

SUMMARY

The most serious losses revealed in this investigation were those from malnutrition, particularly as a result of inadequate winter feed, and from accidents associated with the rough terrain. These two types of loss are closely connected. It is obvious that an improvement in winter nutrition will reduce losses from drowning and falling, from mismothering and lactation failure, from predators and intercurrent disease which would not affect the well-nourished animal to the same extent. On the other hand, a marked improvement in the general level of farming including regeneration of grazing land from heath to grass-clover swards, increased use of lime and fertilisers, fencing of hill areas and the increased stocking rate associated with such changes, would undoubtedly bring to the fore other problems which are not serious under present low-intensity farming conditions. Liver fluke and cobalt deficiency are foremost in this regard.

Experience with peat soils which have been reclaimed, re-seeded and heavily stocked has revealed the great dangers of widespread increases in liver fluke and any such developments in this area should be accompanied by fluke control measures. The demands on the already low levels of cobalt in the soil are greatly increased as pasture swards and stocking intensity are improved and the necessary preventative measures must be taken to combat this. In like manner, other trace element effects may increase, *e.g.*, swayback. Certain diseases will also assume more serious proportions if control measures do not keep pace with improving pasture and animal production *e.g.*, pulpy

kidney disease, grass tetany and parasitic gastro-enteritis (particularly in lambs). With the improved dips available adequate control of ecto-parasites is possible.

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TABLE 2—Number of men and boats engaged in sea fishing (1960-1966)—West Donegal Survey Area

	1960		1961		1962		1963		1964		1965		1966		1967		
	S ¹	P	S	P	S	P	S	P	S	P	S	P	S	P	S	P	
Number engaged in sea fishing	...	260	424	254	425	254	420	251	426	244	426	231	421	249	423	265	417
BOATS																	
<i>Motor vessels</i>																	
75-120 tons		1		1		1		1		2		2		3		6	
50-74 " "		6		6		6		6		6		7		B		8	
25-49 " "		22		21		22		22		20		16		17		15	
15-24 " "		3		3		2		2		2		2		2		3	
10-14 " "			1		1		2		2		2		2				
Under 10 tons		36	8	37	8	36	9	26	6	27	7	25	16	29	14	32	14
<i>Outboard engines, sails or oars</i>																	
Over 18 feet keel		47	36	46	40	46	42	48	49	48	49	47	48	48	35	46	34
Under 18 feet keel	...	1	13	4	13	1	13	1	12	1	12	1	12	1	11	1	14
Total boats	...	116	58	118	62	114	66	106	69	106	70	100	78	108	60	111	62

Source: Department of Agriculture and Fisheries.

^—Solely engaged. P—Partially engaged.

THE SEA-FISHING INDUSTRY*

INTRODUCTION

The Survey area embraces the stretch of coastline which extends from the village of Dunkineely in south-west Donegal to close by Bunbeg in north-west Donegal and includes a number of offshore islands, some of which are populated.

The coastline is rocky and exposed to the Atlantic and harbours with safe shelter for fishing craft are few. Altogether there are only four harbours where fishing craft over 40 feet may be accommodated and, of these, three are in use all the year round. Rising steeply out of the Atlantic between Killybegs and the prolific Rosbeg fishing grounds is Glen Head and the inability of a large number of the Killybegs fleet to round this headland during bad weather in the herring season, restricts somewhat the herring activities of this fleet. The south-western grounds, in the Sligo and Mayo areas, are more easily accessible in bad weather.

An advantage of this area is the absence of strong tides, which are prevalent on other coasts and which affect fishing operations at times, especially in places on the east coast.

Bottom conditions generally in Donegal Bay and Rosbeg Bay are muddy and most of the ground is workable by trawlers. There are, however, stretches of rough ground where these vessels cannot operate their gear in safety. These areas are an asset in another way as the fish shoals spawn on these rough bottoms thus providing the recurrent cycle where stocks are replenished close to the shore and kept fairly constant.

THE CHANGING PATTERN OF SEA-FISHING

Apart from the established ports of Killybegs and Burtonport, sea-fishing activities in the rest of the Glenties Rural District are mainly confined to part-timers, the bulk of whom are farmer-fishermen. Where farms are small and not in themselves capable of providing a livelihood a large proportion of the men on the coast turn to the sea to supply the additional income.

Seasonal fishing is pursued at all points along the rugged coast, often in hazardous conditions. The spring lobster season, the summer salmon season and again lobster fishing in the autumn, with winter herring fishing to a diminishing extent, provide an additional livelihood for some hundreds of part-time fishermen. Modern methods of herring fishing, such as mid-water trawling by larger vessels up to 75 feet in length, have superseded the traditional herring drifting using small craft. These mid-water vessels, in suitable weather, by using modern electronic location equipment, can land herrings in bulk. Fast discharge and easy access to piers at the larger herring ports are factors which have further influenced the change from the drift-netting methods.

*Submitted by Bord Iascaigh Mhara (Irish Sea Fisheries Board).

The smaller craft previously used often landed their catches at small piers, not easily accessible to lorries. Here also telephones were few and communication difficult. Markets are now available only at the larger ports where buyers can conveniently wait for the discharge of catches. The change has led to many of these part-timers forsaking their small boats altogether and joining the larger vessels as crewmen. Some of these men have now settled in the vicinity of the bigger ports and this trend continues. Besides, Killybegs and Burtonport have become the centres for many fishermen who prefer a full-time occupation. The centralization into growth centres has facilitated the provision of the shore facilities necessary to handle a growing fleet of modern craft.

Fishing methods have improved considerably in recent years. Modernised craft and up-to-date gear are now common, even in the more remote fishing areas. The days when crews had to row to and from the fishing grounds are gone. All the small craft are now engined; the outboard motor has proved a boon to the small fishermen. The more ambitious have modern engined craft ranging from 26 to 35 feet in length for pot fishing

The introduction of the larger vessels and the growth of white-fishing in the larger ports of Killybegs and Burtonport is of recent origin. Before World War Two, fishing as it is now was unknown in these ports. The seas around this coast were fished by trawlers from Fleetwood mainly and occasionally visiting boats from Arklow or Dingle spent a few months at a time on the grounds, using Killybegs as a base for operations. The traditional herring fishing, mainly pursued by drifters from Lowestoft, Buckie, Yarmouth and other British ports, had declined in the early 1930s and the few local fishermen who had large boats in Killybegs and Teelin went out of business. The fishing tradition in Killybegs declined and apart from a few smaller boats which carried on at lobster, line or herring fishing, there was nothing for the local fishermen but to seek berths on British trawlers working the Donegal grounds. The early 1940s saw the revival of Killybegs and Burtonport. Killybegs is now the premier fishing port in the country and when harbour works are completed at Burtonport it too will undoubtedly expand: the pier accommodation is very limited here at present.

SIZE OF INDUSTRY

The general size and value of the sea-fishing industry in the survey area is given in the previous section on "Fisheries". The number of men fully employed in fishing varies somewhat from year to year but is in the region of 300 whilst between 40 and 500 are occupied part-time. The industry is a sizeable source of direct employment which is of great value in an area such as this. Besides it provides considerable indirect employment in servicing operations such as processing and transport.

The total capital value of the boats of all sizes, numbering in the region of 200, is estimated at £686,000 of which £610,000 is invested in the larger (over 40 ft) boats. The capacity of the supporting facilities and installations on-shore is given in Table 1.

FUTURE POTENTIAL OF SEA-FISHING

There is a great future for fishing in the district. The major ports of Killybegs and Burtonport must continue to expand as more competent and experienced young men acquire their own craft. The future for both wholetime and part-time fishermen is promising. Salmon and lobster fishing have both become big business and this area is in the centre of the most lucrative salmon and shellfish grounds in the country. Bord

TABLE 1—Capacity of on-shore installations

Installation	Capacity
Fish meal factory - Killybegs	100 tons/day
One smoking plant - Killybegs	30 cwts/day
<i>Freezing and cold storage facilities</i>	
One in Killybegs ¹	40 ton store 8 ton freezing
One in Burtonport	20 ton store 3 ton freezing
<i>Ice-making plants</i>	
One in Killybegs	30 tons/day
One in Burtonport	2 tons/day
<i>Filleting plants</i>	
Three in Killybegs	15 tons/day
One in Dunkineely	—
<i>Curing stations (herrings)</i>	
Four in Killybegs	25,000 barrels
One in Dunkineelv	per season
One in Teelin	
Two in Burtonport	25,000 barrels
One in Kincasslagh	per season
<i>Boatyards</i>	
One in Killybegs	—
<i>Net factories</i>	
One in Killybegs	—

¹The smoking, freezing, cold storage and one filleting facility at Killybegs are combined in one factory.

lascaigh Mhara's Marine Credit Plan is geared to give financial aid to suitable experienced fishermen and technical advice is available to these men at all times.

As markets for fish are expanding, interest in both new and secondhand vessels is widespread. Exports of pelagic and demersal fish, salmon and shellfish, from this area have increased considerably in recent years and should continue to increase as production increases. Central depots, where catches can be marketed to the best advantage, are available at the major ports. The fishermen, by forming organisations in their own localities, can arrange transport to the central auctions, at reasonable cost.

With the increase in the fleet in this area, particularly at the main ports of Killybegs and Burtonport, investment in shore processing facilities and other ancillary industries is growing. Killybegs has been designated a major fishery growth centre based on an expanded harbour now under construction. Development of the facilities at Burtonport is planned to cater for a growing fleet. This in its turn will attract other investments as the potentialities are recognised.

OTHER SEASHORE ACTIVITIES

Some people who are not active fishermen take advantage of the abundance of periwinkles along the shores during periods of low tide when strands are exposed. The periwinkles are gathered, often by whole families, and 'screened' so that under-sized winkles are rejected. There is a regular trade through exporters to Continental markets.

Seaweed harvesting is another occupation which can be lucrative for families living near the coast. In the Rosses area a considerable amount of money is earned annually. The seaweed, common wrack, is collected along the shore, dried and transported to one of the processing factories in the West. Here it is converted into meal for animal feeding and a good export market exists. There is one of these factories in Bundoran and a second has recently been opened at Burtonport.

A more detailed account of local sea-fishing is given in the Appendix.

APPENDIX

DETAILS OF LOCAL SEA-FISHING

The Survey Area and its coastline features vary considerably from district to district and so does the way of life. Perhaps the most satisfactory way to examine the local scene *vis-a-vis* the sea-fishing industry is to consider each of the coastal parishes and their landing places in more detail starting with Dunkineely in the south-west.

Dunkineely

Fishermen:	12 part-time; 4 x 17ft punts
Catches:	Lobster, salmon, herring, mackerel
Sale points:	Salmon—Local Lobster—Dublin and local Herring and mackerel—Killybegs.
Landing facilities:	Nil.

St. John's Point

The peninsula stretches seawards between Dunkineely and Killybegs. The three main landing places used by the fishermen on this peninsula are:

(i) *Ballysaggart*

Fishermen:	9 part-time; 3 x 18 ft punts 3 x 12 ft punts
Catches:	Lobster, salmon, herring, mackerel
Sale points:	Salmon—Local Lobsters—Dublin Herring and mackerel—Killybegs
Landing facilities:	Slipway and stormwall.

(ii) *Ballyederland*

Fishermen:	9 part-time; 3 x 18ft punts 4 x 12 ft punts
Catches:	Lobster, salmon, herring, mackerel

Sale points: Salmon—Local
Lobsters—Dublin
Herring and mackerel—Killybegs
Landing facilities: Small pier and slipway.

(iii) *Castlesoutul*

Fishermen: 19 part-time; 2 x 26 ft yawls
3 18 ft punts
3 x 12 ft punts
Catches: Lobster, salmon, herring, mackerel
Sale points: Salmon—Local
Lobsters—Dublin
Herring and mackerel—Killybegs
Landing facilities: Pier; slipway; hand-operated winch
and boat storage area.

Bruckless

(i) *Bruckless*

Fishermen: 4 part-time; 2 x 17ft punts
Catches: Lobster, salmon
Sale points: Salmon—Local
Lobsters—Dublin
Landing facilities: Public pier and privately-owned slip.

(ii) *Ben roe*

Fishermen: 4 part-time; 2 x 17 ft punts
Catches: Lobster, salmon, herring
Sale points: Salmon—Local
Lobsters—Dublin
Herring—Killybegs
Landing facilities: Slipway.

Killybegs

The harbour

This is the major fishing port in Ireland. The town has a population of 1,100 which is increasing annually. It has a growing income (presently circa £5 million) from the fishing industry. It has a deep, well-protected harbour. Landing facilities consist of a concrete pier, constructed in 1952. It is over 300 ft in length, with a depth of water between 6 and 12 ft at low water. At present, this accommodation is taxed by a fleet of up to 30 modern trawlers. Half of these vessels are in excess of 50 gross tons. This fleet is manned by 190/200 full-time fishermen. At certain periods of the year this fleet may be augmented by up to a dozen vessels from other ports.

The harbour has been selected as one of five for development as a major fishing port under a Government scheme now being implemented. A new fitting-out pier has been completed and work is commencing on a new landing pier and fish handling area. An industrial area has been allocated by the County Plan. Most varieties of pelagic and demersal fish are landed by the local fleet and to a limited extent lobsters and crawfish as well.

This is a commercial harbour operated by a Board of Commissioners on behalf of the Minister for Transport and Power but is destined to come under the control of the Ministry for Agriculture and Fisheries under the Fishery Harbour Centres' Act 1968.

Shore facilities

Shore facilities at Killybegs include:

- (a) *Ice making plant*: This is owned and operated by B.I.M.* Capacity—30 tons cube ice per day.
- (b) *Fish processing factory*: This factory is owned by B.I.M. and leased to Killybegs Seafoods Ltd. Main activities include: filleting and freezing of demersal and pelagic fish for home and export markets; smoking of herrings and white fish; herring marinating and salting; processing and freezing of shellfish. A cold store attached to the factory has a holding capacity of 40 tons.
- (c) *Fish meal factory*: This can handle 100 tons of fish per day and is operated by the Irish Agricultural Wholesale Society (I.A.W.S.)
- (d) *Boat-building yard*: This modern boat yard, owned by B.I.M., employs 40 skilled male workers. Boats of 65 ft long have been built here and a new slipway and repair yard now completed will accommodate vessels of up to 90 ft overall length.
- (e) *Bridport Gundry (Ireland) Ltd.*: This is a subsidiary of the well-known firm of Bridport Gundry Ltd., Bridport, Dorset. Net making and repairing is the main business.
- (f) *Fimarex Ltd.*: This firm is operated by French interests for herring salting and marinating for export. Later on, the firm will process other varieties of fish.
- (g) *Donegal Co-operative Fisheries Ltd.*: Founded in 1963 following the withdrawal of B.I.M. from marketing activities, this co-operative has been trading very successfully. The majority of the local fishing skippers and crewmen are members and the main function of the co-operative is the marketing of members' catches, exporting, filleting, curing, *etc.* A ships' chandlery business has also been established. A new chill room with a holding capacity of 15 tons was recently installed adjacent to the pier. The co-operative operates its own transport. Recently, it has established a refrigerated container service for transporting fresh fish to markets in Britain and is planning the construction of new handling premises to cater for this trade which is expanding on an export group basis.
- (h) *Gallagher Bros.*: This firm, which has a branch in the Gaeltacht district of Teelin, has been engaged in the fish business for many years. A successful fish wholesale and retail business is carried on and the firm is also a substantial trader in salmon and shellfish. Filleting and smoking, freezing, salt-curing of demersal and pelagic fish are engaged in at their Killybegs premises. Here also there is a cold store with a capacity of 15 tons and a smoking plant. Two additional fish handling and processing firms are being established to handle demersal and pelagic fish.

*Bord Iascaigh Mhara.

Local employment

The following figures give an idea of shore employment resulting from fishing activities at the port.

B.I.M. boatyard	40 male workers
Donegal Co-operative Fisheries	30 male workers
I.A.W.S. fish meal factory	9 male workers
Killybegs Seafoods Ltd.	18 male workers
Bridport Gundry—this factory has just commenced operations	6 male and female
Fimarex Ltd.	25 male workers
Others	41 mostly male

Casual dockers also receive a share of the employment, as commercial shipping activities to and from the port include export of fish to the Continent and import of salt and barrels.

Small ports in the Killybegs area include:

(i) *Roshin*

Fishermen:	3 part-time; 1 x 16ft punt
Catches:	Lobsters
Sale point:	Dublin
Landing facilities:	Small stone quay.

(ii) *Portnacross*

Fishermen:	7 part-time; 3 x 17ft punts
Catches:	Lobster, salmon, herring
Sale points:	Salmon—Local Lobsters—Dublin
Landing facilities:	Slipway; hand-operated winch and lay-up yard.

Kilcar

(i) *Gortalia*

Fishermen:	15 part-time; 5 x 18 ft punts
Catches:	Lobster, salmon
Sale point:	Local
Landing facilities	Small pier, slipway and hand-operated winch.

(ii) *Towney*

Fishermen:	4 part-time; 2 x 16 ft punts
Catches:	Lobster, salmon
Sale points:	Salmon—Killybegs Lobsters—Burtonport
Landing facilities:	Small pier.
Shore facilities:	One private boat-builder with capacity for small unengined vessels.

(iii) *Muckross*

Fishermen:	4 part-time; 2 x 17 ft punts
Catches:	Lobster, salmon
Sale points:	Salmon—Killybegs Lobsters—Burtonport

Landing facilities: Pier.

(iv) *Cladnageragh*

Fishermen: 30 part-time; 6 X18 ft punts
Catches: Lobsters, salmon
Sale points: Salmon—Killybegs
Lobsters—Dublin
Landing facilities: Pier; slipway and good anchorage
for half-decked motor craft.
Shore facilities: There is a boatyard in the area.

Teelin

Teelin Harbour is a small protected inlet some seven miles west of Killybegs Harbour. The inner portion of the bay is shallow. The outer portion is deeper and has landing piers on both east and west shores. (The east pier is at Cladnageragh, already dealt with above). The deeper water landing place at Cladnageragh is now practically in disuse and the fishing fleet in the area is based on Teelin pier, on the better protected western shore. This pier, which dries out over most of its length, has 12 ft of water at low tide at the seaward end. (H.W.S.T.=23 ft; L.W.S.T. = 12 ft). It is exposed to south-westerly winds.

However, the pier is sometimes used by vessels of the Killybegs fleet. In the summer-time, white fish catches may be discharged and trucked to Killybegs and the vessels may berth for the night. It saves an hour's steaming each way to and from the fishing grounds and is a boon when boats are fishing 50 or 60 miles from Killybegs. During the herring season also many of the Killybegs vessels discharge their cargoes at the pier where there is a curing station.

Fishermen: 50 part-time; 2 x26 ft vessels
12 x 17ft punts
Catches: Lobster, salmon, herring
Sale points: Salmon—Local
Lobsters—Burtonport and Dublin.
Landing facilities: Pier and slipway but no public winch.
There is, however, a privately-owned winch in the boathouse near the slip.

A salmon auction during the season is conducted by Gael-Linn which purchased the fishing rights of Teelin Bay some years ago and most of the catches are sold here.

Glencolumbkille

There are four small landing places in the Glencolumbkille area,

(i) *Malinmore*

Fishermen: 6 part-time; 4 x 18 ft punts
Catches: Lobster, cod, pollack
Sale points: Dublin and Burtonport
Landing facilities: Slipway and hand operated winch.

(ii) *Malinbeg*

Fishermen: 15 part-time; 1 x24 ft yawl
4x18 ft punts

Catches: Lobster, herring, mackerel
Sale points: Lobsters—Dublin and Burtonport
Herrings and mackerel—Killybegs
Landing facilities: Small pier; slipway and hand-operated winch.

(iii) *Doonalt*

Fishermen: 6 part-time; 2x 17 ft punts
Catches: Lobster, crawfish
Sale points: Local and Dublin
Landing facilities: Slipway and hand-operated winch.

(iv) *Port*

Fishermen: 10 part-time; 4x 17 ft punts
Catches: Lobster, crawfish, salmon
Sale points: Local and Dublin
Landing facilities: Small pier, breakwater and winch.

Ardara

This area includes Loughros Point, Sandfield and Burkestown and is generally referred to as the Shanaghan area as fish are landed at this point.

Fishermen: 50 part-time; 10 x 18 ft punts
1 x 26 ft vessel
Catches: Salmon
Landing facilities: Nil.

Glenties

(i) *Portnoo*

Fishermen: 8 part-time; 4 x 18 ft punts
Catches: Lobsters
Sale points: Burtonport and Dublin
Landing facilities: Pier.

(ii) *Rosbeg*

Fishermen: 25 part-time; 2 x 26 ft vessels
8 x 18 ft punts.
Catches: Lobster, salmon
Sale points: Burtonport and Dublin.
Landing facilities: Small slip but no winch. A good anchorage for half-decked motor boats.
Shore facilities: Two private boatbuilders.

(iii) *Doochary*

Fishermen: 20 part-time; 8 x 16 ft punts
Catches: Salmon
Sale point: Burtonport
Landing facilities: Nil.

(iv) *Russell's Ferry* (including Lettermacaward)

Fishermen: 16 part-time; 6 x 17 ft punts.

Catches:	Salmon
Sale point:	Local
Landing facilities:	Small pier and stormwall.
Shore facilities:	One boatbuilder.

Burtonport

The harbour

Burtonport is a land-locked bay with narrow entrance channels which are protected by nearby Arranmore Island (population 1,200). The bay is very shallow—an approach channel was dredged there to give a depth of 6 ft (except at a rocky bar near the entrance) at low water. There is a depth of about 8 ft alongside the pier at low water (pier depth: 15 ft H.W.S.T.; 6 ft L.W.S.T.). A slip has been provided and oil and water supplies are laid on. A development scheme for the harbour is due to commence shortly.

Burtonport is a small village with a population of about 200. There are 32 full-time and 7 part-time fishermen engaged at the port. The fleet at present consists of four 56 ft boats, two 50 ft boats, two 26 ft motor boats and three 16 ft punts. Fishing activities include salmon, lobsters, herrings and white fish. Herrings, salmon and lobsters are auctioned at the port by the Burtonport Fishermen's Co-operative. White fish catches are generally sent to the Dublin Market through a link-up with the Killybegs transport but at times are auctioned at Killybegs or sold locally.

Burtonport is the ferry terminal for traffic to and from the nearby islands of Arranmore, Inishfree and Rutland.

Shore facilities

A factory established by the British firm of Marinpro Ltd., exports herring products to different countries, including U.S.A. Herrings are filleted and cured by a special process called "marinating" and are exported in barrels. A cold store is also attached to the factory. A small herring-curing station is also operated by Campbell and Doherty (The firm's main premises is at Kincasslagh). An ice-store has been provided by B.I.M. and ice supplies are drawn from Killybegs. The Burtonport Fishermen's Co-operative is planning the provision of fish-handling premises, ice plant and lobster tanks. A new ice-making plant and shellfish handling and processing facility has been completed by private enterprise in the port.

Burtonport is the centre of the largest deep-sea salmon fishery in the country and a large number of migratory workers return from Britain every year for this fishing. Although the season is short, perhaps of six weeks' duration in July and August, it has proved to be a very big factor in the economy of the district.

The following are some landing places associated with Burtonport:

(i) *Cloughglass*

Fishermen:	8 part-time; 8 X16 ft punts
Catches:	Lobsters
Sale point:	Burtonport
Landing facilities:	Small quay.

(ii) *Inishfree Island*

Fishermen:	25 part-time; 1 x28 ft vessel 11 X17 ft punts
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Catches: Lobster, herring, salmon
Sale point: Burtonport
Landing facilities: Pier and good anchorage.

(iii) *Arranmore Island*

(a) *Aphort*

Fishermen: 41 part-time; 3 x 16 ft punts
9 motor vessels up to 30 ft.

Catches: Lobster, salmon, herring

Sale point: Burtonport

Landing facilities: Pier and slipway.

(b) *Ballintra*

Fishermen: 24 part-time; 6 x 28 ft vessels

Catches: Salmon, lobster, herring

Sale point: Burtonport

Landing facilities: Pier.

Shore facilities: One boatbuilder.

(c) *Leabgarrow*

Fishermen: 36 part-time; 8 x 28 ft vessels
2 x 17 ft punts

Catches: Lobster, salmon, herring

Sale point: Burtonport

Landing facilities: Pier, slip and hand-operated winch

Shore facilities: One boatbuilder.

(d) *Poulawaddy*

Fishermen: 18 part-time; 3 x 22 ft yawls
3 motor boats up to 30 ft.

Catches: Lobster, salmon

Sale point: Burtonport

Landing facilities: Quay but no slipway or winch

Shore facilities: One boatbuilder.

Kincasslagh

Three landing places are associated with Kincasslagh:

(i) *Gortnasate*

This pier lies about a mile from the village of Kincasslagh which has a population of less than 100. The local fishermen operate two 50 ft motor boats mainly salmon drifting and seining for white fish but they fish from Killybegs most of the year. Landing facilities consist of a pier and two small slipways situated on the south-east corner of a deep bay which is exposed to northerly storms. The main pier has deep water alongside, maybe up to 15 ft at low water and is used commercially for importation of barrels, salt, *etc.*, and export of cured herrings. The pier and surrounds are government owned.

A fish curing station is operated by Messrs. Campbell and Doherty, local fish merchants.

(ii) *Owey Island*

Fishermen: 34 part-time: 4 x 30 ft vessels
1 X 24 ft yawl
12x10 ft curraghs

Catches: Lobster, salmon, herring
Sale point: Burtonport.
Landing facilities: Small pier; slipway and hand-operated winch.
Shore facilities: Two boatbuilders on the island.

(iii) *Carrickfin(including Mullaghduff)*

Fishermen: 6 part-time: 1 x24 ft yawl
17 ft punts
Catches: Lobster, crawfish
Sale point: Burtonport
Landing facilities: Nil
Shore facilities: There are two boatbuilders locally.