Soil Survey Bulletin No. 17

Soils of Co. Carlow

by

M. J. Conry and Pierce Ryan

National Soil Survey of Ireland

An Foras Taluntais

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FOREWORD

The programme of the National Soil Survey for determining the fundamental characteristics of Irish soils and for mapping their distribution was initiated shortly after An Foras Taliintais commenced activities in 1958. Its primary aim is to develop an inventory of our soil resources as a basis for rational land-use planning.

The main activities of this survey are being carried out on a county basis. When introducing the first of the reports in the county series—that covering the Soils of County Wexford—the role of soil survey in agricultural development, and indeed in general planning activities, was outlined.

Carlow, although small in extent, is one of the most important agricultural areas in the country. It is also a county of contrasts, in its general landscape features, in its soils and in its agriculture. The rolling lowlands of the extensive central portion of the county are dominated by deep, well-drained fertile soils. These are devoted to mixed farming with a high proportion of tillage and a fair concentration of livestock, principally dairy cattle and sheep. The hills associated mainly with the Castlecomer Plateau consist of physically difficult and mostly poorly drained soils. Here livestock farming is at a low to moderately intensive level and forestry is being extended. On the steeply sloping flanks of the Blackstairs Mountains, which carry degraded mineral soils on the lower slopes and peats at the higher elevations, the emphasis is on sheep raising mostly at low intensity levels, and forestry is proving a useful alternative form of land use.

Some of the earliest investigations in this country on trace element problems, following reported cases of ill-thrift and pine in sheep and cattle over a wide area, were conducted in County Carlow. It was found that the main problem was a deficiency of cobalt, an element vital in ruminant nutrition. The investigations established a well-defined relationship between soil character and the uptake of cobalt through the plant to the animal. This relationship formed the basis for subsequent studies on cobalt and other trace element problems both in crops and livestock thioughout the country.

It is now generally accepted that the future development of agriculture requires more intensification at farm level, with greater emphasis on higher output per acre and per unit of manpower employed. The procedure involved and the extent to which new management systems can be developed, not only in the mixed farming areas on the better soils but perhaps even more so on the less favourable soils of the county, will be primarily determined by soil characteristics and especially those of a physical nature. To attain the desired norms of production every acre of land must be devoted to the enterprise for which it is best suited. Land-use planning to this end must be based on a full knowledge of the true character and potential of different soils and on their adaptability to alternative uses. The results of the survey now presented will be of basic importance in guiding these developments and the associated land-use adjustments in the years ahead.

This scientific survey adds another highly important chapter to the records of the land resources of our country. The successful completion of the project has been made possible by the co-operation of advisers and farmers with the surveyors involved. My Council trusts that the survey will be of value to Carlow farmers and to those involved in planning the use of the land resources of that county in the years to come.

T. WALSH,
Director

PREFACE

This publication, Soil Survey Bulletin No. 17 and the third in the county survey series, presents the findings of the soil survey of County Carlow. These county surveys form part of the work programme of the National Soil Survey of An Foras Taluntais (The Agricultural Institute). This Department is charged with the task of surveying, classifying and mapping the soils of Ireland.

Mr. M. J. Conry was responsible for the operation of this survey; he commenced in Carlow in 1962 and finished the field programme in 1965. He was assisted from time to time by Mr. P. Feeney, Mr. T. O'Shea, Mr. A. Comey and other staff of the National Soil Survey and by Mr. J. Bouma, a Netherlands exchange student who conducted a detailed survey of two areas. Mr. M. J. Gardiner and Mr. S. Diamond gave assistance and guidance in soil correlation and classification and Mr. R. F. Hammond in peat classification. The information was compiled and the bulletin written by M . J. Conry assisted by Dr. P. Ryan.

Various members of the staff of the National Soil Survey and of the Soils Division of An Foras Taluntais contributed to this bulletin: Mr. E. Culleton wrote the first part of Chapter VII and provided major assistance in the preparation of the entire bulletin. Mr. M. J. Gardiner prepared Appendix IV; Mr. G. A. Fleming contributed the section on trace elements and Mr. J. P. O'Callaghan the section on clay minerals in Chapter VII. Dr. A. O'SulIivan provided the information on vegetation throughout Chapter IV. Mr. P. Feeney prepared the section on climate in Chapter I. The analytical data in Appendix I were provided mainly by the laboratory staffs of the Soil Department (with assistance from the Soil Fertility and Chemistry Department) and of the Plant Nutrition and Biochemistry Department. The colour maps and the various figures and plates were prepared by Mr. J. Lynch of the Cartographic Section assisted by Mr. A. Walsh and Mr. V. Staples. Assistance in final preparation and proofing was given principally by Mr. E. Culleton and Mr. J. Lynch.

Dr. T. Walsh, Director of An Foras Taluntais, gave the survey his enthusiastic support. Dr. M. Neenan and Mr. T. F. Leonard of the Plant Sciences Division, An Foras Taluntais, contributed to the information on land-use. Mr. P. V. Geoghegan edited the bulletin.

Assistance also came from a number of outside sources. Mr. M. CTMeara, Geological Survey, contributed Chapter II; Mr. B. Aldwell of the Geological Survey and Mr. G. F. Mitchell of Trinity College also assisted with the geological investigations. Mr. T. Murray, Chief Agricultural Officer for County Carlow, provided Chapter VI. In compiling the information on soil suitability, personnel in the local Agricultural and Horticultural Advisory Services and in particular, Mr. P. Brady, Mr. M. Ryan, Mr. J. Moore, Mr. M. Reilly, Mr. D. Carey and Mr. P. McEnroe; personnel in the Land Rehabilitation Project and, in particular, Mr. M. Carr, Mr. J. J. Sullivan,

Mr. E. J. Thornton and Mr. B. J. Hanley and the Agricultural Advisers of Comhlucht Suicre Eireann Teo (Irish Sugar Co.) and especially Mr. V. Grogan gave valuable assistance. Information on forestry (Appendix V) was provided by the staff of the Research Branch, Forestry Division, Department of Lands, through Mr. O. V. Mooney, Head of the Branch. The farmers of the county gave the entire project their wholehearted co-operation. Climatic records were provided by the Meteorological Service. The colour printing of the maps was done by the Ordnance Survey which was also the source of base maps for the field mapping; the printed maps are based on the Ordnance Survey by permission of the Government.

Unfortunately the entire detail mapped on the field sheets at a scale of 6 inches to 1 mile (1:10,560) could not be shown on the published soil map, due to scale limitation, but copies of the field maps are available for inspection in the Soil Survey Office at Johnstown Castle, Wexford. Place-names throughout the bulletin and on the maps are not, in all cases, in accord with local spelling, but it was thought preferable to adhere to the official place-name spelling used in the Ordnance Survey.

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

PIERCE RYAN,
Head, National Soil Survey of Ireland.

Soils Division,
An Foras Taluntais,
Johnstown Castle,
Wexford.

August 1967.

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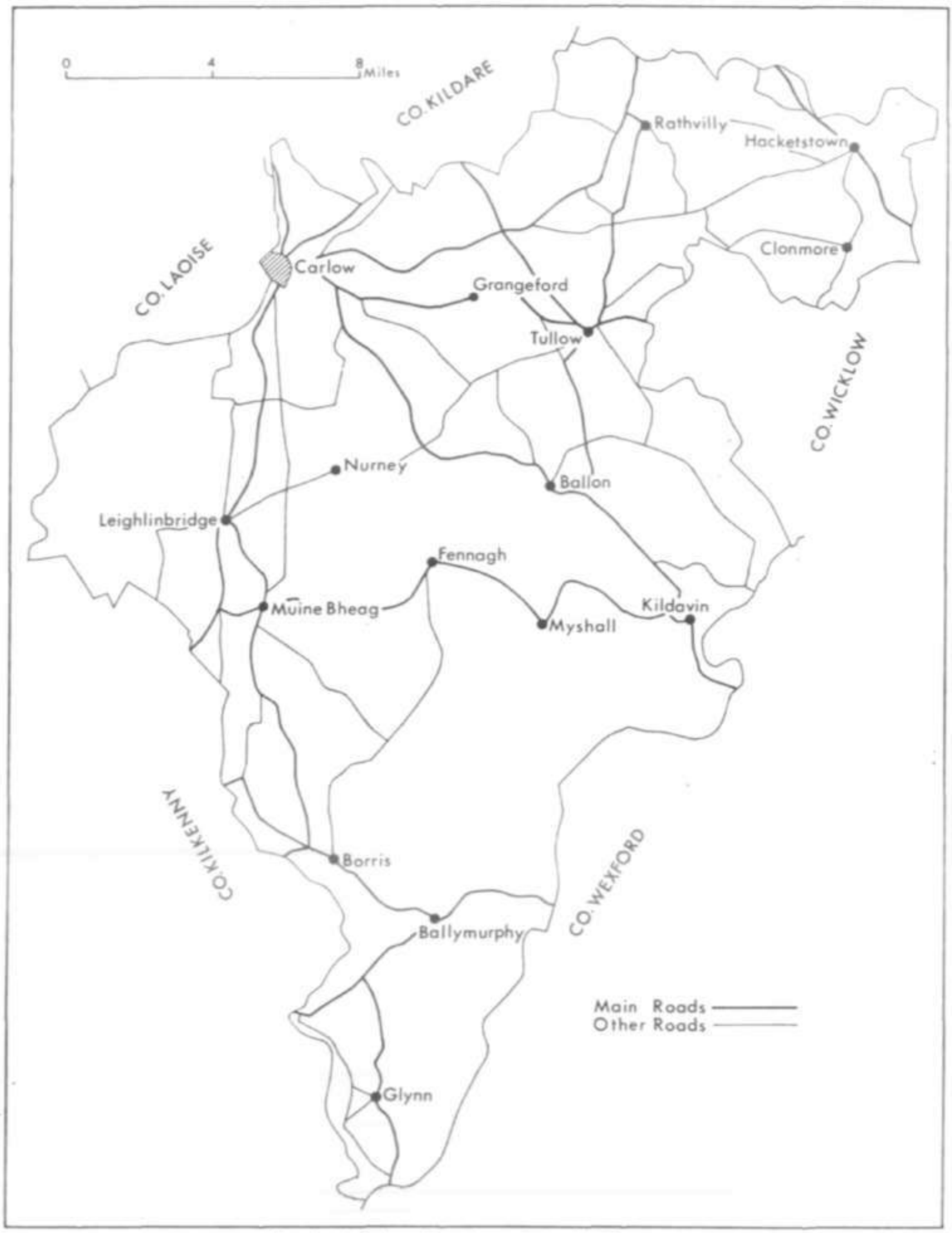


Based on the Ordnance Survey by permission of the Government.

Fig. 1—*County Carlow—geographic location and principal towns and villages.*

CHAPTER I

GENERAL DESCRIPTION OF THE AREA

Location and Extent

County Carlow is situated in the south-east of Ireland, between 52^{c}27' and 52°55' north latitude and 630' and 7^{C}7' west longitude. It is an inland county bounded on the south and south-east by County Wexford, on the east and north-east by County Wicklow, on the north by County Kildare and on the west by Counties Laois and Kilkenny (Fig. 1).

The county occupies an area of 221,539 acres (346 sq miles) and occurs almost entirely on the ^-inch (1:126,720) Ordnance Survey Sheet 19 with a small portion on |-inch Ordnance Survey Sheet 16. The principal towns within the county are Carlow, Muine Bheag, Tullow, Hacketstown, Borris and Leighlinbridge. Smaller communities include Rathvilly, Clonegall, Kildavin, Fennagh, Myshall and Oldleighlin. Carlow, the principal town of the county, has a population of 7,787 (Census of Population, 1966).

Topographic Features

The county may be divided into five main physiographic regions as follows (Fig. 2):

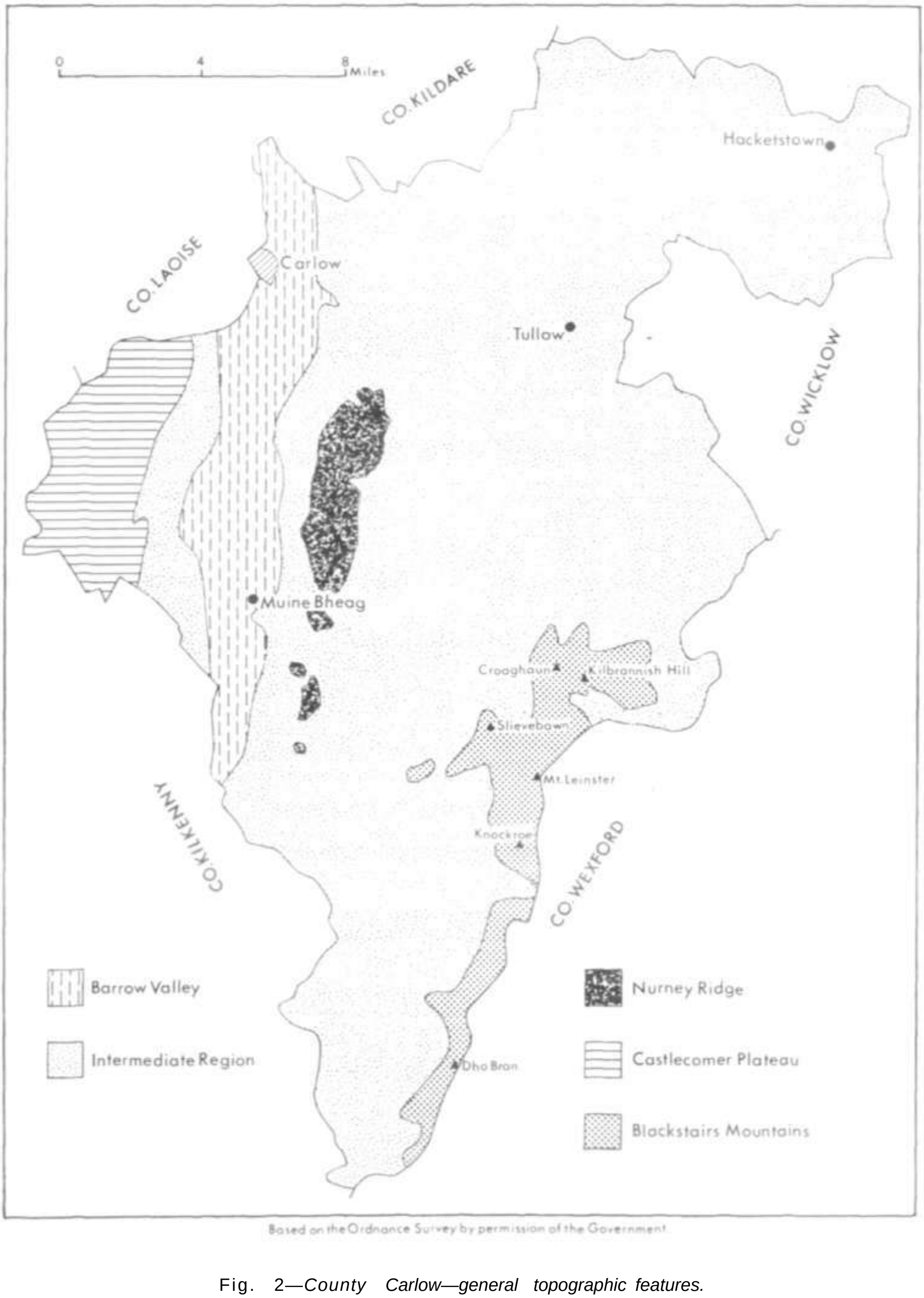
(a) *Barrow Valley*—lowlying region (less than 200 feet O.D.)—flattish, hummocky topography. This area occurs on both sides of the River Barrow and extends from the Kildare boundary to the north to as far south as Goresbridge.

(b) *Intermediate Region*—(200-800 feet O.D.)—undulating to rolling topography. Almost the entire central portion of the county has these landscape features.

(c) *Nurney Ridge*—(400-677 feet O.D.)—rolling topography. This relatively elevated ridge runs in a north by north-easterly direction through the centre of the county.

(d) *Castleeomer Plateau*—(400-1,055 feet O.D.)—undulating topography with some moderately steep slopes. This area occurs in the extreme west of the county and represents portion of the Castleeomer Plateau which also extends into Counties Laois and Kilkenny. Topography varies from undulating on top of the plateau to moderately steep on the eastern slopes.

(e) *Elevated Region—Blackstairs Mountains*—(800-2,610 feet O.D.)—moderately to steeply sloping topography. This area occurs in the south-eastern portion of the county and is characterised by considerable elevations such as Mount Leinster (2,610 ft), Blackstairs (2,409 ft), Knockroe (1,777 ft), Slievebawn (1,727 ft), Dho Bran (1,679 ft), Croaghaun (1,499 ft) and Kilbrannish (1,338 ft).



Based on the Ordnance Survey by permission of the Government.

Fig. 2—*County Carlow—general topographic features.*

River Systems

The county is drained by the Rivers Barrow, Slaney and Nore and their tributaries. The largest of the catchment areas is drained by the Barrow and its tributaries: the Burren, the Black, the Mountain, the Aughavaud and the Aughananagh. The most noteworthy of these tributaries is the Burren which rises at the Black Banks, near Mount Leinster, in the southern portion of the county and flows in a northerly and north-westerly direction for 24 miles before entering the Barrow at Carlow town. The eastern portion of the county is drained by the Slaney and its tributaries: the Derreen, the Douglas, the Clashavey, the Derry and the Clody. A small area on the Castlecomer Plateau is drained by the Dinin, a tributary of the River Nore.

Climate

Ireland has a typical west maritime climate with relatively mild, moist winters and cool, cloudy summers. For the greater part of the year, warm maritime air associated with the Gulf Stream helps to moderate the climate. The prevailing winds are westerly to south-westerly. The average humidity is high. Annual average precipitation is highest on the west coast and in inland areas of high relief.

The information presented here on the climate of County Carlow is based on the lecords of the Meteorological Office. The rainfall figures weie collected at 12 recording stations for the 15 year period 1950-64. The figures for air temperature, sunshine, relative humidity and ground frost were recorded at Carlow over the period 1954-64.

Rainfall

The mean annual rainfall varies within the county from approximately 33 inches (840 mm) at Tullow to almost 57 inches (1,446 mm) on the Blackstairs Mountains. The average monthly and annual rainfall figures for 12 recording stations in the county are given in Table I. The minimum rainfall occurs in April and the maximum in December: a secondary peak occurs in September. An annual minimum of 22.8 inches was recorded at Tullow in 1952 and an annual maximum of 71 inches was recorded at Knockroe, in the Blackstairs Mountains, in 1960.

TABLE 1: Average monthly and annual rainfall (1950-64)

Rainfall, millimetres (25.4 mm = l inch)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly total
Muine Bheag	77	68	73	57	62	60	76	81	98	87	90	108	927
Ballon	72	70	72	54	62	58	70	79	95	80	86	98	896
Borris	81	71	76	58	63	61	73	82	97	89	89	101	941
Carlow	78	63	63	53	61	54	62	80	91	79	77	97	858
Glynn	92	79	86	53	77	64	76	101	108	103	92	133	1064
Hacketstown	83	76	78	65	63	66	87	107	102	96	97	112	1032
Leighlinbridge	74	60	60	50	60	55	67	84	96	76	79	89	850
Blackstairs Mountains	126	106	120	83	98	93	106	123	154	130	156	151	1446
Graignamanagh	92	76	96	67	73	67	77	83	105	108	92	117	1053
Rathvilly	71	65	68	54	64	63	90	95	98	82	84	95	929
Tullow	64	67	57	42	64	57	77	83	94	66	74	95	840
Bunclody	98	83	98	66	76	66	82	97	107	106	106	129	1114

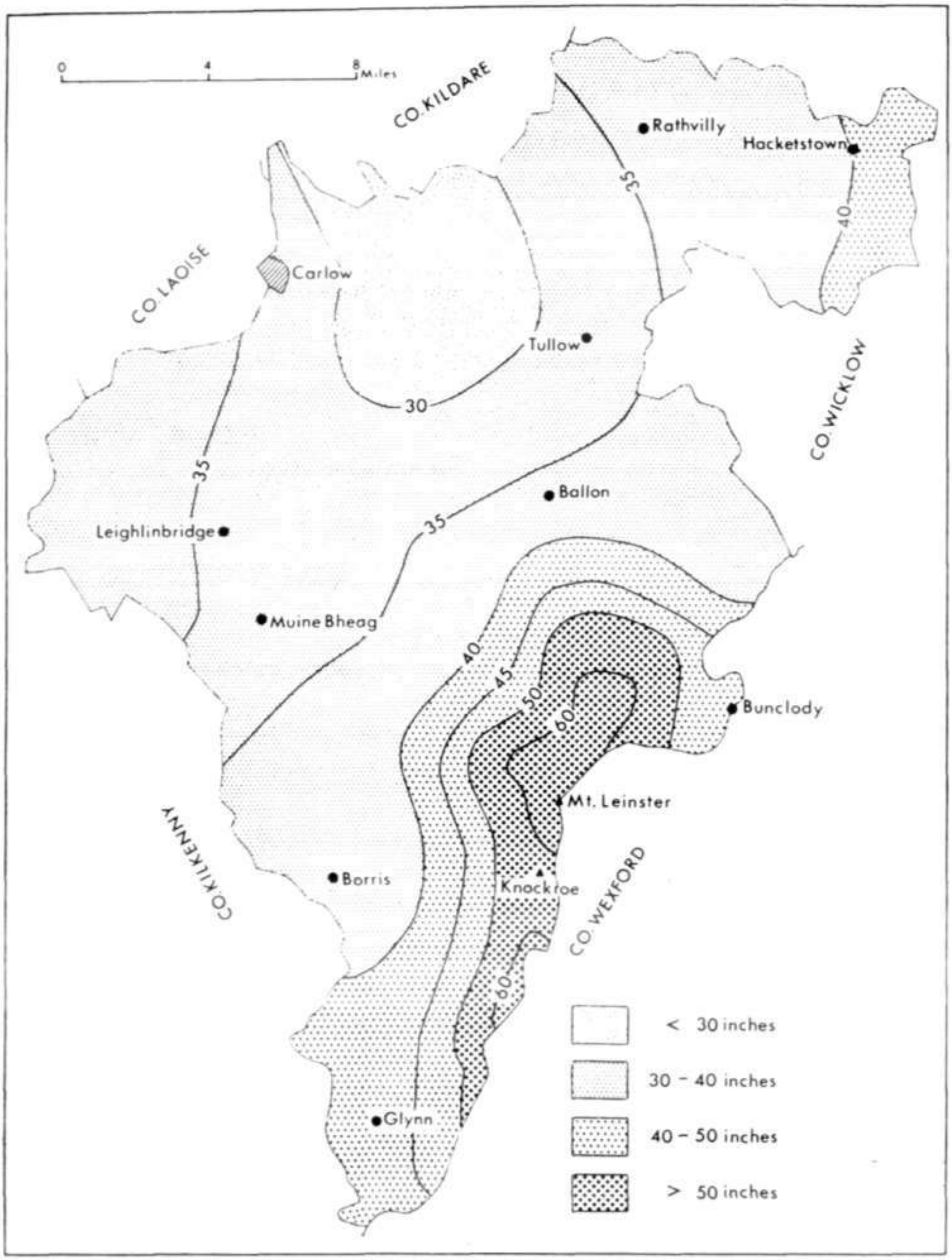


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Fig. 3—*Rainfall distribution pattern throughout the count v {average annual rainfall 1950-64).*

The county may be divided broadly into high, intermediate and low rainfall areas (Fig. 3. Table II).

TABLE II: Average monthly rainfall for three areas in Co. Carlow (1950-64)

Rainfall, millimetres (25.4 mm^1 inch)

Rainfall area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
High[1] ...	126	106	120	83	98	92	106	122	154	130	156	150
Intermediate[2]	91	79	90	63	72	66	81	97	106	103	97	123
Low[3]	74	66	67	53	62	58	74	83	96	80	83	98

[1] Greater than 1,200 mm (47 in.) * 1,000—1,200 mm (39 to 47 in.)
[8] Below 1,000 mm (39 in.) average annual rainfall.

The "high" rainfall region is associated with the Blackstairs Mountains; the only recording station in this region is at Knockroe. Although the average annual rainfall is in excess of 1,200 mm (47 in.) great seasonal fluctuation is apparent. For April, on average the driest month, the rainfall recorded ranged from 24 mm in 1956 to 245 mm in 1961. The figures for December, the wettest month, ranged from 98 mm in 1952 to 218 mm in 1956. The figure of 338 mm recorded for September 1962 was the highest for any one month during the 1950-64 period, while the lowest was 10 mm in July 1955.

The "intermediate" rainfall region has an average annual rainfall between 1,000 and 1,200 mm but some variation from year to year is apparent from the different stations' records. The highest annual rainfall recorded at Glynn was 1,339 mm in 1958 and the lowest 861 mm in 1953; the highest at Hacketstown was 1,350 mm in 1960 and the lowest 807 mm in 1952. The highest at Graignamanagh was 1,350 mm (1960) and the lowest was 839 mm (1953) and at Bunclody the corresponding figures were 1,547 mm (1960) and 827 mm (1952).

In the "low" rainfall region the highest annual rainfall recorded was 1,315 mm at Muine Bheag in 1960; the lowest was 579 mm at Tullow in 1952. The highest monthly rainfall recorded was 199 mm at Rathvilly in August 1950; the lowest was 0.1 mm at Leighlinbridge in March 1961.

Temperature

Temperature records are available only for one station within the county. Average monthly air temperature figures recorded at Carlow over the period 1954-64 are shown in Table III.

TABLE III: Average monthly maximum and minimum air temperature, °F (Carlow, 1954-64)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum ...	45	46	50	56	60	65	67	67	63	58	51	47
Minimum ...	33	34	37	39	43	49	51	50	48	43	39	35

January on average is the coldest month and July the warmest. Recorded temperature extremes over the period 1954-64, not given in Table III, show a maximum of 74^{C}F in July 1955 and a minimum of 26 F in January 1963. The average annual temperature ranges from 46°F (1963) to 51°F (1959) with a mean for the 1954-64 period of 49°F—almost the same as that for county Dublin and 2°F less than that for West Cork.

Sunshine

Average daily mean of bright sunshine registered at Carlow (1954-64) was as follows (hours): January 1.71, February 2.64, March 3.14, April 5.05, May 6.53, June 5.96, July 4.85, August 4.93, September 3.99, October 2.94, November 1.98, December 1.55. The yearly average of a daily mean of 3.77 hours at Carlow is comparable with that for West Cork (3.79 hours) and only 0.48 hours below that for Rosslare; however, in the period June to September inclusive, West Cork on average has 20 minutes and Rosslare one hour of bright sunshine per day more than Carlow.

Relative Humidity

Relative humidity figures for the county (recorded at 9.00 a.m. G.M.T.) are high, ranging from 76 per cent in May to 91 per cent in January.

Frost

Average number of days with ground frost recorded at Carlow (1954-64) was as follows: January 20.7, February 16.8, March 13.5, April 12.9, May 8.5, June 2.5, July 0.3, August 1.6, September 4.0, October 8.9, November 15.3, December 18.9. Obviously, the frost-free period in this region is very limited in most years; in this regard it compares unfavourably with most of neighbouring County Wexford where mid-April to mid-October is frost-free most years.

CHAPTER II*

GEOLOGY OF THE COUNTY

Solid Geology

The bedrock of County Carlow is comprised largely of granite, but other important formations are also represented giving a rather varied landscape. The granite forms steep mountains (Leinster Range) cut through by several deep, narrow valleys, in the south of the county, but in the north it forms a lowlying, rolling plain. The compact areas of the other rock formations provide their characteristic and contrasting landscape features. The solid rock formations are all of Palaeozoic Age and as such aie old in geological time.

Figure 4 shows the distribution pattern and relative extent of the various rock formations; a brief account of these in chronological order follows.

Lower Palaeozoic Formations

Ordovician: A ragged projection of the broad Ordovician belt extending across Counties Wexford and Wicklow enters Carlow north-east of Mount Leinster. The formation has been influenced, especially along its outer edges, by subsequent intrusions of molten granite; the intensely folded and cleaved slates and phyllites (with rare grits) pass into mica-schists as the granite is approached. Close to the boundary between the slates and the granite, high-grade schists and hornfels, with minerals such as staurolite, andalusite and garnet, are commonplace. The tough schists form the abrupt foothills of the mountains.

Upper Palaeozoic Formations

Granite: The rolling lowlands with a few knolls, that slope gently from the foot of the mountains to the Barrow valley, have developed over an extensive granite intrusion. At a higher level on the landscape, the granite caps Mount Leinster and to the south of here the cap tilts steeply to form the more rugged, narrow Blackstairs ridge; small remnants of the granite cap still survive on other isolated peaks, such as John's Hill.

The granite is mostly of medium-grained texture but some coarse and fine veins cut the mass. Being composed of well-developed potash feldspar crystals, glassy quartz and black mica, it has a white background colour flecked with black. Along joints the granite is often deeply weathered to sand leaving solid blocks in-between. On the higher slopes, when the sand has been washed away, a scree of these granite

*This chapter was contributed by Mr. M. O'Meara, Geological Survey of Ireland, whose co-operation is gratefully acknowledged.

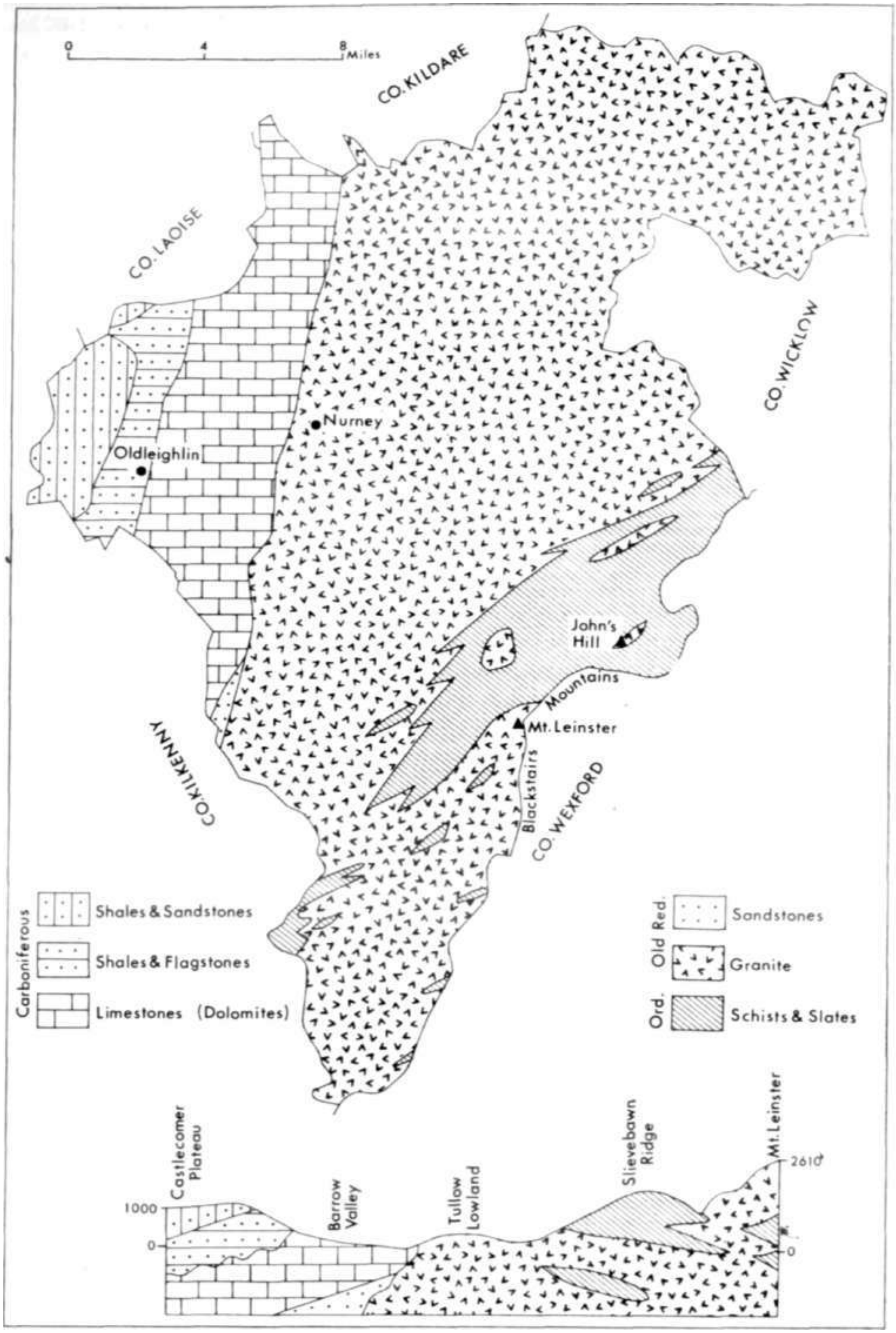

Fig. 4—*Distribution of solid geological formations in the county.*

blocks remains. Although the knolls on the low ground, in many cases, have retained a schist cap, nevertheless, along the Nurney Ridge, just inside the western limit of the exposure, fresh granite appears frequently at the surface.

Old Red Sandstone: Just east of Goresbridge part of the Old Red Sandstone formation occurs as a small wedge of coarse, micaceous-felspathic sandstones between the limestone to the west and the granite to the east. Like the granite, from which it was derived, the sandstone also weathers along joints resulting in a spread of large, loose blocks.

Carboniferous Limestone: North of the above Old Red Sandstone wedge and abutting against the granite along the latter's western boundary, a fairly extensive formation of Carboniferous limestone occurs and forms the floor of the Barrow valley. The formation comprises earthy limestones at the base, then dolomites and oolites and finally, fairly pure limestones.

Carboniferous Shales and Sandstones: The western projection of County Carlow across the River Barrow embraces a small part of the Castlecomer Plateau, which is comprised of Upper Carboniferous black shales and grey mudstones with some beds of sandstone. Sandstone forms two distinctive horizons, a lower one of flagstones, and an upper one of coarse, felspathic sandstones with angular pieces of shale. The latter horizon and overlying strata are part of the Castlecomer basin of Coal Measures, but only thin seams of impure coal extend into County Carlow. The steep scarp on the eastern side of the Castlecomer Plateau is capped by the upper sandstone. This scarp fades out towards Oldleighlin, where an outer scarp, capped by the lower flagstones, forms the face of the plateau.

Glacial Geology

The solid geological formations of the county for the most part are overlain by a drift mantle comprised mainly of deposits of the Great Ice Age. Most of the important soils of the county are derived from these deposits and not from the solid formations. During the Ice Age, which embraces the last million years of the earth's history, Ireland was overrun by a succession of vast ice-sheets. The sequence of local events in the Carlow region follows the generally accepted pattern for Ireland, and the different glaciations here are correlated with their equivalents in Northern Europe. In Ireland, little is known about the earlier events of this period.

In common with Northern Europe, Ireland was influenced by three separate glaciations, namely, Elster, Saale and Weichsel (Fig. 5).

Elster Glaciation

Only limited evidence of this, the earliest of the three glaciations, has been found in Ireland to date. North of Carlow, blocks of Leinster granite occur freely in the older glacial drifts for a few miles to the west of the main granite outcrop and as far as the River Barrow; the few granite pebbles found in the drifts across the river to the west are all of Connemara origin. This distribution of granite erratics is not accounted for by the known pattern of later glaciations. It suggests, therefoie, an earlier westerly dispersal of the deeply rotted granite by an ice-cap on the Leinster Range; the westerly spread was held along the line of the River Barrow by a more powerful ice-sheet moving in from the west coast of Ireland. Although no glacial deposits have survived, the extraneous granite blocks described above may represent relics of the Elster (?) Glaciation.

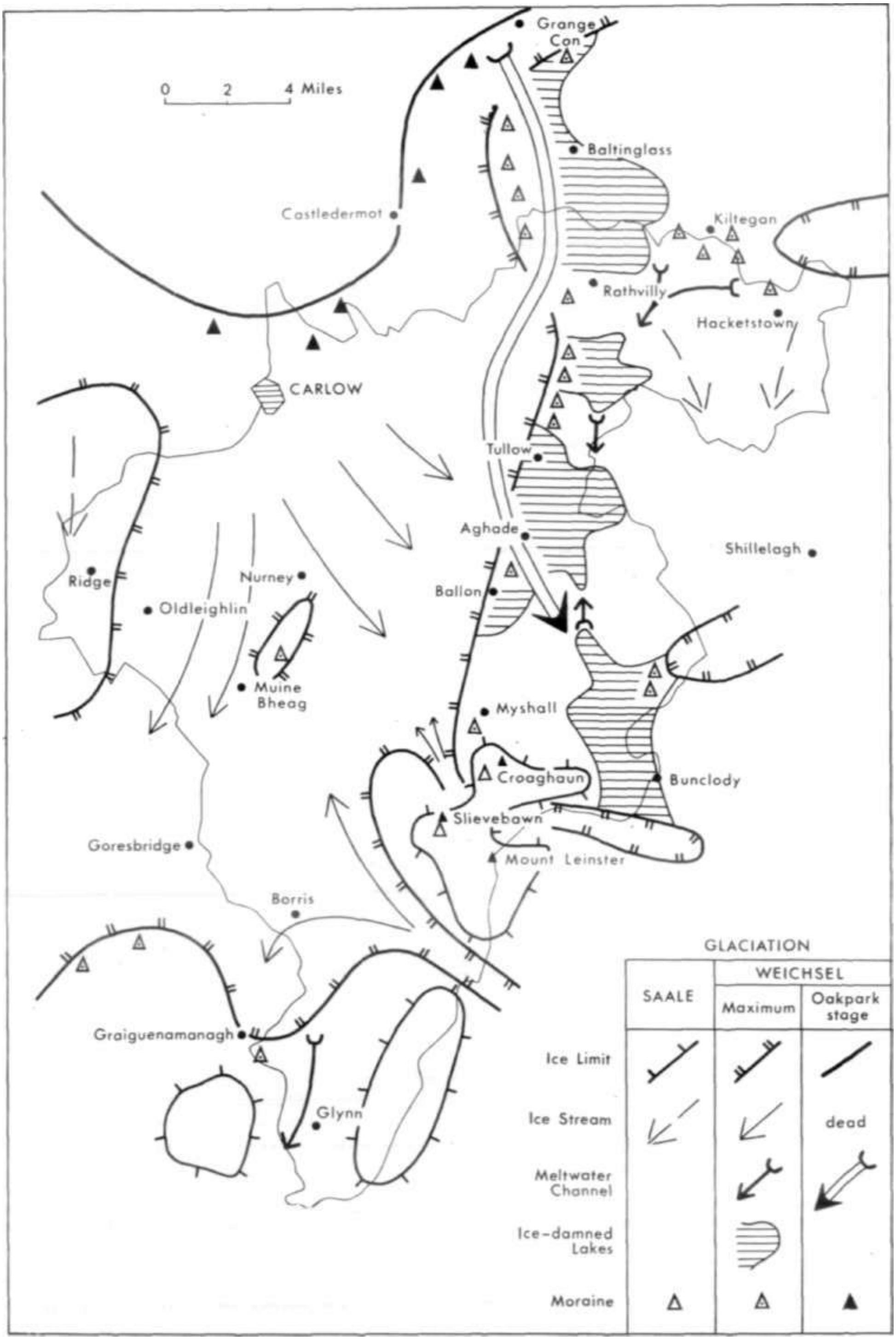

Fig. 5—*Pattern of glacial events in thecounty.*

Saale Glaciation

Following a long, genial, temperate interval, known as the Great Interglacial, arctic conditions returned and ice again formed in great masses on the Leinster Range and began flowing outward. However, it was quickly contained by an invading ice-sheet from the north. Evidence of the route of the invading ice is contained in the north-south ice scratches on the bedrock formations of the Castlecomer Plateau and in the andesite boulders borne southward from County Kildare. The local ice was confined mostly to the inner recesses of the mountains; here the drift contains only local rock debris. On the outer slopes, on the other hand, the invading ice pushed its deposits to a height of 1,200 feet O.D. These deposits were mainly granite debris derived from the local bedrock, some earlier drift and limestone and Silurian Shale debris from County Kildare. Above 500 feet, of the original limestone in this drift only chert survives, whilst below 500 feet the glacial tills are often calcareous and, in places towards the north, contain weathered limestone. On the shoulders of the Croghan and Slievebawn hills, thick sheets of granite debris completely cover the schist bedrock almost to 1,200 feet O.D. From the steeper slopes this mantle was removed almost entirely by later frost action to give nearly flat spreads on the lower ground.

The softer rocks of the Castlecomer Plateau were readily incorporated into the ice so that here the glacial till is composed of local shales and sandstones with only a little limestone. As the wasting ice-sheet gradually shrunk to lower levels, the drift exposed on the higher ground was subjected to severe frost action. Following the complete withdrawal of the Saale ice-sheet, another interglacial period ensued, during which the Saale drifts were deeply weathered, their limestone component being completely leached out to a depth of about 6 feet.

Weichsel Glaciation

This, the last glaciation, is comparatively recent in our geological history so its deposits are still quite fresh. Although lacking the more vigorous and widespread activity of the Saale ice-sheet, nevertheless since the most fertile soils of County Carlow are derived from its deposits, the events of the Weichsel Glaciation are described somewhat more fully than for the previous glaciations.

The beginning of this arctic episode was again marked by ice accumulating on the mountains, and subsequently acting as separate glaciers filling the surrounding valleys. On the north and west sides of Mount Leinster, individual glaciers coalesced on the lower ground between Borris and Ballon and moved north-west as a confluent or piedmont glacier. On the east side, a glacier filling the Clody valley dammed the melt-waters from the Derry glacier, the only one of the more extensive glaciers descending from the Wicklow Mountains to penetrate into County Carlow. Another Wicklow glacier came to a stop just outside the Carlow boundary at Kiltegan, depositing thick terraces of granite and schist outwash gravels along the Derreen River, north of Hacketstown.

Meanwhile, heavier precipitation in the west and north of the county produced still greater ice flows. These coalesced into a vast sheet which pushed south-east across the Midlands, and so is known as the Midland General ice-sheet. This ice rasped off and partially ground to clay great quantities of the rock occurring in its path through the Midlands, so that its load of rock-waste, or till, consisted mainly of Carboniferous limestones with some Old Red and Silurian sandstones and slates. By the time it reached County Carlow, its impetus and erosive effect were so reduced

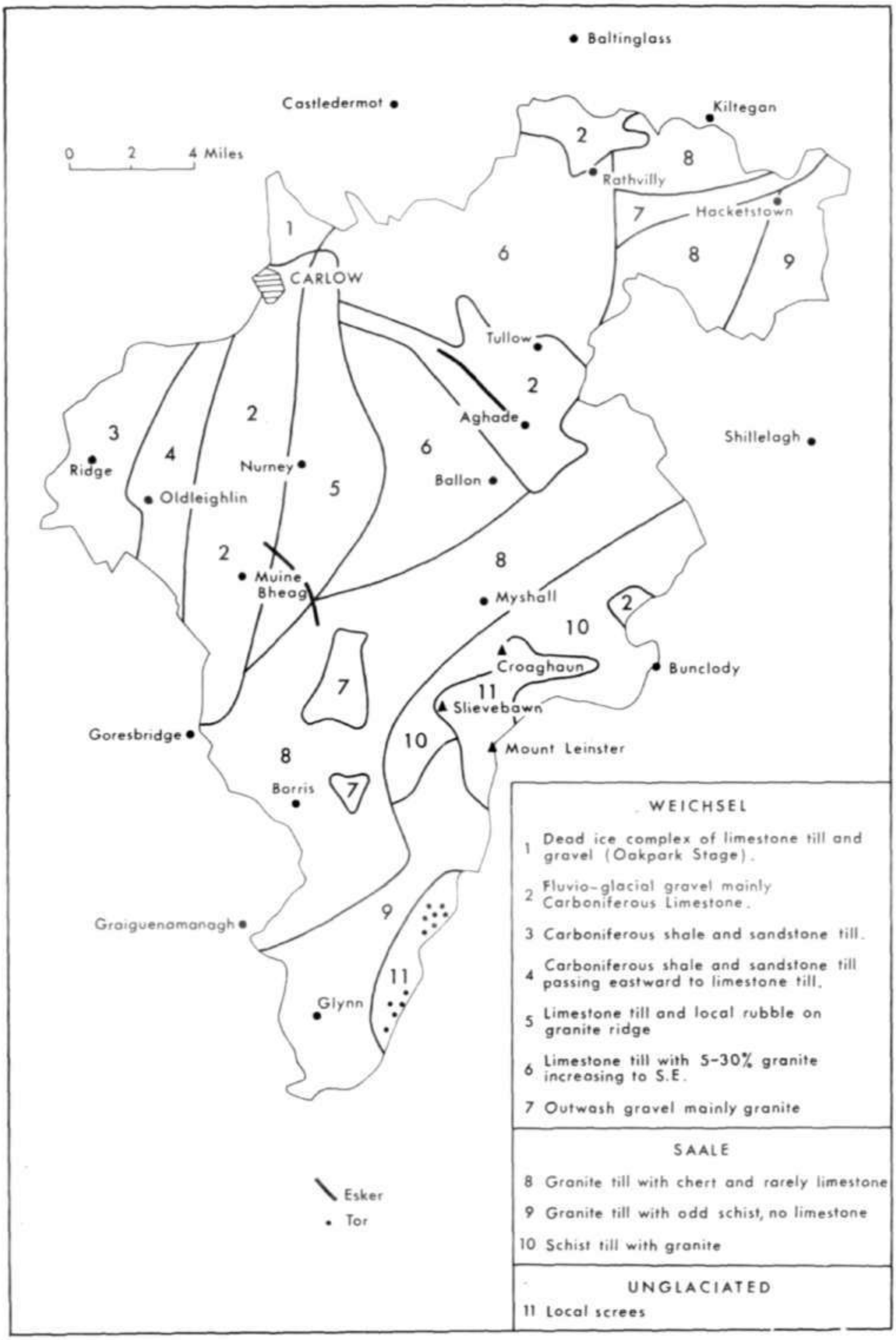

Fig. 6—*Distribution of the glacial drifts in the county.*

that it could only cross the extensive granite bedrock formation for a distance of 8 miles and could only add less than 20 per cent of that rock to its till load, except where rotted granite occurred at the surface. Along a line from Ballon to Goresbridge the Midland General ice pushed against and mingled with the piedmont glacier from Mount Leinster described earlier. The resulting flat spread of till in this region imperceptibly changes in composition from limestone with granite, typical of the Midland General till, to redeposited Saale till with an addition of granite often as huge blocks, typical of the Mount Leinster ice-sheet.

The Midland General ice made no contact with the Wicklow glaciers. Against the free edge of the ice-sheet, north of Ballon, a hummocky moraine of tills and gravels was formed which extended through Tullow and Rathvilly and on to Baltinglass. The ice was too weak to override the Castlecomer Plateau and even the higher parts of the Nurney Ridge were not submerged; occasionally a terrace of gravels marks the upper limit of this ice-sheet. The older drift on top of the Castlecomer Plateau was heavily soliflucted during this period, but no new glacial materials were added.

The melt-waters from the ice formed a chain of lakes in the low ground in front of the moraine (Fig. 5); these were filled with limestone gravels from the Midland General ice-sheet and on their eastern margins, by a fringe of gravels of local origin from the mountain ice. The overflow from the lake impounded between the Clody and Derry glaciers (Fig. 5) cut through a ridge one mile east of the present River Slaney gorge, which was not cut until later. The original cutting is now a dry gap. The overflow from all the glacial lakes in this vicinity escaped as a river through the ice; the river eventually emerged cutting a deep gorge at Glynn. The esker at Aghade and that near Muine Bheag are parts of the silted up tunnel through which the river flowed.

When ice ceased to form on the mountains, the local glaciers melted, leaving mounds and spreads of gravels, mainly of granite; these are partially masked by subsequent solifluction flows. Similar flows of shale and sandstone drifts from the steep slopes of the Castlecomer Plateau often overlie the limestone drifts in the Barrow valley. The Midland General ice also melted, depositing its till and finally leaving spreads of gravels in the landscape depressions. Crescentic ridges of gravels across the Barrow valley mark the recession of the ice-front towards the depression in South Kildare where the ice finally stagnated. The dead ice slowly melted, mostly from the base, leaving alternating tills and gravels and along its outer edge a hummocky moraine extending from Oakpark to Grange Con. Along the River Barrow the copious melt-waters deposited a terrace, 5 miles wide at Oakpark and tapering to 2 miles at Goresbridge; thereafter the terrace suddenly constricts to 100 yards as the river swings into the granite.

The ice cover finally disappeared from the landscape and a tundra vegetation developed. A subsequent cold spell (8,800-8,300 B.C.) caused ice to form in the huge corrie at the head of the Clody valley on Mount Leinster and resulted in a local spread of granite blocks from the Mount Leinster cap. The post-glacial period finally set in shortly before 8,000 B.C.

Post-glacial

As the climate became warmer and drier, the bare drifts were clothed with heath and grass and later with dense forests. A colder and more moist period about 3,000 B.C. caused peat to form in the swampy hollows and on the flatter mountain slopes. The spread of the peat, and the advent of Neolithic farmers about the same time, caused a decline in the forest cover. The rivers, mostly canalised by the torrential floods of melt-waters from the wasting ice, are still cutting down, so that deposition of alluvium is insignificant except on a few of the older ones flowing north-east.

A summary of the main glacial events in the county and their relation to the general pattern usually accepted for Ireland is provided in Table IV.

TABLE IV: Main glacial events in County Carlow and their association with the general glacial pattern in the country

Ireland	Carlow
Late Glacial	Mount Leinster Corrie Glacier
Weichsel Glaciation	Midland General Ice-Sheet Mount Leinster Piedmont Glacier
Last Interglacial	
Saale Glaciation	Northern General Ice-Sheet Mount Leinster Mountain Ice-Cap
Great Interglacial	
Elster Glaciation	(?) Leinster Chain Ice-Cap

Soils and the Geological Pattern

The distribution of the glacial drifts in the county is shown in Figure 6. Obviously, the geological materials from which the soils of the county have been derived are of very mixed origin and constitution. The glacial history of the area has played a major part in creating this situation, which, to a considerable extent, accounts for the complexity of the soil pattern prevailing.

The general relationship of the soils to the geological materials within the county is given in Appendix II.

CHAPTER III

CONSIDERATIONS IN SOIL SURVEY

Introduction

Soil is the natural medium for the growth of land plants. Although the soil mantle of the earth is far from unifoim, all soils have certain factors in common. Every soil consists of mineral and organic matter, living organisms, water and air. The relative proportions of these components vary between different soils. As a small segment of the earth's surface, every soil extends downwards as well as laterally over the surface and must, therefore, be regarded as being three-dimensional, having length, breadth and depth (Plate 1).

The Soil Profile

The soil profile refers to a vertical section of the soil down to and including the geological parent material. The nature of the soil profile is important in many aspects of plant growth, including root development, moisture storage and nutrient supply. The profile is, therefore, the basic unit of study in assessing the true character of a soil. It usually displays a succession of layers that may differ in properties* such as colour, texture, structure, consistence, porosity, chemical constitution, organic matter content and biological composition. These layers, known as **soil horizons,** occur approximately parallel to the land surface.

Soil Horizons

Most soil profiles include three main horizons that are usually identified by the letters A, B, C. The combined A and B horizons constitute the so-called solum or 'true soil' whilst C refers to the parent material beneath. Certain soils lack a B horizon and are said to have AC profiles. In some soils also, organic layers (O horizons) overlie the mineral horizons.

Some soils may have a relatively uniform profile with A and C horizons whilst others are so complex that they possess not only A, B and C horizons, but also several sub-horizons (Fig. 7). Where horizons need to be sub-divided on the basis of minor differences, the sub-horizons are identified by the horizon designation plus a suffix number thus: A_1, A2, A3, B_1, B2, etc. The various horizons in a soil and their character reflect the process of soil formation that has been operative and

"Texture, structure and porosity are defined and discussed in Appendix III.

A LANDSCAPE SECTION showing the variation that can be found in topographic features, in soil profile characteristics (horizon development etc.), and in associated land use pattern.

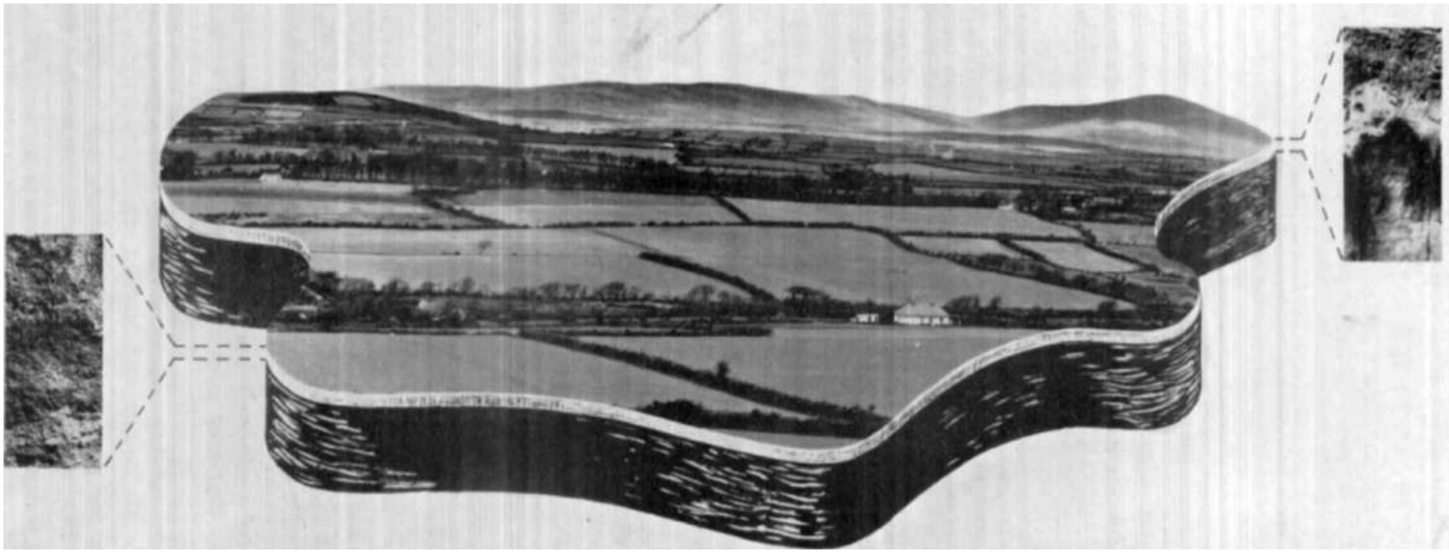

Plate I *The soil Is the surface layer of the earth's crust.*

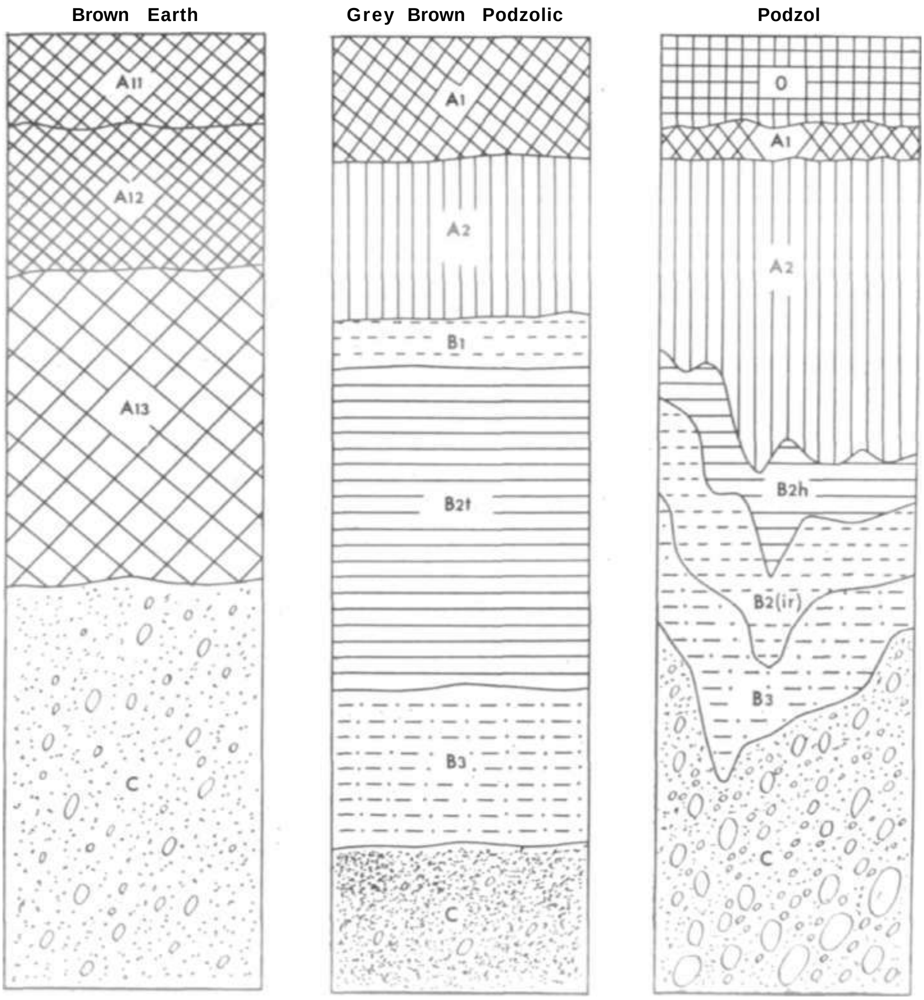

Fig. 7—*Diagrammatic representation of hypothetical soil profiles showing horizon sequences.*

present a picture of the true nature and salient characteristics of a soil which are important in its use and management.

The A horizon: This horizon is the uppermost layer in mineral soils and corresponds closely with the so-called 'surface soil'. It is that part of the soil in which living matter, e.g. plant roots, bacteria, fungi, earthworms, and small animals, is most abundant, and in which organic matter is usually most plentiful. Being closest to the surface, this horizon is the first to be reached by rainfall and is, therefore, more leached than underlying horizons. The A horizons in most Irish soils have been depleted of soluble chemical substances and, in certain cases also, of some of their very fine clay particles. Where the soils have been strongly leached they may be depleted of iron and aluminium oxides and of other constituents besides (Plate 2).

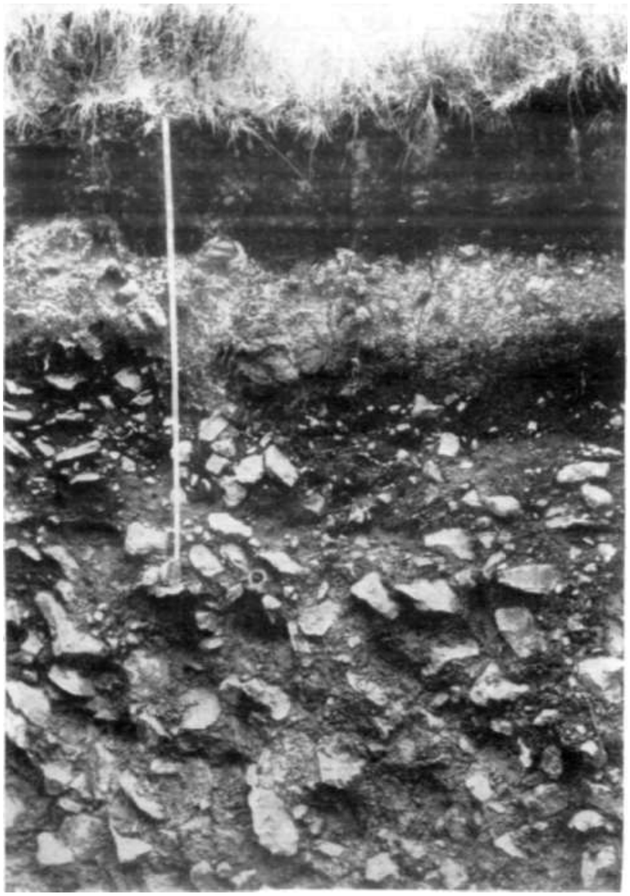

Plate 2—*A Podzol profile showing the surface horizon enriched with poorly decomposed organic matter, overlying the grey, strongly leached A2 horizon and underneath this the dark-coloured B2 horizon with its accumulation of iron oxides and humus.*

Two sub-divisions of the A horizon are commonly made, namely, Ai and A2. Either the Ai or both may be represented in a profile. The Ai is a surface mineral horizon that usually contains a higher proportion of organic matter, incorporated with the mineral matter, than any of the underlying horizons. In cultivated soils this horizon conesponds to the plough layer and may be designated Ap. The A2 is a comparatively light-coloured horizon and frequently has a bleached appearance. The A2 always refers to the horizon which has undergone the greatest degree of leaching. This is reflected in the lighter colour, mostly the result of a partial removal of colouring constituents, principally iron. A3 signifies a transition zone or horizon between the A and B horizons.

The B horizon: This horizon lies immediately beneath the A and corresponds closely to the so-called 'subsoil'. Lying between the A and C horizons, it possesses some of the properties of both. Living organisms are fewer than in the A but more abundant than in the C horizon. Compared with the A horizon, the B horizon is one of accumulation and usually has a relatively high content of iron and aluminium oxides, humus or clay that, in part at least, have been leached from the overlying horizons. Usually a more pronounced blocky or prismatic structure is found where this horizon is clay-enriched. Stronger colours are apparent in the B horizon, especially when the accumulation products are iron oxides or humus, or both.

Depending on the degree and pattern of accumulation of constituents within the B horizon, several divisions of the horizon, e.g. Bi, B21, B22, B3, may be warranted, B2 representing the zone of most intense accumulation. Besides, symbols such as B2t, B2(ir) and B2h are used to denote significant accumulations of clay, iron and humus respectively. Bi and B3 denote transition horizons from A to B and from B to C horizons, respectively. If the B horizon is without any appreciable accumulation of leached products but has distinctive colour or structure characteristics, it is usually referred to as (B) horizon.

The C horizon: This horizon refers to the geological material beneath the A and B horizons (solum). It consists of the upper part of the loose and partly decayed rock or other geological material, such as glacial drift, similar to that from which the soil has developed. It may have accumulated locally by the breakdown of the native rock or it may have been transported by ice, water or wind. The C horizon is less weathered, has less organic matter and is usually lighter in colour than overlying horizons.

The O horizon: This horizon refers to a surface layer of raw or partly decomposed organic matter more usually associated with very poorly drained or very degraded (podzolized) mineral soils. Where little or no decomposition has taken place the symbol Oi is used; O2 denotes more advanced decomposition. The organic matter content of O horizons is commonly several times greater than that of the underlying mineral horizons or of surface A horizons.

Factors of Soil Formation

The character of every soil can be attributed largely to the interaction of five major factors of soil formation: parent material, climate, living organisms, topography and time. These factors control the rate of weathering of rocks, the constitution and composition of the resultant soils, and subsequent gains, losses and alterations within the profile. The relative influence of these factors is responsible for many of the differences in our soils. A sixth factor influencing many non-virgin soils is man's interference with the natural development processes, and his modification of the soils for his own particular purposes.

Parent Material

Parent material may be either solid rock which has weathered or some superficial deposit such as glacial drift or alluvium which has been derived from weathered rocks and transposed. Rocks vary greatly in composition, and such variation is reflected in the soils derived from them. For example, quartzite is highly resistant to weathering and, during its slow weathering process, little clay is formed and release of mineral nutrients is poor. Besides being inherently poor, soils on such materials degrade easily as the leaching process outpaces the rate of weathering. Fortunately, most rocks are mixtures of many minerals, few of which are able to withstand weathering as well as quartz. Glacial drift, the most common parent material of Irish soils, varies considerably in constitution and in geological composition, giving rise to many different soils.

Climate

Even on a uniform parent geological material, soils may vary widely due to the environmental factors that influence them, in their genesis, formation and development. One of the most active agents in this regard is climate. It is now recognised that our post-glacial climate showed distinct variations over time, and current climate varies widely from season to season and from region to region. The main element of our climate influencing soil development is the rainfall-evaporation regime. With the ratio balanced well in favour of rainfall, most of our soils tend to be leached to varying degrees, being strongly podzolized in more extreme cases. Apart from leaching, the humid climate is also partially responsible for the extensive areas of wet gley soils and for much of the peat formation in the country.

Living Organisms

Living organisms in the soil include plants, animals, insects, fungi, bacteria and other biological forms. These play an important role in soil development, such as determining the kind and amount of organic matter that is incorporated in the soil under natural conditions. They also govern the manner in which organic matter is added, whether as leaves and twigs on the surface or as fibrous roots within the profile. The rate of organic matter decomposition is strongly influenced by the type and activity of living organisms present. Plants can reverse the leaching process in part: the roots take up calcium, potassium, phosphorus and other elements from the lower horizons and, on the decay of leaves, roots and other plant remains, return them to the surface.

The nature of the vegetative cover itself is known to have a decided influence on soil development. Other factors being equal, a forest cover promotes a different soil-forming process than either grass or cultivated crops. Trees also differ in their influence on soil development; in general, conifers are more conducive than broad-leaved trees to soil degradation and podzol formation, particularly on acid parent materials. Certain forms of ground cover, e.g. heath, are also very conducive to podzol formation.

Earthworms, insects, and micro-organisms, e.g. fungi and bacteria, strongly affect soil character and behaviour.

Topography

Since topography governs the position of a soil on the landscape, it is important in many respects, especially in its effect on water runoff and drainage. The amount of water that moves through a soil is less on steep than on gentle slopes, or lowlying or flat areas. This accounts, to some extent, for the preponderance of poorly drained soils in lowlying areas. Soils *of* poor drainage, however, may be found on good slopes where the lower soil horizons or parent material are of poor permeability, leading to retardation of water movement.

Elevation, with its attendant climatic and vegetational changes, strongly influences the soil development pattern. Topography is important in its effect on aspect and in deciding the use of soils.

Time

Considerable time is needed for the accumulation of soil parent material and for the development of horizons in the soil profile. The degree of maturity of a soil depends to a large extent on age, and also on the parent material and other factors. Soils developed on young deposits, such as alluvium, show less distinct horizons, in general, than those developed on old materials over a longer period.

Differences and Similarities among Soils

None of the five factors of soil formation is universally uniform. There are many kinds of rocks, many types of climate, many combinations of living organisms, great variation in topography and in age of different land surfaces. As a result there are innumerable combinations of the factors of soil formation, giving many different soils.

Differences among soils are both local and regional. Most farms consist of local kinds of soil, which have importance to management and productivity, whilst over the whole country there are also many different soils. Although it is true that great variability exists, the distribution is not so haphazard as might be expected. Each soil reflects the environment in which it has formed, occupies a definite geographic area and occurs in certain patterns with other soils. By recognising the main factors of soil formation and by distinguishing the reflected characteristics in the soils themsehes, we can segregate geographic soil units. Thus similarities and differences among soils can be recognised, and the various soils can be classified and their distribution mapped.

Plate 3—*Headquarters of Plant Sciences and Crop Husbandry Division of the Agricultural Institute at Oakpark, Carlow.*

Soil Mapping

Soil Series

It is principally on the basis of profile character, as expressed by the nature of the various horizons, that soils are classified and mapped. Although each profile has its individual character, some have so many important features in common that they can be placed together in a single primary category. The primary category used in mapping is the **soil series,** which comprises soils with similar type and arrangement of horizons, and developed from similar parent material. The soil series is also a basic category in soil classification.

A major problem in mapping soils is the delineation of boundaries between different series. Typical profiles of two different soil series may differ widely but, where the series are contiguous, it is usual for them to merge, sometimes over a considerable distance. Consequently, a line on the map \ery often defines the merging zone between soils rather than a sharp change in the soil character.

A soil series is named usually after the location in which the particular soils are best expressed or occur most widely.

Soil Variants

Variants are really separate soil series that are too small in extent to be shown at certain scales of mapping. A soil which is recognised and defined as a variant in one survey area, however, may be designated as a separate series later in another area, depending on its extent.

Other Soil Units

Soils within a series may be further sub-divided into **soil types** on the basis of surface textural differences. Different **soil phases** may also be mapped covering variations in features, such as slope, depth or stoniness, that are important in soil behaviour and land use. Segregation at these levels requires more detailed survey than that employed in County Carlow.

Soil Associations

To relate soils to their environment and, in particular, to their geological parent materials, series may be grouped into larger mapping units, or **soil associations.** A soil association is a grouping of series developed on similar parent materials but varying in profile character as a result of differences in other soil forming factors. Soils within the same association, therefore, although they may fall into a number of series on the basis of profile differences, have important physical and chemical properties in common, which have been inherited from the same parent material. The association unit has not been employed generally in County Carlow, but the soil series of the county are grouped in this manner in Appendix II.

Scale of Mapping

Field mapping is carried out on a scale of 6 inches to 1 mile (1:10,560), but this detail is reduced to a scale of \ inch to 1 mile (1:126,720) for publication. Since one 6-inch sheet covers an area of 24 square miles, to publish on this scale would necessitate, in the case of County Carlow, at least 26 individual map sheets. Considerations such as the cost of colour printing, ease of handling and general use of the map warrant reduction to the smaller scale.

This reduction, however, introduces certain difficulties. It has been found necessary to consolidate and, in some cases, delete some of the least extensive soil separations shown on the larger scale. On a scale of 1:126,720 it is possible to show a minimum area of 25 acres, and so any uniformly coloured area on the published map may include enclaves of less than 25 acres. Where soil series are recognised, but where their distribution pattern with contiguous series is so intricate as to defy clear-cut delineation on the map, a **soil complex** is mapped. The component series within the complex are named and, where possible, their relative proportions are given.

To accommodate those who are interested in more detail for special purposes, the field sheets (at a scale of 1:10,560) showing the entire field survey records are being retained for consultation at the National Soil Survey headquarters, Johnstown Castle, Wexford.

Description of Soil Profiles

During the survey of an area, profiles typical of each soil series are selected for special study. Fresh profile pits are opened for this purpose. The depth of pit varies according to soil depth but is usually about 4 to 5 feet. Each profile is thoroughly examined and described and a record made of its salient characteristics (Plate 4).

Plate 4—*Soil profiles representative of each soil series are examined and described. The various horizons are sampled for laboratory analyses.*

A soil profile is described by first noting certain features of the soil's environment, followed by details of its general characteristics. The characteristics which apply to the site include relief, slope, aspect, altitude and vegetation. Drainage conditions and the pattern of horizon development within the profile are considered next and, finally, properties of the individual soil horizons such as texture, structure, consistence, colour, mottling, amount of organic matter, stoniness, presence of hardpans and root development are described.

A bulk sample from each soil horizon is analysed physically and chemically at the Soil Laboratory. The analytical data supplement many of the field observations and provide a more complete picture of the true soil character. The results of these analyses for representative profiles of each soil series are given in Appendix I.

CHAPTER IV

THE SOILS

Thirty-seven Soil Series have been recognised and mapped within County Carlow; the series category has been defined in the previous chapter. The different series have been given geographic names based on the location in which the particular soils are best expressed or occur most widely. Two soil complexes and four variants have also been recognised and described.

In mapping their distribution in any area, the soils can be classified, on a broad scale, into major or Great Soil Groups, each consisting of a collection of closely related Soil Series. Each Great Soil Group then is comprised of soils having a number of important profile characteristics in common. A certain latitude in profile variation is allowable at this level of classification, but the degree of similarity, nevertheless, is of quite a high order. A single Great Soil Group may not be confined to a particular geological parent material, as the basic criteria for classifying the soils at this stage are the characteristics of the profile.

Description and discussion of the various soils mapped in County Carlow, arranged according to Great Soil Groups, are given in the following pages. Table V (page 64) shows the great soil groups, and their respective series and the extent of the county occupied by each.

In Appendix II the main soil series in the county are grouped according to close geological similaiities in parent materials.

Grey-Brown Podzolic Group

The development of these soils is associated primarily with the leaching process; the principal constituent accumulated in the P horizon is the finely divided clay fraction. To qualify as a Grey-Brown Podzolic, a soil must have a B horizon significantly higher in clay content than either the A or C horizons; such a horizon is termed a textural B or Bt horizon. The occurrence of clay skins on the structural ped surfaces is a further characteristic of the Bt horizon.

In geneial, the Grey-Brown Podzolics possess a somewhat heavy texture; they are well to moderately well drained, possess a moderately well- or well-developed structure and are usually moderately acid to neutral in reaction. The organic matter content in the surface is within the normal range for mineial agricultural soils and the humus is of the desirable mull-type.

Under Irish climatic conditions, the 'lighter' textured members of the Grey-Brown Podzolics are good all-purpose soils and, when adequately manured and managed, are very productive under most agricultural enterprises. The 'heavier' textured members are suitable grassland soils, responding well to good manurial and management practices. The grey-brown podzolic soils are not generally available for afforestation but should be highly productive for this purpose.

Ballinabranagh Series

Soil Character: This series occurs on undulating to rolling topography in the vicinity of Ballinabranagh and of the Clongrenan limeworks. The area has an elevation of 150 to 500 feet O.D. The series occupies 0.63 per cent (1,400 acres) of the county. The soils are derived from dense, calcareous, soliflucted drift material composed of a mixture of chert, flagstone, limestone, sandstone and shale. The soliflucted material comprises a mixture of calcareous till of Weichsel Age, composed mainly of limestone and chert, and non-calcareous drift material of Saale Age, soliflucted from the Castlecomer Plateau and composed mainly of Carboniferous shale, sandstone and flagstone.

These are very deep, well-drained soils of loam tending to clay loam texture and of high base status. The profile has a dark greyish-brown to brown, loam to clay loam, weak-structured, surface horizon containing 20 to 24 per cent clay and 4 to 6 per cent organic matter; this overlies a pale-brown to brown, leached A2 horizon. The surface horizon is about 10 inches deep and the sub-surface A2 varies in depth from 10 to 13 inches. Beneath the A2 horizon a very deep, brown textural B horizon merges with the dense, calcareous parent material at approximately 70 inches. Structure is weak throughout the profile and the soil is rather compact. Root development is largely confined to the surface 10 inches.

Soil Suitability: These soils have a wide use-range. Although not ideally suited to tillage due to their somewhat heavy texture and weak structure, they are capable of producing a wide range of farm and vegetable crops. Good yields of wheat, oats, feeding barley, potatoes, sugar-beet, swedes, mangels, cabbage, peas and French beans are obtained; oats, however, is very prone to lodging. The soils are considered rather heavy for carrot growing. In wet seasons tillage operations and harvesting can be difficult. These soils have a high potential for grass production which can be achieved by proper standards of management, including lime and fertiliser application as required. To avoid poaching, management must include restricted grazing in prolonged wet periods and conservation of summer surplus herbage for winter keep off the land.

Profile description and analyses—Appendix 1, Table 1.

Kellistown Series

Soil Character: These soils occur on undulating to rolling topography at elevations of 200 to 400 feet O.D. in the triangular area between Rathvilly, Goresbridge and Carlow. They occupy 19.69 per cent (43,619 acres) of the county. Parent material consists of calcareous, non-tenaceous glacial till of Weichsel Age, composed mainly of limestone with an admixture (less than 20 per cent) of granite and sandstone.

These are deep, well-drained soils, of sandy loam texture and of medium base status. The profile has a deep, friable, dark greyish-brown to brown sandy loam surface horizon with a moderately strong granular structure. This A horizon is normally 14 inches deep but varies from 12 to 18 inches; it contains 13 to 15 per cent clay and 4 to 7 per cent organic matter. Beneath this horizon a leached, sometimes slightly indurated, yellowish-brown A2 horizon, varying in thickness from 2 to 8 inches, overlies a thick, dai k yellowish-brown textural B horizon with a clay content

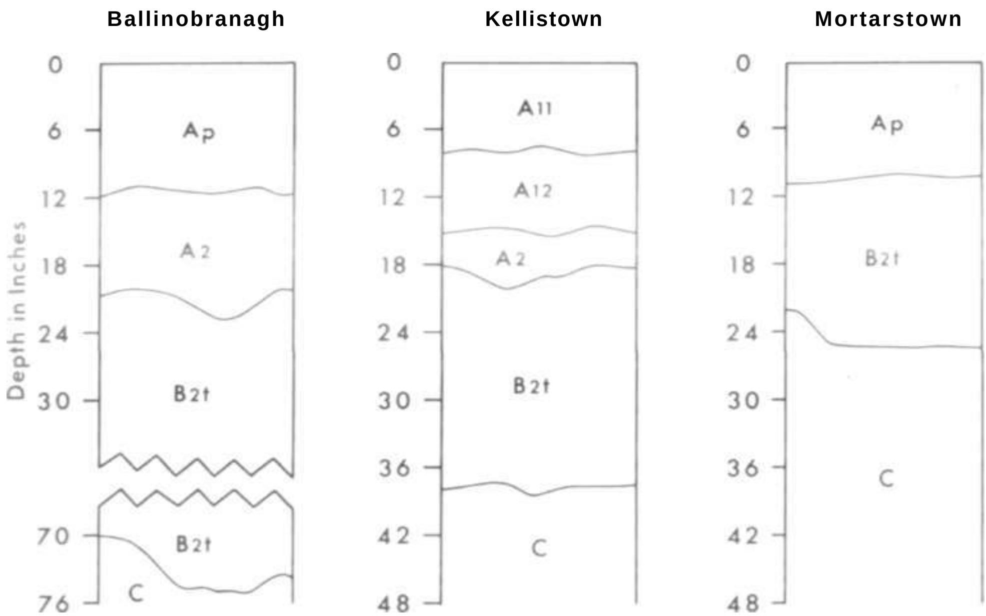

Fig. 8—*Horizon sequence in some grey-brown podzolic profiles.*

of 18 to 24 per cent and in which clay skins are prominent. There is an abrupt transition from the textural B horizon to the parent material. The soil profile varies in depth from 38 to 54 inches.

Soil Suitability: These soils have a wide use-range, being well suited to the production of farm, fruit and vegetable crops. Together with the soils of the Borris Series and of the Athy Complex, they are largely responsible for Carlow's reputation as a tillage county. With their medium to light texture and their good structure and friability, the Kellistown soils are easily tilled. Where properly manured, including the regular application of lime, excellent yields of wheat, malting and feeding barley, oats, sugar-beet, swedes and other root crops can be obtained. Strawberries give satisfactory returns and the acreage under this crop is increasing on these soils. Peas, French beans, carrots and cabbage are grown extensively for food processing.

Due to their depth, desirable physical properties and excellent conditions for root penetration, these soils have also a high potential for grass production^which can be utilized over a long grazing season.

Sporadic occurrences of molybdenum deficiency have been recorded locally in brassica crops, but more generally higher than normal levels of this element are found in these soils.

Profile description and analyses—Appendix I, Table 2.

Mortarstown Series

Soil Character: This soil occurs in isolated pockets among the outwash gravel soils of the Athy Complex in the vicinity of Carlow town. Topography is undulating and elevation varies between 150 and 200 feet O.D. The series occupies 0.40 per cent (880 acres) of the county. The soils are derived from compact but non-tenaceous, calcareous, glacial till mainly of limestone origin and of Weichsel Age.

The soils of this series are well drained, of loam texture and high base status, and vary in depth from 22 to 30 inches. The soil profile consists of a brown to dark-brown surface A horizon, approximately 10 inches deep, overlying a yellowish-brown textural B horizon which displays prominent clay skins on the ped surfaces. The clay content of the A horizon varies from 19 to 23 per cent with 4 to 7 per cent organic matter; the Bt horizon contains up to 42 per cent clay. Roots are plentiful in the surface horizon and penetrate freely down to the parent material. Moisture-holding capacity is high.

Soil Suitability: These soils are suitable for the production of a wide range of farm, fruit and vegetable crops and are capable of supporting high-class grassland. Responses to lime and fertilisers, particularly potassium, are good. Due to the somewhat heavy texture and rather weak structure of the soils, tilling and harvesting can be difficult in unfavourable seasons, resulting in reduction in crop yields and quality. For the same reason, poaching by grazing stock in prolonged wet periods is a hazard. Nevertheless, wheat gives excellent returns in favourable years, and although lodging in oats is very prevalent, yields are high. Whereas feeding barley gives good returns, the soils are less suitable for malting barley. High yields of potatoes are obtained but quality is often poor. Swedes, mangels and sugar-beet grow satisfactorily. Peas, French beans and cabbage give good returns, but carrots and asparagus are disappointing on these heavy soils.

Profile description and analyses—Appendix I, Table 3.

Pauls town Series

Soil Character: This series occurs to a limited extent in the vicinity of Royaloak, Muine Bheag, but more extensively across the county boundary in County Kilkenny, hence the series name. Topography is undulating and the elevation varies between 150 and 300 feet O.D. The series occupies 0.41 per cent (900 acres) of the county. Parent material consists of mixed glacial till of predominantly Carboniferous limestone composition with an admixture of shale and sandstone.

The soils of this series are deep, moderately well to well drained, of loam tending to clay loam texture and of high base status. The profile has a brown to dark-brown, loam to clay loam surface An horizon over a lighter coloured sub-surface A12 horizon. The structure of the A horizon is moderately good and the depth varies from 9 to 25 inches; clay content varies between 20 and 25 per cent and organic matter between 4 and 7 per cent. Burnt lime concretions have been observed in this horizon down to a depth of 16 inches in many places throughout the series. The B horizon shows a sharp clay increase and distinct clay skins, and merges with the calcareous parent material at a depth varying between 36 and 52 inches. Roots are plentiful in the surface A horizons and penetrate freely to a considerable depth. Moisture-holding capacity is high.

Soil Suitability: These soils have a wide use-range, being suitable for the production of a variety of farm and vegetable crops. Although tilling and harvesting can be difficult in wet seasons, good yields of wheat, oats, feeding barley, potatoes, sugar-beet, swedes and mangels are obtained. These soils are particularly noted for wheat growing. They are rather heavy for carrots and asparagus. Blackcurrants give excellent yields and strawberries, notwithstanding the heavy textured nature of the soils, are very satisfactory. Good yields of cabbage, peas and French beans are obtained.

Owing to their depth, free drainage, heavy texture and excellent moisture-holding

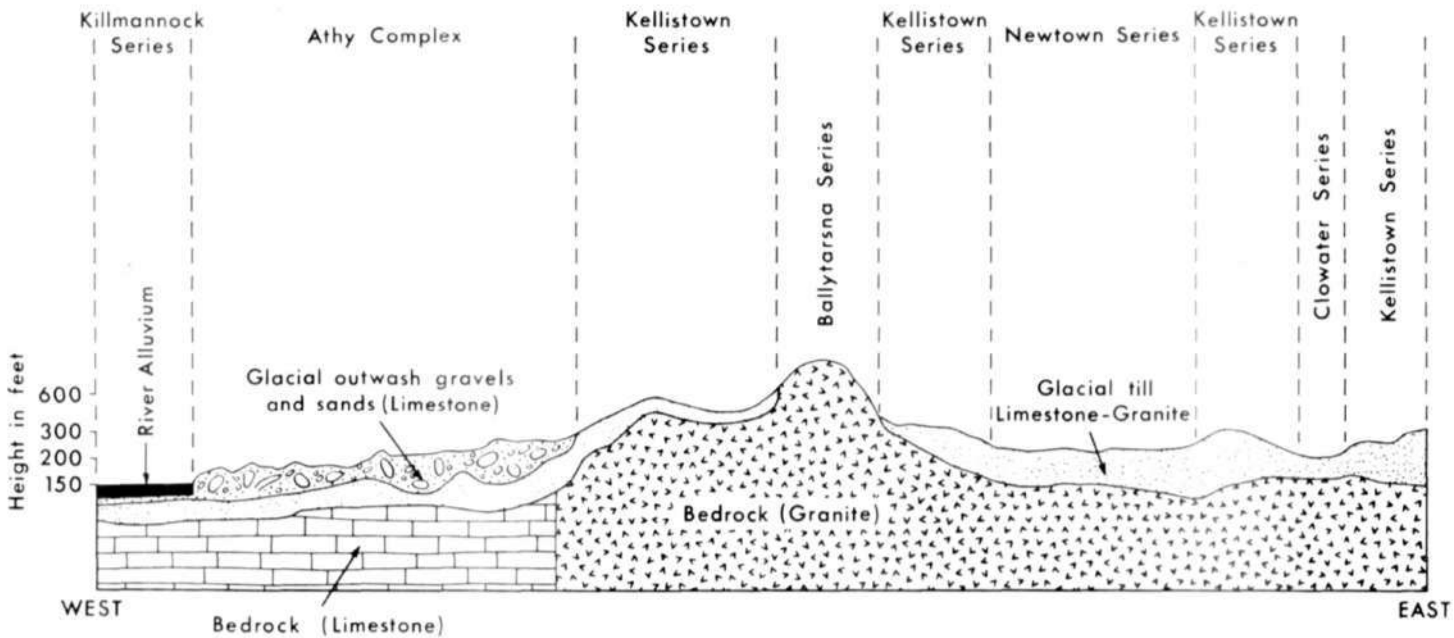

Fig. 9—*Diagrammatic representation of soil series in relation to landscape features and geology.*

capacity, these are first-class grassland soils. When adequately limed, fertilised and well managed, very high levels of production can be obtained. Controlled grazing is necessary, however, to prevent poaching and to attain maximum utilization; stocking must be restricted when ground conditions are soft and surplus summer growth should be conserved for winter keep off the land.

Profile description and analyses—Appendix I, Table 4.

Rathvinclen Series

Soil Character: These soils occupy a narrow strip on the western side of the River Barrow in the vicinity of Leighlinbridge; they occur on undulating topography between 150 and 200 feet O.D. The series occupies 0.43 per cent (960 acres) of the county. The origin of the parent material is difficult to explain, but it was probably derived from a mixture of at least three different glacial components; the calcareous limestone till of Weichsel Age was influenced both by soliflucted material from the local Carboniferous shale, sandstone and flagstone formations and by the stony, fluvioglacial limestone gravels of the Barrow valley. The resulting parent material is composed of a mixture of limestone, chert, flagstone, sandstone and shale and is very stony and also calcareous.

The soils of this series are well drained, of stony sandy loam tending to stony sandy clay loam texture and of high base status. The solum* varies between 36 and 40 inches in depth. Colour is fairly uniform throughout the profile. The surface horizon, which varies in depth from 10 to 15 inches, has a moderate, fine and medium granular structure; clay content here is usually 18 to 20 per cent and organic matter about 5 to 10 per cent. The underlying A13 horizon rests on the heavier textured B2t in which clay skins are prominent. A feature of this soil is the high proportion of rounded and angular stones throughout the profile. Roots are plentiful in the surface 15 inches and penetrate freely into the textural B horizon.

Soil Suitability: These soils have a wide use-range. They are excellent for tillage, being well suited to the production of a wide variety of farm, fruit and vegetable crops. Good yields of wheat, feeding and malting barley, oats, potatoes, sugar-beet and other root crops are obtained. Peas, French beans and carrots are also satisfactorily grown for processing. The soils respond well to fertilisers; liming is necessary only on a limited scale.

These soils are suitable for grass production. With proper manuring and management, a very high output can be attained and, although there is a hazard of poaching under soft ground conditions, pastures can be grazed over a long season.

Profile description and analyses—Appendix I, Table 5.

Brown Earth Group

The Brown Earths are relatively mature, well-drained, mineral soils possessing a rather uniform profile, with little differentiation into horizons. It follows, therefore, that these soils have not been too extensively leached or degraded, with the result that there are no obvious signs in the profile of removal and deposition of materials such as iron oxides, humus or clay. However, in many cases, some leaching has occurred, resulting in the translocation of soluble constituents, notably carbonates of calcium and magnesium.

Some Brown Earths are derived from parent materials poor in lime or base-rich components and are, therefore, inherently acid: these are called Acid Brown Earths or Brown Earths of low base status. Others have developed on more lime-rich parent materials, are less acid or may even be alkaline, and are distinguished as Brown Earths of high base status. An intermediate sub-group classified as Brown Earths of medium base status can also be distinguished. These and the Brown Earths of low base status can develop also on lime-rich parent materials under conditions conducive to excessive depletion of bases.

Brown Earths normally possess medium textures (sandy loam, loam, sandy clay loam), and desirable structure and drainage characteristics, and a high degree of friability. They are generally good arable soils. Although normally of rather low nutrient status in their natural state, they respond well to manurial amendments. With good management, they constitute high-quality grassland and are also ideally suitable for a wide range of forest tree species.

Acaun Series

Soil Character: These soils occur in the Derreen river valley, in the north-eastern portion of the county, on undulating to hummocky topography, at elevations between 300 and 400 feet. The series occupies 0.23 per cent (520 acres) of the county. The parent material is coarse textured and calcareous and comprises gravels (Saale Age) of limestone, granite, mica-schist and sandstone. As a result of long-term weathering, it is leached of calcareous material to a depth of 8 feet.

The soils of this series are well drained, of high base status and of coarse sandy loam texture. The profile consists of a dark-brown, friable surface horizon over a yellowish-brown sub-surface (B) horizon. The surface A horizon (An) contains 12 to 15 per cent clay, 6 to 12 per cent organic matter and has a moderately strong granular structure. The entire A horizon, or the combined An and A12, varies in depth from 12 to 18 inches. The (B) horizon is approximately 15 inches thick and merges with the parent mateiial at about 30 inches; the latter grades into calcareous gravels at around 8 feet. The solum varies in depth from 26 to 35 inches. Root development is good throughout.

Soil Suitability: These soils, like those of the Borris Series to which they are closely related, have a wide use-range. Being coarse-textured, free-draining, friable soils with a moderately good structure, they are easily cultivated and can produce good crops of malting and feeding barley, oats, wheat, potatoes, sugar-beet, swedes and mangels. Natural nutrient status is low and regular applications of fertilisers are required for optimum crop yields. Lime status is mainly satisfactory.

When well manured and managed, new leys on these soils are highly productive. Although moisture-holding capacity of the soils is moderately good, they are liable to drought in prolonged dry periods; nevertheless they are good pasture and meadow soils capable of being grazed over a long season.

Profile description and analyses—Appendix I, Table 6.

*Ballindaggan Series**

Soil Character: The series occupies 0.42 per cent (940 acres) of the county and occurs in the more elevated areas associated with the Blackstairs Mountains around Bunclody and Myshall. Topography is steeply rolling to rolling and elevations range

•Ballindaggan soils were first mapped in County Wexford (Gardiner & Ryan, 1964). There they were included with the Brown Podzolics but on the basis of current thinking they are considered closer to the Brown Earths.

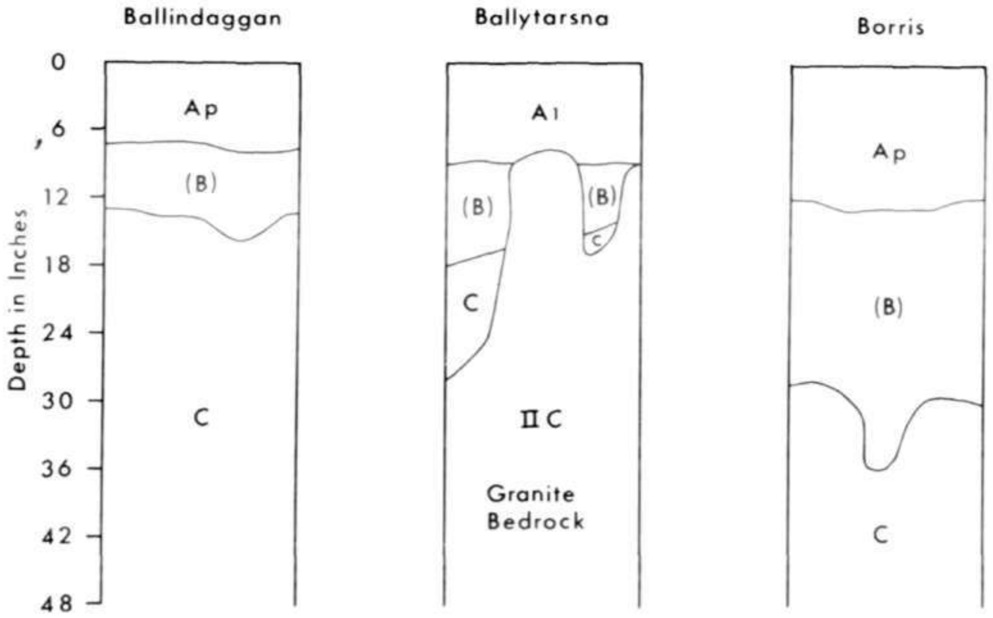

Fig. 10—*Horizon sequence in some brown-earth profiles.*

between 600 and 1,000 feet. Because of the elevation and steep slopes, the area for the most part has not been covered by glacial drift. The soils, therefore, are derived mainly from the local shale (with some mica-schist) materials.

These are moderately shallow, well-drained soils of loam to clay loam texture and of low to medium base status. The profile is characterised by a friable, reddish-brown surface horizon overlying a yellowish-brown (B) horizon which merges with the parent material at a depth of about 15 inches. The surface horizon varies in c'epth from 8 to 11 inches. It has a well-developed strong crumb structure, a clay content of 23 to 29 per cent and an organic matter content of 8 to 12 per cent. Solum depth varies from 13 to 18 inches. Root development throughout the soil profile is very good.

On the steeper slopes at higher elevations, where cultivation with modern machinery is practically impossible and where the soils are planted to forestry, natural degeneration of the profile has been taking place. Here the profile is very similar to the more common cultivated version but is characterised by a surface mat of decaying organic material and by lower pH values throughout.

Soil Suitability: On the less steeply sloping landscape these soils have a moderately wide use-range. They are suited to the pioduction of a variety of tillage crops, particularly malting and feeding barley, wheat, oats, potatoes, sugar-beet and other root crops. Their physical properties render cultivation easy, but their natural lime and nutrient status is low and, for best results, constant attention must be given to liming and manuring. These soils can support satisfactory pasture and meadow. If manuring and management are neglected, however, the sward rapidly degenerates.

On the steep slopes degeneration of pasture has reached an advanced stage; without rotation, cultivation and the application of lime and fertilisers, furze, bracken and heather become dominant. Many of these areas are now being planted successfully with forest trees.

Profile description and analyses—Appendix I, Tables 7-8.

Ballytarsna Series

Soil Character: This series occurs in small patches throughout the Kellistown Series and is chiefly associated with the higher topographic features of the Nurney Ridge. Topography is rolling to moderately steep; elevation varies between 300 and 650 feet O.D. The series occupies 0.42 per cent (940 acres) of the county. On account of the elevation difference and the moderately steep slopes, glacial drift cover is absent and the soils are, therefore, derived from the underlying granite bedrock.

These shallow to moderately deep soils are well drained, of coarse sandy loam texture and of low base status. They are very similar in profile characteristics to the Borris Series. The soil profile consists of a dark-brown, friable surface A horizon which overlies a yellowish-brown, friable (B) horizon.

The A horizon varies in depth from 7 to 12 inches and has a moderately strong, granular structure; the clay content ranges from 10 to 13 per cent and the organic matter from 6 to 10 per cent. The (B) horizon, approximately 10 inches thick, is non-continuous and is known locally as "weak earth". This horizon passes abruptly into granite bedrock and in places merges with an intermittent, coarse-textured, light yellowish-brown layer of weathered granite. The profile depth varies widely, from 7 to over 28 inches. Roots are abundant in the surface horizon and penetrate freely down the profile.

Soil Suitability: These soils have a wide use-range. Being coarse textured, friable and well drained, they are easily tilled. In places, however, cultivation is rather hazardous due to sub-surface granite boulders and outcropping rock. The Ballytarsna soils can produce good crops of malting and feeding barley, wheat, oats, potatoes, sugar-beet, swedes and mangels. Their natural lime and nutrient status is low, but they respond well to liming and manuring.

With proper manuring and management, these soils are highly productive under grass, but unless well managed the sward quickly reverts to indigenous species; where cultivation is impracticable, furze *(Ulex europaeus)* and bracken *(Pteridium aquilinum)* tend to dominate. In contrast to the geographically associated soils of the Kellistown Series, the moisture-holding capacity of these soils is insufficient to preclude a moisture deficit in prolonged dry periods.

Although soil cobalt levels are borderline, pining in sheep is not a problem in the area, since on the farms sheep are not confined exclusively to this soil, but have access to grazing on soils of the Kellistown Series in which cobalt levels are satisfactory.

Profile description and analyses—Appendix I, Table 9.

Borris Series

Soil Character: The soils of this series, the most extensive in the county, occupy 22.73 per cent (50,339 acres). They occur on rolling topography and predominantly between 100 and 500 feet O.D. in the south-eastern half of the county; they stretch from Drummin in the south to Hacketstown in the extreme north-east. Parent material consists of granitic till of Saale Age, but the presence of chert indicates that the drift, prior to weathering, contained a proportion of limestone.

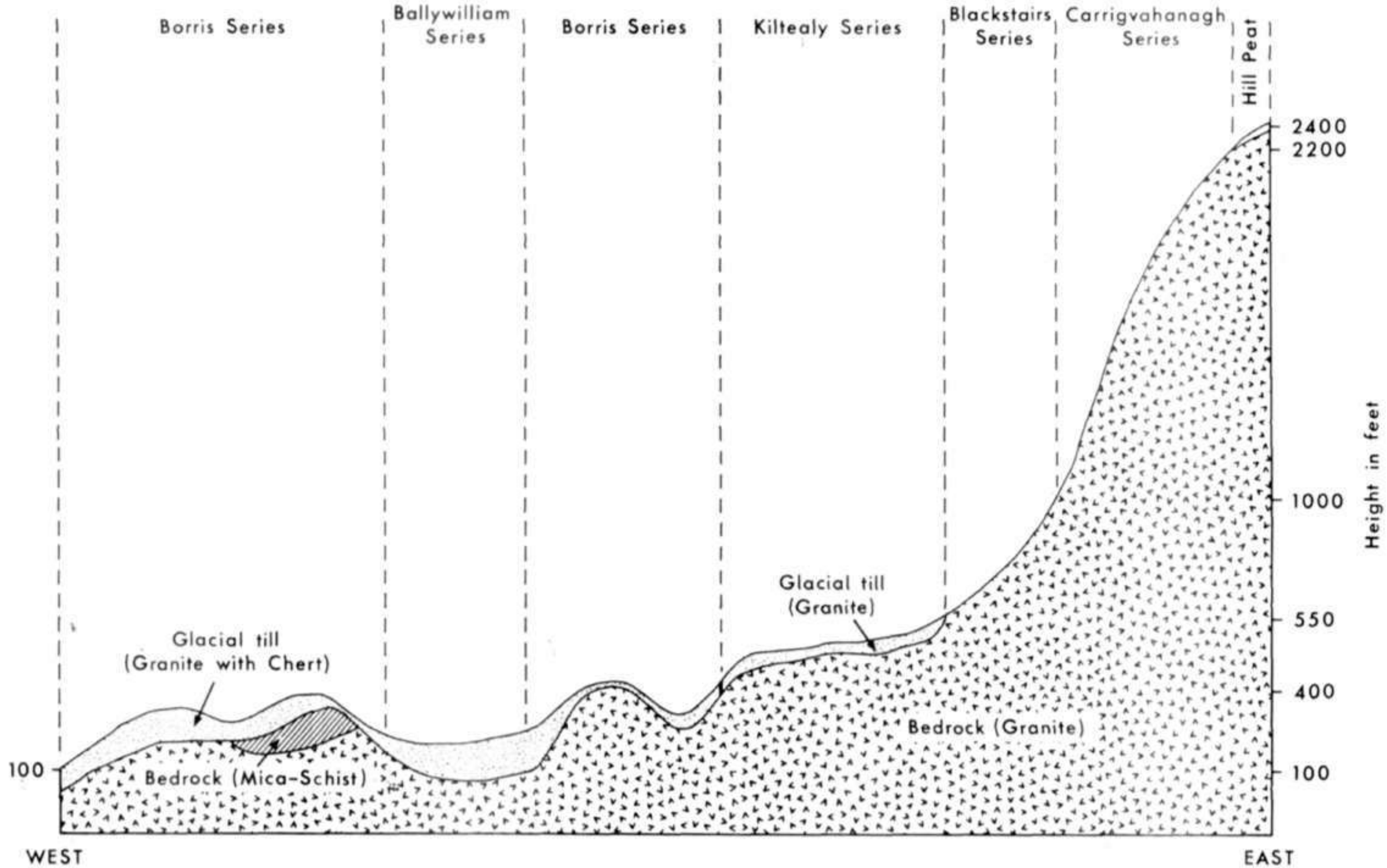

Fig. 11—*Diagrammatic representation of soil series in relation to landscape features and geology.*

These soils are moderately deep, well-drained, coarse sandy loams of low base status. 1 he profile has a dark-brown, friable, surface (Ap) horizon overlying a strong brown (B) horizon, which in turn overlies a light yellowish-brown, coarse-textured parent material at about 30 inches. The profile is moderately deep, ranging from 20 to 30 inches; root development is good throughout.

The surface horizon has a moderately strong, granular structure and is usually 14 inches deep but may range from 6 to 18 inches; it contains 10 to 13 per cent clay and 5 to 7 per cent organic matter. The (B) horizon does not normally show an iron accumulation, but in some profiles examined within the seiies an enrichment in free-iron is apparent; these are considered to represent a "weakly podzolised variant" of the series.

Soil Suitability: These soils have a wide use-range and are suited to the production of a variety of farm, fruit and vegetable crops. Being coarse textured, friable and well drained, with moderately good structure, they are easily tilled. In places, however, sub-surface granite boulders can render ploughing and cultivation rather difficult. With proper manuring and management, the Borris soils provide good yields of malting and feeding barley, wheat, oats, potatoes, sugar-beet, fodder beet, swedes and mangels. Their natural lime and nutrient status is low, but excellent responses to lime and fertilisers, particularly phosphorus, are obtained. Lime must be applied every 4 to 5 years as it is readily leached from these coarse-textured soils. Manganese deficiency in oats and barley following high lime applications often occurs.

Good crops of strawberries and raspberries can be obtained; the latter, however, are also susceptible to manganese deficiency. Peas and carrots give excellent returns. Crown rot, due to boron deficiency, occurs especially in parsnips and to a lesser extent in carrots.

The Borris soils are also noted for sheep grazing, the area giving its name to the well-known Borris ewe. Under grass, unless adequately limed, fertilised and managed, the sown species in the sward are rapidly replaced by poor quality indigenous ones. Moisture-holding capacity of these soils is moderately good, but a deficit is a problem in very dry seasons.

Cobalt deficiency is a serious problem where livestock health is concerned; soil levels of four parts per million (ppm), and lower, are not uncommon. As a result, pining in sheep through insufficient intake of cobalt from the herbage is quite widespread. This condition, however, can be remedied by cobalt sulphate dressings on the land or by oral administration of cobalt to the animals. In certain areas within this series, particularly in the Coolyhune-Coolnamara-Ballykeenan district, pining in sheep is not so common: small portions of the Clonegall Series, which have adequate levels of cobalt and to which the sheep have access, occur within the Borris Series. The enclaves were too limited in size and too scattered to separate them at the scale of mapping employed.

Profile description and analyses—Appendix I, Tables 10-11.

Keeloge Series

Soil Character: This series occupies 0.60 per cent (1,320 acres) of the county, and occurs on the moderately steep to steep slopes on the eastern escarpment of the Castlecomer Plateau. Although most slopes are under 30°, many are between 15 and 22°. The elevation varies from 400 to 1,000 feet O.D. Due to the steep slopes, glacial drift material is absent and the soils, therefore, are derived from the underlying Carboniferous shale bedrock.

The soils are naturally well drained, of loam tending to clay loam texture and of low to medium base status. The profile consists of a dark-brown surface (Ap) horizon, over a yellowish-brown (B) horizon which merges gradually with the weathered, shaly parent material at a depth of 18 to 24 inches. The surface horizon varies in depth from 10 to 12 inches, has a well-developed crumb structure, a clay content of 23 to 26 per cent, with 40 to 50 per cent silt and 8 to 12 per cent organic matter. The (B) horizon despite a distinct colour contrast does not show a free-iron enrichment. Moisture-holding capacity is moderately good. Roots are abundant in the Ap horizon and penetrate freely.

Soil Suitability: These soils have a moderately wide use-range. Due to their good crumb structure and friable consistence, a good tilth is easy to produce. However, steep slopes render ploughing, cultivation and other farm operations rather hazardous. Formerly, when mechanisation was largely confined to horse-drawn implements, the acreage of these soils under tillage was much greater. Good yields of oats, feeding barley, potatoes, swedes, mangels, kale and sugar-beet can be obtained. A limited acreage of peas for processing is grown.

Without regular use of lime and fertilisers, particularly phosphorus, good yields are difficult to attain. This is equally true of grass production. New leys are highly productive, but without manuring and good management the pastures degenerate quickly. On the steeper slopes where cultivation is impossible, the fields become overgrown with bracken, furze and brambles. In very dry periods the soils are liable to develop a moisture deficit.

Profile description and analyses—Appendix I, Table 12.

Brown Podzolic Group

The Brown Podzolics are a more intensely leached version of the Brown Earths and as a result, the upper horizons are more depleted of bases and other constituents. A characteristic feature of these soils is a sub-surface horizon of strong red-brown or yellowish-brown colour due to enrichment, principally by iron oxides leached from the upper horizons. They are more degraded generally and of a more acid nature than the Brown Earths.

Although the Brown Podzolics are more leached and of lower natural nutrient status than the Brown Earths, they closely resemble each other in behaviour and productive capacity. On account of their desirable texture, structure, drainage and friability, the Brown Podzolics are considered highly suitable for cultivated cropping, except where they occur on excessively steep slopes. Although lacking in natural nutrient and lime status, they respond well to manurial amendments. Highly productive short-term leys can be obtained within the crop rotation, when manuring and management are satisfactory. Like the Brown Earths, they are ideal forest soils under Irish climatic conditions.

Clonegall Series

Soil Character: The soils of this series are derived from glacial till of Saale Age composed of shale, granite and some mica-schist. They occupy 6.10 per cent (13,524 acres) of the county. They are found mainly on rolling topography and between 150 and 600 feet O.D. in the south-eastern portion of the county, around Clonegall, Kildavin and Myshall. Slope varies from 8 to 22°, the more dominant ones being about 12 to 16°.

The soils are moderately deep, well drained, of loam to sandy loam texture and of low base status in their natural state. The profile consists of a dark greyish-brown surface horizon overlying a yellowish-brown B horizon which shows a substantial enrichment in free-iron. The surface horizon varies in depth from 8 to 14 inches; it contains 14 to 18 per cent clay, 7 to 14 per cent organic matter and has a moderately strong granular structure. Root development throughout the profile is good. Solum depth ranges from 22 to 28 inches.

These soils may be considered as intermediate in some respects between those of the Ballindaggan and Borris Series since they are derived from a mixture of the principal components of the parent materials of these two series. Consequently, they are coarser textured than the soils of the Ballindaggan Series and finer textured than those of the Borris Series.

Soil Suitability: These soils have a wide use-range. Because of their desirable texture, structure, friability and drainage conditions, they are easily tilled and root development is good. In some places, however, cultivation is rather difficult due to the slope gradient. They are capable of producing a variety of tillage crops, including malting and feeding barley, wheat, oats, sugar-beet, swedes and mangels. Swedes are grown extensively for winter feeding to sheep. The soils have a poor reputation for potato production. The only soft fruits grown are strawberries and to a lesser extent black-currants.

In their natural state, these soils have a low lime and nutrient status, but they respond well to regular applications of lime and fertilisers. They have a good potential for grass production and are capable of being grazed over a long season. Unless adequately manured and managed, however, the more valuable sown species in the sward are rapidly displaced by indigenous grasses and weeds.

Profile description and analyses—Appendix I, Table 13.

*Kiltealy Series**

Soil Character: This series occupies 2.01 per cent (4,445 acres) of the county. The soils are found mainly in the extreme south-eastern portion of the county adjacent to the Blackstairs Mountains, and occur on rolling topography and at elevations ranging from 300 to 600 feet O.D. The parent material, which is coarse textured and compact *in situ,* consists of highly weathered granitic till of Saale Age. In places it contains a small proportion of shale.

The soils are well drained, of coarse sandy loam texture and of low base status. The profile consists of a very dark-brown, friable surface horizon over a well-developed, strong-brown B horizon which shows distinct iron oxide accumulation. The B horizon merges with the light yellowish-brown parent material. The A horizon varies in depth from 13 to 18 inches and contains 8 to 13 per cent clay, and 6 to 16 per cent organic matter. The solum is usually 35 to 40 inches deep. Moisture-holding capacity of the soils is moderately good and roots penetrate freely throughout the profile.

Soil Suitability: These soils have a moderately wide use-range. They are suitable for a fairly limited range of tillage crops, and are noted for their suitability for sheep

*Kiltealy soils were first mapped in County Wexford (Gardiner & Ryan, 1964), hence the series name.

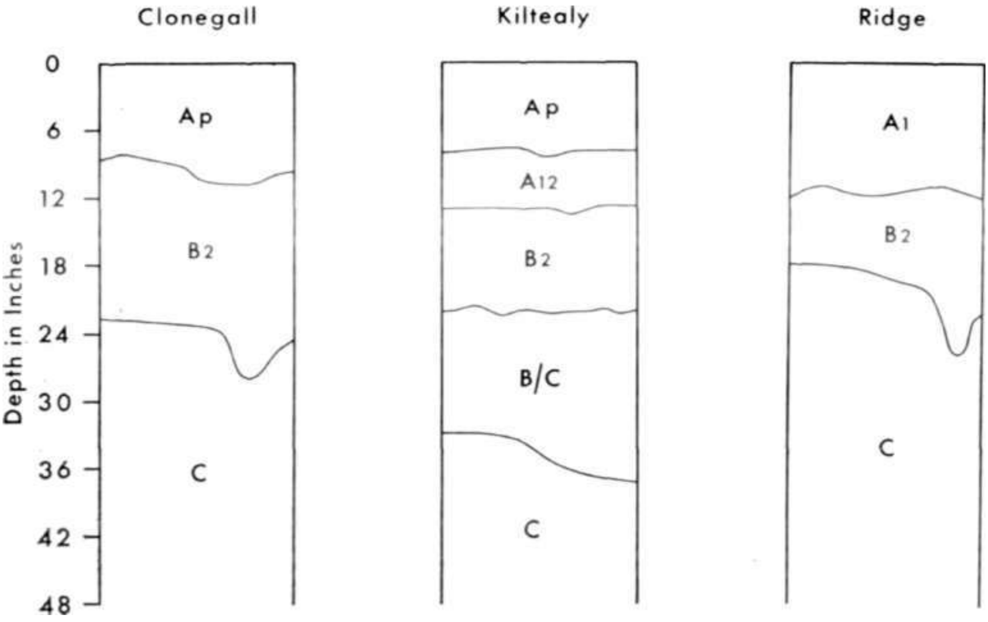

Fig. 12—*Horizon sequence in some brown podzolic profiles.*

grazing. Being coarse textured and friable, with a strong granular structure, they are easily tilled. However, near-surface granite boulders and occasionally bedrock can render ploughing and cultivation rather difficult. Their natural nutrient status is low, but excellent responses to lime and fertilisers, particularly phosphorus, are obtained.

The acreage of wheat on these soils is extremely small and yields are below average. With the more liberal use of lime both the acreage and yields of feeding barley are increasing. These soils are noted for the production of top-quality oats and particularly of the black oat varieties. However, with the increased use of lime, grey speck disease, due to an induced manganese deficiency in the oat crop, is becoming more prevalent. High yields of top-quality potatoes are obtained. A large acreage of swedes and mangels is grown for winter feeding to sheep. With good management including the application of lime and fertilisers and particularly phosphorus and nitrogen, new leys are highly productive. Such management must be sustained for high-quality swards, otherwise pastures deteriorate rapidly and indigenous species become dominant. Moisture-holding capacity of these soils is relatively good, but a deficit develops in very dry seasons.

Cobalt deficiency is a problem on these soils where livestock health is concerned. Soil levels of 4 ppm and even lower are common. As a lesult, the cobalt intake of sheep and cattle grazing these lands is insufficient to meet their needs; pining in sheep on this account is particularly widespread. But the condition can be remedied by cobalt sulphate dressings on the soil or oral administration of cobalt to the animals.

Profile description and analyses—Appendix 1, Table 14.

Kiltealy Series—Shallow Variant

Soil Character: The soils of this variant occupy the tops and steeper slopes of the rolling hills within the Kiltealy Series. They have not been separated from the main series at the scale of mapping employed, because of their intricate pattern of distribution.

The soils of the variant are well drained, of coarse sandy loam texture and of low base status. The profile is similar to that of the Kiltealy Series except that it is shallower—varying from 14 to 18 inches in depth—and it overlies shattered granite bedrock instead of granitic till.

Soil Suitability: These soils have a somewhat more limited use-range than the Kiltealy Series. Although they resemble the latter in general land use suitability, because of the bedrock being nearer the surface ploughing and cultivation operations are more difficult; also they are more prone to develop a moisture deficit in dry periods.

Profile description and analyses—Appendix I, Table 15.

Knocksquire Series

Soil Character: This series occupies 0.77 per cent (1,700 acres) and occurs mainly in the southern portion of the county associated with the Borris and Kiltealy Series. The soils occur on moderately steep to steeply rolling topography at elevations between 600 and 900 feet O.D. Due to elevation and slope there is no glacial drift cover and the soils are derived from the granite bedrock formation.

Distinctive features associated with this series are the steep slopes and high proportion (20 to 40 per cent) of outcropping granite rock and boulders. Between the outcrops, the soils are moderately deep, well to excessively drained, of coarse sandy loam texture and of low base status. The profile consists of a very dark greyish-brown, friable surface horizon overlying a fairly thick sub-surface B horizon in which iron oxide enrichment is apparent. The A horizon is relatively thin, most usually 7 inches but ranging between 5 and 8; it has a moderately strong granular structure and a diffuse rooting system, which penetrates to the underlying bedrock. The B horizon is up to 20 inches thick.

Soil Suitability: These soils have a limited use-range. Due to slopes and rockiness they are unsuitable for tillage except in small isolated patches. For the same reasons they are unsuitable for meadowing. Their greatest potential probably is in grass production for grazing by sheep and dry stock.

The natural lime and nutrient status of these soils is very low, and for optimum returns lime and fertilisers must be applied regularly. Mechanical application is so difficult that at present most of these soils are neglected and the sward overgrown with bracken and furze. As their moisture-holding capacity is low they are prone to develop a deficit in dry periods.

Profile description and analyses—Appendix I, Table 16.

Ridge Series

Soil Character: These soils are situated on the top of the Castlecomer Plateau on undulating to rolling topography. Slopes generally are less than 10° and elevations range between 700 and 1,055 feet O.D. The drift cover deposited by the Saale ice movement on these topographic features has been eroded by the frost action of the last (Weichsel) glaciation. Consequently, the soils are derived from the underlying Carboniferous shales known locally as "slig". The series occupies 0.70 per cent (1,560 acres) of the county.

The soils of this series are moderately deep, well drained, of clay loam to loam texture and of low base status. The profile is characterised by a dark-brown, friable, clay loam surface horizon overlying a strong-brown, friable loamy B horizon enriched with iron oxides. The latter horizon merges with the olive-brown, shaly parent material at a depth varying between 18 and 26 inches.

The A horizon, which varies in depth from 10 to 15 inches, has a moderately strong granular structure and contains 23 to 30 per cent clay, 40 to 50 per cent silt and 7 to 12 per cent organic matter. Roots are plentiful in the surface horizon and penetrate freely down the profile. Moisture-holding capacity is moderately good.

The soils of this series are very similar to those of the Mountcollins Series, Co. Limerick (Finch & Ryan, 1966).

Soil Suitability: These soils have a moderately wide use-range. Physically they are excellent soils, but the high elevation and its attendant colder and wetter climatic conditions cause late spring growth in most crops and late ripening, particularly of cereals. There is also a serious lack of shelter belts.

Natural lime and nutrient status is low, and without liberal use of lime and fertilisers, especially phosphorus, yields are usually disappointing. The acreage of feeding barley is increasing with the increased use of lime. Good yields of excellent quality oats are obtained, as well as good crops of potatoes, swedes, mangels, kale and cabbage. Cabbage, for food processing, gives good financial returns to farmers but yields are lower than on lowland soils.

Grassland must be liberally manured and well managed if the potential of these soils for pasture and meadow is to be realised. Even with good management, however, early grass production is difficult due to late warming-up of the soils in spring and the colder conditions generally.

Profile description and analyses—Appendix I, Table 17.

*Ridge Series—Flaggy variant**

Soil Character: This soil occurs in close association on the landscape with the Ridge Series, but because of its small extent and intricate pattern of distribution it could not be delineated at the scale of mapping employed. Consequently, it has been mapped with the Ridge Series from which it differs only in being extremely flaggy and having a lighter texture. It occurs on undulating to rolling topography and is derived from the underlying Carboniferous flagstone bedrock.

The soils are moderately deep, well drained, of loam texture and of low base status. The profile consists of a dark-brown, friable surface A horizon with a strong granular structure overlying a yellowish-red, friable B horizon enriched with iron oxides. The B horizon gives way abruptly to flagstone at 19 inches. The A horizon varies in depth from 5 to 9 inches and contains 20 per cent clay, 40 per cent silt and about 10 per cent organic matter. Roots are plentiful in the surface horizon and penetrate freely down to the bedrock. Moisture-holding capacity is moderately good.

Soil Suitability: These soils have a slightly more restricted use-range than those of the Ridge Series. Although they resemble the latter in general land use suitability, ploughing and cultivation are more difficult owing to the high concentration of flaggy stones present.

Profile description and analyses—Appendix I, Table 18.

*Fragmented flagstones.

Podzol Group

These soils are more intensely leached than the Brown Podzolics. They display well-defined horizons of depletion and accumulation within the profile and are considered to be degraded soils. They develop from parent materials of very low base reserves or under conditions which deplete the base reserves to a low level. The granite mountains for instance provide a situation in which both of these factors operate; with the acid nature of the geological parent materials together with the high rainfall, considerable leaching of soil constituents, principally bases, iron and aluminium oxides, and humus takes place. In more advanced deterioration, the surface becomes very acid, the environment for decomposition by micro-organisms becomes unfavourable, and a peat-like layer accumulates on the surface, on which heath-type vegetation develops.

Podzols are generally pooi soils with high lime and fertiliser requirements. In their unreclaimed state they usually have a cover of semi-natural vegetation. In lowland areas, they have been successfully reclaimed for cultivated cropping and other purposes, but unless management is good they revert easily. The more extreme forms, which occupy hill and mountain areas throughout the county, have not been ameliorated to any extent. In most cases the nature of the terrain associated with these soils is such that mechanical reclamation and cultivation are not feasible. Here they are devoted mostly to rough grazing or forestry. Considerable improvement in stock-carrying capacity is possible by surface regeneration of the rough grazing, through manuring and improved management.

Where an ironpan occurs within the profile, it hinders root penetration (an important factor in forestry and in the agricultural use of these soils) and water percolation. For the latter reason drainage in the surface horizons may be very poor—a further unfavourable feature of many of the Podzols. Besides having a low level of major nutrients, these soils are usually very deficient in trace elements.

Podzols are the most widely available mineral soils for afforestation in the country and are usually planted with pines *(Pima* spp.). However, with deep ploughing and the application of phosphorus fertiliser in particular, they can support other species, such as Sitka Spruce *(Picea sitchensis),* with relative success.

Ballinagilky Series

Soil Character: The soils of this series occupy 0.34 per cent (760 acres) of the county. They occur mainly to the east of Hacketstown and also, to a lesser extent, associated with the Kiltealy Series in close proximity to the Blackstairs Mountain range. They are found on undulating to rolling topography between 500 and 650 feet O.D. and are derived from granitic till of Saale Age.

Cultivation with the addition of lime and fertiliser has altered the physical, chemical and biological properties of the soil. The peaty surface horizon has been mixed with the greater part of the greyish, leached A2 horizon, thereby lowering the natural surface organic matter content; the remainder of the A2 horizon has been obliterated by incieased worm activity following the amelioration process. Portion of the ironpan has been destroyed by mechanical means, consequently both internal drainage and rooting depth have been greatly improved. The application of lime and fertilisers has decreased acidity and raised the nutrient status of the soil while the use of farmyard manure, in particular, is considered to have increased the earthworm activity.

The profile now consists of a dark-coloured, friable, organic coarse loamy sand surface horizon, approximately 10 to 15 inches deep, overlying a broken, non-continuous ironpan. Beneath the pan, the friable B horizon of humus and iron accumulation grades into the coarse-textured granitic parent material at 20 to 30 inches. The strong-brown lower B horizon contains blotches of dark reddish-brown and reddish-brown colours, which have a more intense humus accumulation.

Soil Suitability: These soils have a somewhat limited use-range. As a result of extreme podzolization, natural lime and nutrient status is extremely low. However, generations of cultivation with additions of lime and manure have tended to improve the fertility and general nutrient status.

Even with lime, manures and good management, serious limitations still exist for cereal production. Oats is the most suitable grain crop, but barley is becoming more important with the increased use of lime. However, liming these organic-rich soils predisposes both oats and barley to induced manganese deficiency. Wheat gives poor returns. With extra good management satisfactory yields of potatoes, cabbage, rape, kale, swedes and mangels can be obtained. New leys, when adequately limed, manured and managed, give moderately good returns; for sustained output, however, management must be of a high standard. Low soil and herbage cobalt levels are a further problem where livestock health is concerned: cobalt must be supplied for best results, particularly in sheep.

Profile description and analyses—Appendix I, Table 19.

*Black Rock Mountain Series**

Soil Character: This series occupies 1.88 per cent (4,160 acres) of the county, on the mountainous areas to the north of Mount Leinster. The soils occur on steep slopes and at elevations ranging from 1,000 to 2,000 feet, areas which have not been covered by glacial drift. The soils are derived, therefore, from the underlying weathered bedrock. The high altitude, with attendant higher rainfall and lower temperatures, has contributed to the highly leached nature of the Black Rock Mountain soils and to the surface accumulation of raw humus.

The profile is characterised by a peaty surface horizon, a strongly leached A2 horizon, a thin, continuous, tonguing ironpan and a thick, strong-brown B22 horizon overlying the shattered shale bedrock. The surface peat varies from 7 to 13 inches in depth. The ironpan shows a highly significant free-iron accumulation and a humus enrichment while the underlying B22 horizon also shows a substantial increase in free-iron. Root and water penetration are impeded by the ironpan; root development is confined to the horizons above the pan.

So/7 *Suitability:* The soils of this series have a very limited use-range. They are suited only to forestry or extensive grazing. Their nutrient status and lime content are very low, and cobalt levels are deficient. The application of lime and to a lesser extent fertilisers in these areas is difficult. For hill-grazing purposes, however, stock-carrying capacity can be improved considerably by the application of phosphatic fertilisers with some cobalt, and where feasible, by some overseeding.

Profile description and analyses—Appendix I, Table 20.

•Similar soils have been mapped in County Wexford (Gardiner & Ryan, 1964) under the same series name.

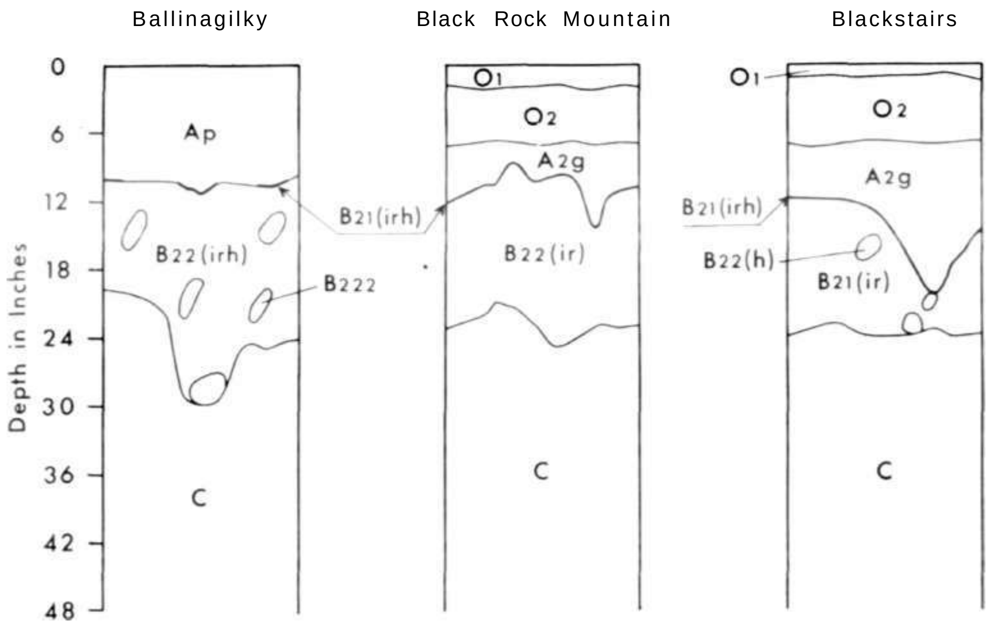

Fig. 13—*Horizon sequence in some podzol profiles.*

*Blackstairs Series**

Soil Character: The soils of this series occupy 0.90 per cent (2,000 acres) of the county. They occur on moderately steep slopes on the Blackstairs Mountains south of Mount Leinster. Because of the high elevation, the area was largely unaffected by glacial action and the soils are, therefore, derived from the underlying granite bedrock formation. Elevation varies from 500 to 1,300 feet and the majority of the slopes are between 15 and 20°. This series is closely associated on the landscape with the skeletal, peaty soils of the Carrigvahanagh Series; the latter, however, usually occur at higher elevations and on steeper slopes.

The Blackstairs soils are moderately deep, but are strongly leached and of low base status. The higher rainfall and lower temperatures, associated with the high elevation, have contributed to the strongly leached nature of the profile and to the surface accumulation of raw humus. The soil profile consists of a peaty surface layer over a strongly leached, tonguing A2 horizon, a thin, continuous well-developed ironpan, and a thick yellowish-brown lower B horizon overlying weathered granitic debris. The surface peat varies in depth from 6 to 16 inches. Dark-coloured streaks or blotches showing a higher humus content occur within the lower B horizon. Rooting

*Similar soils have been mapped in County Wexford (Gardiner & Ryan, 1964) under the same series name.

depth is limited due to the impermeable ironpan, and there is evidence of drainage impedance above the pan while below it the profile is free draining. Large granite boulders are common on the soil surface.

Soil Suitability: These soils have an extremely limited use-range. Adverse physical factors include elevation, slope, ironpan and impeded drainage rendering the soils suitable only for extensive hill-grazing, preferably for sheep. Native nutrient levels are extremely low and cobalt deficiency is a serious problem where animal health is concerned. Soil cobalt levels lower than 1 ppm are not uncommon, while herbage levels are generally in the region of 0.02 to 0.05 ppm.

Some improvement in stock-carrying capacity can be expected from lime and fertiliser application with overseeding, where practical. However, the physical task of applying lime, and to a lesser extent fertilisers, is likely to be a barrier to any such improvement throughout the series. Cobalt must be applied to the land or administered to the grazing stock if pining is to be avoided.

Profile description and analyses—Appendix I, Table 21.

Tomard Series

Soil Character: The soils of this series occupy 0.36 per cent (800 acres) of the county. They occur on the Castlecomer Plateau on undulating topography and at elevations between 800 and 1,034 feet O.D. Parent material consists of weathered flagstone bedrock.

These imperfectly drained, dark-coloured soils of slightly peaty, silt loam texture and of low base status have been classified as reclaimed gleyed Podzols. Prior to human interference the profile was characterised by a black, organic surface horizon, over a greyish-brown leached A2 horizon, over, in turn, a mottled B2 horizon showing a significant accumulation of iron oxides. This B2 horizon was underlain by mottled B3 and Cg horizons. In the 18th and 19th centuries scarcity of arable land and an increasing population forced the inhabitants to reclaim and cultivate this marginal land. Ploughing and cultivation with additions of lime and manures have altered the physical, chemical and biological properties of this soil.

The profile now consists of a very dark-brown, peaty silt loam surface horizon approximately 7 inches deep, overlying the mottled B and C horizons. The solum is about 20 inches thick. The greyish-brown leached A2 horizon has been largely obliterated by cultivation and earthworm activity. The structure of the surface horizon is reather weak, but root development is good throughout the profile.

Soil Suitability: The soils of this series have a somewhat limited use-range. Their marginal nature, extremely poor natural nutrient status, imperfect drainage and the colder and wetter climatic conditions at the higher elevations, all curtail the range of crops, and yields are below average. Even with liberal and regular use of lime and fertilisers, particularly phosphorus, high yields are difficult to obtain. The soils are unsuitable for wheat growing. Oats is the most successful grain crop, but the acreage of barley is increasing. Swedes, mangels, potatoes and cabbage give moderately good yields. Early grass production is extremely difficult. New leys can be productive provided lime and fertilisers are regularly applied; for sustained output a high standard of management must be maintained, otherwise the sward quickly reverts to the poorer grasses and weeds. To avoid poaching it is necessary to curtail the grazing season.

Profile description and analyses—Appendix I, Table 22.

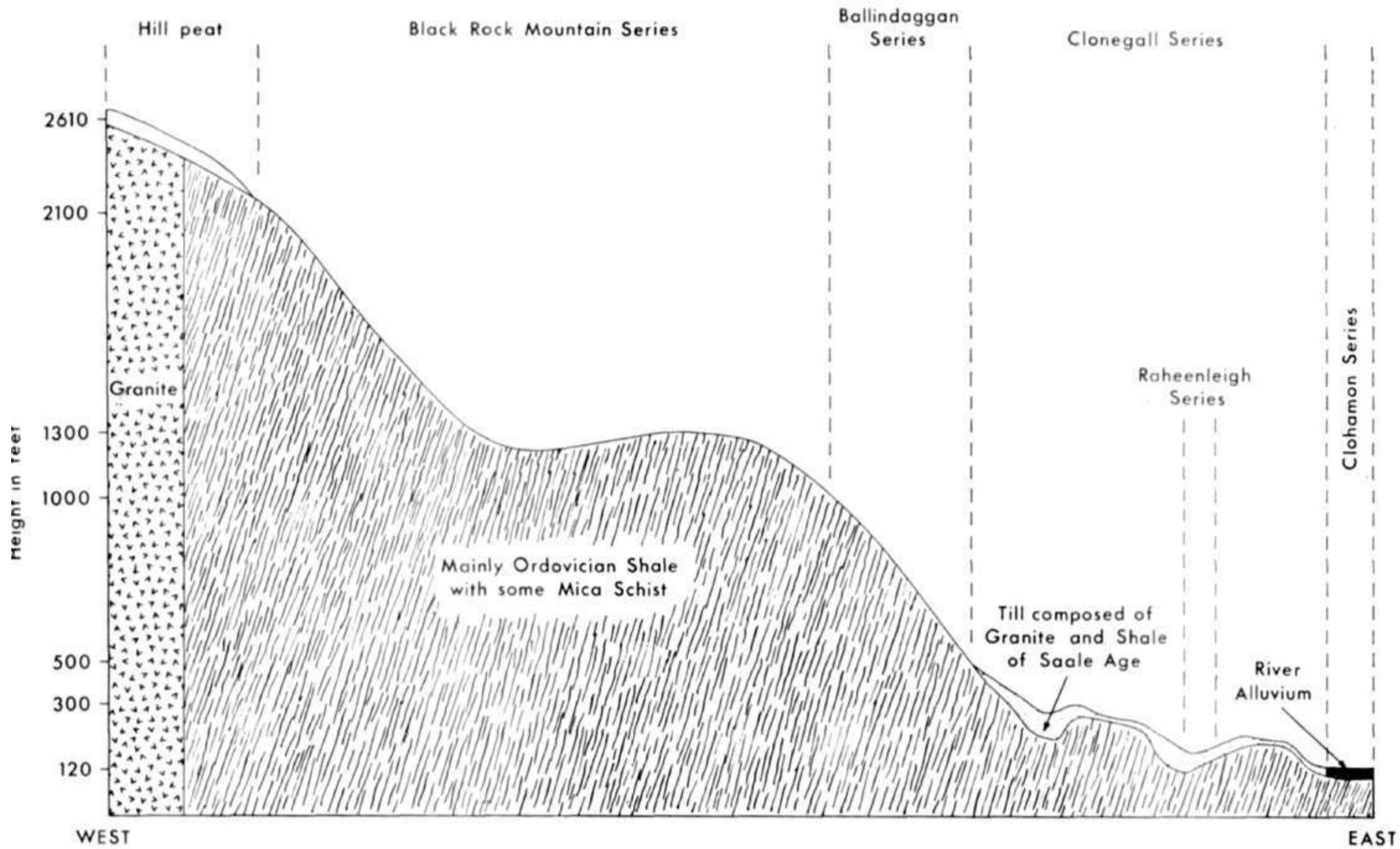

Fig. 14: *Diagrammatic representation of soil scries in relation to landscape features and geology.*

Gley Group

Gleys are soils in which the effects of drainage impedance dominate and which have developed under conditions of permanent or intermittent water-logging. The impeded condition may be caused by a high water-table or by a 'perched' water-table due to the relatively impervious nature of the soils and their parent materials and, in many cases, by both of those factors, together with excess run-off from higher slopes. For this reason, gley soils can occur both in depressions and on elevated sites.

Where the gley condition results from a high water-table, the soils are referred to as ground-water Gleys. Where it is due to the impermeable nature of the soils or of their parent material, or to run-off from higher slopes, the soils are usually referred to as surface-water Gleys.

The mineral horizons of Gleys are usually grey (or bluish-grey, in more extreme cases), with distinct ochreous mottling much in evidence. Relative to the podzolic soil groups, depletion of bases and other constituents is not so pronounced. However, rooting area is limited, aeration poor, rate of decomposition of organic matter slow, and many other unfavourable features prevail.

Podzolised Gleys are soils in which there is evidence of a soil formation process similar to that described for Brown Podzolics or Podzols associated with the Gleys, whilst Podzolic Gleys refer to soils displaying evidence of Grey-Brown Podzolic characteristics associated with the Gley.

The majority of gley soils have weak structure, are not very friable and, in the wet state, tend to become very sticky. Due to their poor physical properties, these soils, except in very favourable seasons, present difficulties in cultivation, especially in the development of a desirable tilth. The poor drainage conditions retard growth in the spring. Even for pasture production, this is a decided disadvantage. Besides poor drainage, the characteristic weak structure renders these soils susceptible to poaching damage by grazing stock, a factor which curtails the length of grazing season and the proportion of fodder utilized. Despite their physical shortcomings, however, the potential of these soils for pasture production is high in many cases, provided management and manuring are satisfactory.

Gleys are generally considered to be relatively productive forest soils. However, windthrow caused by poor root penetration is a common hazard.

Ballinrush Series

Soil Character: This series occupies 0.40 per cent (880 acres) of the county and occurs on flattish topography and in depressional sites where the water-table is consistently high throughout the greater part of the year. On the landscape these soils are found in close association with the poorly drained soils of the Toberbride Series at elevations of 150 to 400 feet O.D. Parent material consists of calcareous, non-tenaceous glacial till of Weichsel Age composed of a mixture of limestone and granite.

These very poorly drained soils of high base status have been classified as peaty Gleys; they are similar in many respects to the soils of the Clowater Series. The profile consists of a peaty sandy loam surface horizon, varying between 8 and 16 inches in depth, overlying the intensely gleyed, coarse sandy loam sub-soil horizons. The depth of solum ranges from 27 to 40 inches. Roots are well developed in the surface horizon but are restricted to this zone.

Soil Suitability: This series has a limited to very limited use-range. The soils are unsuitable for tillage and in the unimproved condition are suitable only for lough grazing. When drained and fertilised, good levels of grass production can be obtained. A very high standard of management is required, however, to prevent poaching damage and to ensure optimum utilization of the grass.

Profile description and analyses—Appendix I, Table 23.

*Ballywilliam Series**

Soil Character: This series occupies 5.69 per cent (12,605 acres) of the county. The soils are closely associated geographically with the well-drained ones of the Borris and Kiltealy Series. These two series are found on rolling topography while the Ballywilliam Series is largely restricted to depressions and concave sloping ground. Elevations range from 200 to 600 feet O.D. The poor drainage in the depressions is due to a high water-table, augmented by springs, but on more favourably sloping ground is caused by springs and water seepage. The soils are derived from glacial till of Saale Age composed mainly of gianite with some chert.

The soils are poorly drained, of coarse sandy loam texture and low base status. The profile consists of a dark greyish-brown surface horizon, overlying horizons which, for the most part, are grey and mottled. The leached horizon directly beneath the surface layer has a coarser texture and a lower content of free-iron than the Bg horizon directly below. The latter horizon merges with the gleyed, coarse-textured parent material at approximately 30 inches. Root development is largely restricted to the surface horizon due to water saturation below this zone for the greater part of the year.

Soil Suitability: These soils have a limited use-range. In the unimproved condition they are suitable only for rough summer grazing, and without artificial drainage little permanent improvement can be expected. However, large tracts of these soils have been improved in recent years by drainage together with lime and fertiliser application. Unless the drains are deep enough and the tiles are placed in the coarser-textured parent material, below the poor-structured Btg horizon, and unless all springs are tapped, good results cannot be obtained. Another problem associated with the drainage of these soils is the phenomenon known as "rising bottom": the parent material moves slightly, probably under high water pressure, throwing the tiles out of alignment and thereby rendering the drainage system ineffective. Land reclamation is made difficult also by large granite boulders at the surface.

With adequate lime and fertilisers, in conjunction with a high standard of grazing management, fairly good returns from grass can be obtained. Utilization of the pasture still presents a problem and the grazing season must, of necessity, be limited to avoid poaching and to curtail rush *(Juncus)* infestation. In an attempt to control the latter, a cereal crop, usually wheat, is resorted to, often with poor results. Tillage on these soils is not remunerative, especially in poor harvesting seasons.

Profile description and analyses—Appendix I, Table 24.

Belmount Series

Soil Character: This series occupies 2.94 per cent (6,511 acres) of the county. The soils are closely associated on the landscape with those of the Ballywilliam Series and, because of the intricate pattern prevailing, both series are frequently mapped together. The Belmount Series occurs in the lowest portions of the topography where a high

*Similar soils have been described and mapped in County Wexford (Gardiner & Ryan, 1964) under the same series name.

water-table exists for the greater part of the year. Like the Ballywilliam Series, the soils are derived from non-tenaceous, non-calcareous glacial till of Saale Age and composed of granite with some chert.

These soils differ from those of the Ballywilliam Series in being more poorly drained and of higher base status and in having a peaty surface horizon. This horizon varies in depth from 6 to 15 inches and overlies coarse sandy loam horizons which are weak structured, light-grey in colour and display distinct mottling. The solum varies in depth from 32 to 40 inches. Due to its very coarse texture, the soil is not sticky or plastic when wet. Root development is confined largely to the surface horizon.

Soil Suitability: The soils of this series have a limited to very limited use-range. In the unimproved state they are only suitable for rough summer grazing, and without artificial drainage and reclamation little permanent improvement can be expected. By placing the drainage channel at an adequate depth, usually about 36 inches, by tapping all springs and by taking precautions to control the phenomenon known as "rising bottom" (see Ballywilliam Series), artificial drainage has usually proved successful. Land reclamation is rendered difficult by large granite boulders at and below the surface. With additions of lime and fertilisers, combined with proper management, grassland can be quite productive. However, the grazing season must be curtailed to prevent poaching damage and rush *(Juncus)* infestation.

Profile description and analyses—Appendix I, Table 25.

*Castlecomer Series**

Soil Character: These soils occur mainly on flattish to undulating topography on the Castlecomer Plateau at elevations varying from 600 to 1,000 feet O.D. They are derived from dense, tenaceous, non-calcareous soliflucted glacial drift of Saale Age. The drift is composed of a mixture of Carboniferous shales, sandstones and flagstones. The soils cover an area of 0.96 per cent (2,120 acres) of the county. They are poorly drained, of organic clay loam texture and of low base status. The dense, impermeable nature of the parent material and the heavy texture and poor structure of the soils contribute mostly to the poor natural drainage; consequently, they have been classified as surface-water Gleys.

The profile consists of a very dark-brown surface horizon of weak structure and poor consistence, approximately 8 to 10 inches deep. This horizon overlies a grey and mottled, plastic sub-surface layer which has a coarse, prismatic structure and which merges with the dense parent material at a depth of 35 to 40 inches. The organic surface horizon contains between 26 and 33 per cent clay and up to 50 per cent silt. The sub-surface horizon, known locally as "yellow mud", is mixed with "culm" (the waste coal material from the local mines) for use as domestic fuel. Root development is restricted to the surface horizon.

Soil Suitability: These soils have a limited use-range. Owing to their adverse physical properties they are generally unsuitable for tillage. With artificial drainage and with lime and fertiliser use, they have a potential for grass production, but management must be of a high standard if worthwhile returns are to be attained. Poaching and rush *(Juncus)* infestation are serious problems, so the grazing season must be confined largely to the drier summer period.

•These soils are similar in many respects to those of the Kilrush Series mapped in County Limerick (Finch &Ryan, 1966).

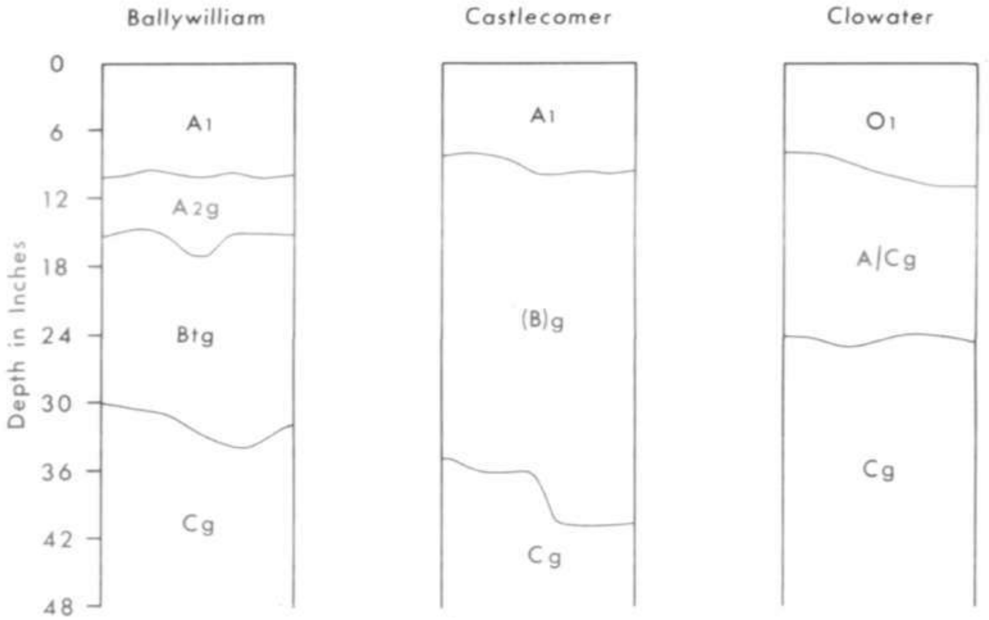

Fig. 15—*Horizon sequence in some gley profiles.*

Within the last 15 years a large acreage of these soils has been planted with Sitka and Norway Spruce which are relatively tolerant of the poor drainage conditions. Present growth rate is most encouraging and it is considered that forestry may be a very good proposition on these soil.

Profile description and analyses—Appendix I, Table 26.

Clowater Series

Soil Character: This series occupies 0.81 per cent (1,800 acres) of the county. The soils are derived from calcareous, non-tenaceous glacial till, of Weichsel Age, composed of limestone with less than 20 per cent granite and sandstone. They are found in depressional areas usually associated geographically with the poorly drained Newtown Series.

These very poorly drained soils have a high base status and a peaty surface horizon. The very poor drainage is caused by a permanently high water-table, so the soil is a ground-water Gley. The water-table is maintained at a high level by water seepage from the surrounding land and by springs, which are numerous where granite forms the underlying bedrock. The profile has a black peaty surface horizon overlying an intensely gleyed sub-soil. The depth of the peaty zone varies from 8 to 14 inches; root development is confined to this zone. These soils are similar in many respects to those of the Ballinrush Series.

Soil Suitability: This series has a limited to very limited use-range. The soils are unsuitable for tillage. In the unimproved condition they are only suitable for rough grazing. When drained and fertilised good levels of grass production can be obtained. But a very high standard of management is required to prevent poaching, to control rush *(Juncus)* infestation and to utilize the sward fully.

Profile description and analyses—Appendix I, Table 27.

Coolnakisha Series

Soil Character: The soils of this series occur on flattish topography and concave slopes between 200 and 500 feet O.D. They occupy 1.59 per cent (3,520 acres) of the county. Parent material consists of dense, calcareous, soliflucted drift material composed of chert, flagstone, limestone, sandstone and shale.

These are poorly drained soils, of silt loam to loam texture, and of medium to high base status. The poor drainage is due largely to the heavy, dense nature of the parent material with its attendant poor structure and permeability giving rise to low moisture penetration. The poor drainage is aggravated, on unfavourable slopes, by water seepage from the Killeshin Hills. The soils may be considered, therefore, as surface-water Gleys. On the landscape they are closely associated with the somewhat better drained soils of the MoandufT Series.

The profile consists of a greyish-brown, mottled surface horizon over horizons which are also grey and mottled. The surface horizon contains 25 to 28 per cent clay, 40 to 50 per cent silt and 10 to 15 per cent organic matter. Structure is weak throughout the profile. Roots are confined largely to the surface 9 inches.

Soil Suitability: These soils have a limited use-range. Due to their poor physical conditions, they are generally unsuitable for tillage. Nevertheless, with artificial drainage and the application of lime and fertilisers they can be used for arable cropping, but success depends largely on weather conditions. Harvesting operations are often particularly difficult. Wheat, feeding barley and oats give good returns in favourable seasons, but yields of root crops including sugar-beet are below average.

These soils are more suitable for grass production, and with manuring (and liming where necessary) a heavy sward is obtained. Poaching by grazing stock, however, is a serious problem and good management is essential.

Profile description and analyses—Appendix I, Table 28.

Greenane Series

Soil Character: The soils of this series occur on flattish topography at elevations ranging from 200 to 400 feet O.D. On the landscape they are associated with the well-drained soils of the Kellistown Series. They occupy 0.76 per cent (1,680 acres) of the county. Parent material consists of calcareous, non-tenaceous glacial till composed of limestone with a smaller amount of granite and sandstone.

These soils are imperfectly drained, of sandy loam to loam texture and of high base status. They have been classified as podzolic Gleys. The soil profile is characterised by a dark-brown surface A horizon, varying in depth from 8 to 13 inches, and overlying a dark yellowish-brown, mottled B horizon of heavier texture. The latter horizon grades into the calcareous, mottled parent material at depths ranging from 20 to 25 inches. Soil stiucture is weak and root development is curtailed by poor aeration in the sub-soil region.

Soil Suitability: These soils have a somewhat limited use-range. Both cultivation and harvesting are rather difficult particularly in unfavourable seasons. In places large granite boulders near the surface render either cultivation or reclamation even more difficult. Nevertheless, with artificial drainage, reclamation and adequate use of fertilisers (the lime status is generally satisfactory), good crops of wheat, barley, oats, sugar-beet and other root crops can be obtained.

These soils are best devoted to grassland and are quite productive provided their drainage is improved and that they are adequately fertilised, with particular emphasis on nitrogen and phosphorus. However, to utilize the grass fully, a high standard of management is necessary and the grazing season must be curtailed somewhat to prevent poaching damage and rush *(Juncus)* infestation.

Profile description and analyses—Appendix I, Table 29.

Knockmullgurry Series

Soil Character: This series occupies 1.66 per cent (3,680 acres) of the county and occurs closely associated with the well-drained soils of the Borris and Kiltealy Series. The series is found on flattish to undulating topography and at elevations between 100 and 600 feet O.D. The parent material consists of non-calcareous, non-tenaceous, granitic till of Saale Age.

The soils of this series are imperfectly drained, of coarse sandy loam texture and of low base status. On flattish topogiaphy the imperfect drainage is due to an intermittently high water table and on more favourable slopes to seepage from springs. The profile consists of a dark-brown to blackish surface Ap horizon which varies in depth from 10 to 16 inches and overlies a strongly gleyed, greyish-brown (A2) horizon. The latter horizon is also coarse textured and friable and overlies an indurated, strongly gleyed (B) horizon. Root development is largely restricted to the Ap horizon.

So/7 *Suitability:* These soils have a somewhat limited use-range. They are moderately suitable for the production of a limited range of tillage crops. They are relatively easily cultivated, but their natural nutrient status is very low. Wheat yields are usually unsatisfactory. Oats, particularly black oats, is extensively grown on these soils. With the extended use of lime, the acreage of barley is increasing. Without the liberal use of lime and fertilisers, particularly phosphorus, good yields cannot be obtained. Manganese deficiency is becoming more prevalent in oat and barley crops with the increased use of lime. Good returns of swedes, mangels and potatoes are obtained. When well fertilised and limed, new leys can be highly productive. However, unless a high level of management is maintained, sown species are quickly replaced by indigenous plants and the sward deteriorates rapidly.

Profile description and analyses—Appendix I, Table 30.

Moanduff Series

Soil Character: These soils occupy 0.70 per cent (1,560 acres) of the county. They occur at the foot of the Killeshin Hills on undulating topography and at elevations ranging from 200 to 500 feet O.D. This series is closely associated geographically with the more poorly drained Coolnakisha Series but is found on the better drained slopes. Parent material consists of dense, calcareous, soliflucted drift material composed of a mixture of limestone, chert, flagstone and shale.

These are imperfectly drained soils, of loam tending to clay loam texture and of high base status. The imperfect drainage is caused by the dense and lather impermeable nature of the parent material. Water seepage from the Killeshin Hills is an important contributory factor. The profile is characterised by a greyish-brown surface A horizon over a strongly gleyed B horizon which merges with the gleyed parent material at 33 inches approximately. The A horizon varies in depth from 13 to 15 inches and has a clay content of 22 to 25 per cent with 40 to 50 per cent silt and 10 to 12 per cent organic matter. Structure is weak throughout the profile and root development is confined to the surface horizons.

Soil Suitability: These soils have a somewhat limited use-range. Due to their poor physical characteristics, they are generally unsuitable for tillage. Nevertheless, where artificially drained and fertilised, they are widely cultivated. But the success of tillage cropping largely depends on weather conditions both in spring and autumn. Wheat, oats and feeding barley give good returns in favourable seasons. Yields of root crops are often well below average, and all vegetable crops, except cabbage, give poor results.

These soils are best suited to grass production. With improved drainage and with the use of lime and fertilisers, grass yields are quite high. However, due to susceptibility to poaching, the grazing season is relatively short and good management is essential for optimum utilization of the pasture.

Profile description and analyses—Appendix I, Table 31.

Newtown Series

Soil Character: The soils of this series are found on concave slopes, flattish topography and local depressions and at elevations ranging from 150 to 400 feet O.D. They are associated on the landscape with the well-drained soils of the Kellistown Series. They occur most extensively in the flattish areas associated with the Douglas and Burren rivers. Parent material consists of calcareous, non-tenaceous glacial till, of Weichsel Age, composed of limestone with less than 20 per cent granite and sandstone. The series occupies 5.45 per cent (12,084 acres) of the county.

The soils are poorly drained, of organic sandy loam surface texture and of high base status. The poor drainage is due to the presence of a high water-table, and in most areas springs and water seepage are contributing factors. The profile consists of a weak-structured, dark greyish-brown surface A horizon which varies in depth from 5 to 8 inches, overlying horizons which are grey and mottled. The sub-surface B horizon has a somewhat heavier texture, a mottled grey colour and poor structure; it is compact and sticky when wet and becomes hard on drying. This horizon merges gradually with the strongly gleyed, calcareous parent material at about 36 inches. Large pockets of coarse gravelly material occur frequently in the parent material. Root development is confined largely to the surface horizon.

Soil Suitability: These soils have a limited use-range. Due to poor drainage and other adverse physical conditions, they are generally unsuitable for tillage. Their optimum agricultural use is in grass production.

Very little permanent improvement can be obtained without artificial drainage and reclamation. This is difficult in many cases without first improving the arterial drainage system, particularly of the River Burren and its tributaries. Where the arterial system is satisfactory, large areas have been drained and reclaimed in the last 15 years. Drainage is most successful when the drains are at least 36 inches deep. Large granitic boulders at or near the surface render reclamation more difficult.

With liberal use of fertilisers, particularly phosphorus and potassium, and with lime as required, cereal and root crops can be grown. The yields, however, are usually disappointing especially in unfavourable seasons. With manuring and a high standard of management, grassland gives good returns. For full utilization of the grass, grazing must of necessity be confined to the drier summer period to prevent poaching damage, rush *(Juncus)* infestation and general deterioration of the sward.

Profile description and analyses—Appendix I, Table 32.

Parknakyle Series

Soil Character: This series occupies 1.21 per cent (2,680 acres) of the county and is located on the eastern slopes of the Castlecomer Plateau, chiefly to the north-west of

Oldleighlin. Elevation ranges from 400 to 1,000 feet O.D. The soils are derived from dense, non-calcaieous, soliflucted drift composed of Carboniferous shale, sandstone, flagstone and chert. On the landscape they are closely associated with the well-drained soils of the Keeloge Series. The latter are found on moderately steep to steep convex slopes and are derived from the underlying Carboniferous shale bedrock. The Parknakyle Series, on the other hand, is found at similar altitudes but on less steep, concave slopes and saddle depressions in which the soliflucted drift accumulated during the last glaciation.

These soils are poorly drained, of sandy clay loam texture and of low base status. They have been classified as podzolic Gleys. The poor internal drainage is due to the dense and impermeable nature of the parent material and the weak structure throughout the profile. The profile has a brownish surface A horizon which overlies a heavier textured, light-grey and mottled, gleyed B horizon. The surface horizon has about 25 per cent clay, 25 to 40 per cent silt, 7 to 10 per cent organic matter and varies in depth from 7 to 11 inches. The solum ranges in depth from 24 to 33 inches. Root development is largely confined to the surface A horizon.

Soil Suitability: These soils have a limited use-range. Due to their adverse physical conditions they are generally unsuitable for tillage. They are more suitable for grass production. With artificial drainage and with lime and fertilisers they can be quite productive. However, as poaching and rush *(Juncus)* infestation are serious problems, the grazing season must be confined to the drier summer period.

Within the last 15 years a large acreage of these soils has been planted with Sitka and Norway Spruce which are tolerant of the poor drainage conditions. Present growth rate is most encouraging and forestry may prove a good proposition on these soils.

Profile description and analyses—Appendix I, Table 33.

Raheenleigh Series

Soil Character: This series occupies 0.78 per cent (1,720 acres) of the county. The soils occur on flattish topography and concave depressions and are associated on the landscape with the well-drained soils of the Clonegall Series. Elevation ranges from 150 to 600 feet O.D. The parent material, as in the Clonegall Series, consists of non-calcareous, non-tenaceous glacial till composed mainly of shale and granite.

The soils of this series are very poorly drained, and of low base status. The profile is characterised by a peaty surface layer overlying horizons which are intensely gleyed. The very poor drainage is due to a permanently high water-table which is maintained by water seepage from surrounding higher ground and to a lesser extent by springs. Root development is largely confined to the surface horizon.

Soil Suitability: These soils have a limited to very limited use-range. In their unimproved state they are only suitable for rough summer grazing. With artificial drainage, and the application of adequate lime and fertilisers together with proper management, they are suitable for meadowing and grazing. Poaching and rush *(Juncus)* infestation are serious problems.

Profile description and analyses—Appendix I, Table 34.

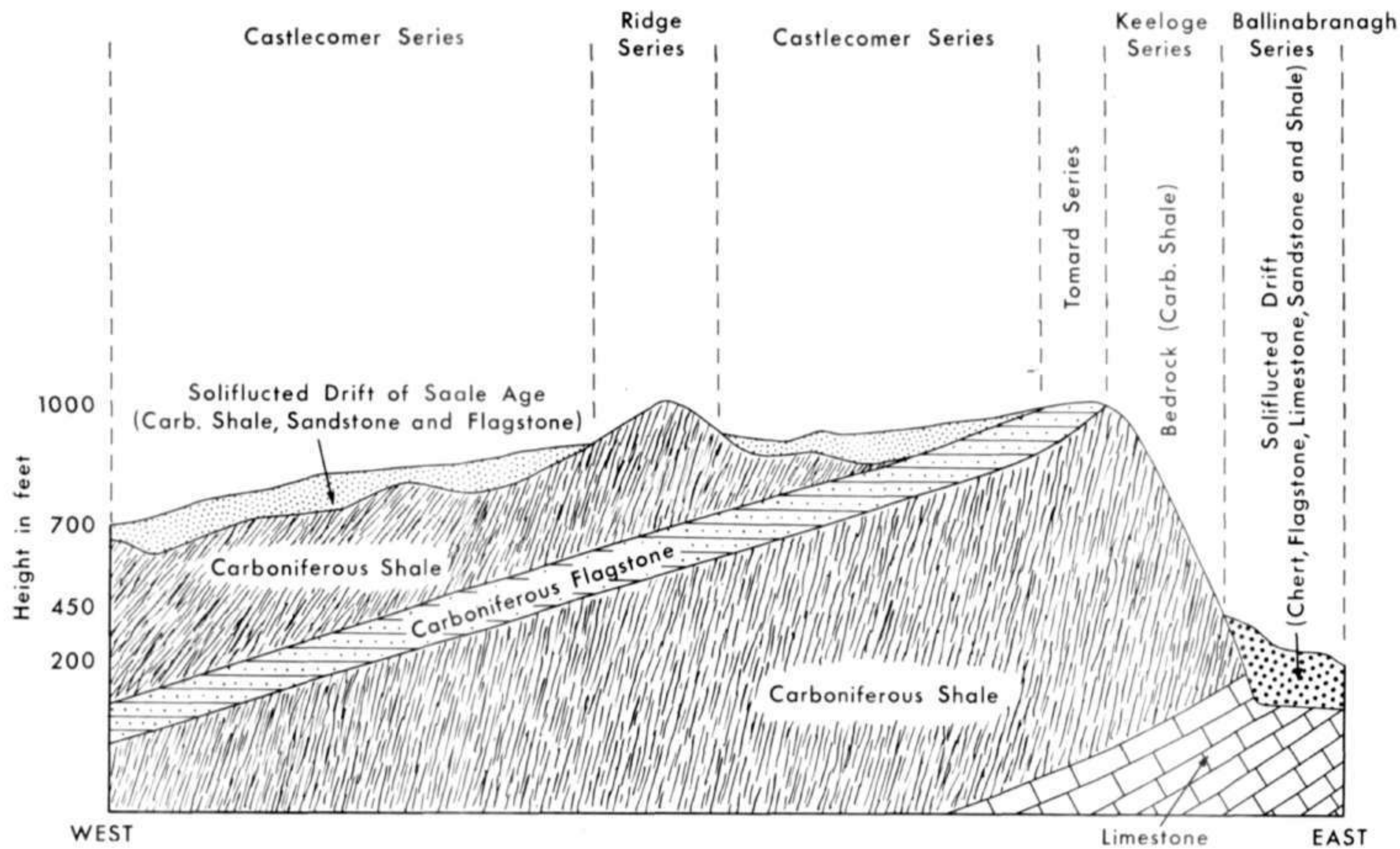

Fig. 16—*Diagrammatic representation of soil series in relation to landscape features and geology.*

*Seskinrea Series**

Soil Character: This series occupies 1.09 per cent (2,420 acres) of the county. It is closely associated on the landscape with the Castlecomer Series, occurring in depressional areas on the Castlecomer Plateau at elevations of 700 to 1,000 feet O.D. The soils are derived from soliflucted drift material composed of Carboniferous shales, sandstone and flagstone.

These are very poorly drained soils with a peaty clay loam surface texture and of low base status, they have been classified as peaty podzolic Gleys. Over much of the area a deeper organic layer has been removed for domestic fuel, leaving a surface horizon varying from 6 to 12 inches in depth. The sub-surface leached, coarse-textured A2g horizon overlies a heavier textured mottled Bg horizon. The latter in turn merges with the heavy-textured parent material at approximately 36 inches. Soil structure throughout the profile is weak. Root development is confined to the surface horizon.

Soil Suitability: These rush-moss dominated soils have a limited to very limited use-range. They are mainly used for rough summer grazing. With artificial drainage and with lime and fertilisers, grass production can be improved to a limited extent. To utilize the grass fully, management must be of a high standard and grazing must be confined to the summer period to curtail poaching.

Like the Castlecomer and Parknakyle Series, a large proportion of these soils have been planted with Sitka and Norway Spruce within the last 15 years. Present growth rate indicates that forestry may be a good proposition on these soils.

Profile description and analyses—Appendix I, Table 35.

Toberbride Series

Soil Character: This series occupies 0.81 per cent (1,800 acres) of the county. The soils occur at elevations of 150 to 400 feet O.D., on flattish, depressional areas near the limit of the terminal moraine of the Weichsel Glaciation between Tullow and Goresbridge. On the landscape they are closely associated with the soils of the Ballinrush Series. The parent material consists of calcareous, non-tenaceous glacial till composed of limestone and granite with some sandstone.

The Toberbride soils, of organic coarse sandy loam texture and of low base status, are poorly drained, and have been classified as podzolic Gleys. The poor drainage is due largely to the high water-table in landscape depressions. The profile has a dark greyish-brown surface horizon with weak, granular structure; this overlies a coarse-textured, light-grey, strongly leached A2 horizon which, in turn, overlies a mottled and heavier textured B2t horizon with a weak structure and poor consistence. Root development is confined to the surface horizon.

Soil Suitability: These soils have a limited use-range. Due to poor drainage and other physical defects, they are generally unsuitable for tillage. Their optimum land use is in grass production. Very little permanent improvement, however, can be obtained without artificial drainage and reclamation. This is difficult in many cases without first improving the arterial drainage system particularly of the River Burren and its tributaries. Where the arterial system is satisfactory, large areas have been drained and reclaimed in the last 15 years. Drainage is most successful when the drains are at least 36 inches deep. The presence of large granite boulders at or near

•Somewhat similar soils have been mapped in County Limerick as the Abbeyfeale Series (Finch & Ryan, 1966).

the surface renders reclamation more difficult. With liberal use of lime and fertilisers, cereal and root crops can be grown. The yields, however, are usually disappointing especially in unfavourable seasons. With adequate fertiliser, and lime as needed, together with a high standard of management, grassland gives good returns. Grazing must be confined to the drier summer period to curtail poaching damage and rush (/uncus) infestation.

Profile description and analyses—Appendix I, Table 36.

Alluvial Soils

These soils are derived from alluvial deposits which can be divided broadly into two major types, fresh-water and marine. The latter do not occur within the survey area. The fresh-water type is sub-divided into lake and river alluvium. The material laid down by rivers is usually found in the vicinity of existing stream and river courses, whilst lacustrine or lake accumulations occur in landscape depressions, originally the sites of glacial or post-glacial lakes. Both the river and lake alluvium are related in their composition to the geological formations in their vicinity. Within County Carlow their composition is quite heterogeneous due to the complex geological formations through which the rivers and drainage channels pass.

Most of these alluvial soils are very immature and, therefore, show little or no profile development; as such they are classified as Regosols. They are differentiated on the basis of such factors as origin and composition of parent material, texture, drainage and base status.

Lake Alluvial Soils

Mil/quarter Series

Soil Character: This series occupies 0.90 per cent (2,000 acres) of the county. It occurs in a flat, depressional area in the upper reaches of the River Burren, between the villages of Myshall and Fennagh and at an elevation of 280 to 300 feet O.D. The area is known locally as the "lollibrooks". The parent materials consist of heavy-textured, non-calcareous lake alluvium derived mainly from mica-schist and granite which form the underlying rocks in this part of the catchment area. Similar soils have been mapped by the same series name in County Wexford (Gardiner & Ryan, 1964).

The soils are poorly drained, of slightly peaty silty clay loam texture and of low base status. They have been classified as Regosols.* The profile consists of a greyish-brown, weak-structured surface layer overlying layers which are greyish-brown and strongly mottled and possess poor, massive structure and plastic consistency. Depth of alluvium varies from 2 to over 6 feet. Root development is largely restricted to the surface soil.

Soil Suitability: These soils have a limited to very limited use-range. They are situated in basin-like areas and are water-logged for long periods of the year. Flooding occurs regularly. Because of the high water-table regime together with the adverse physical conditions of the soils, they are unsuitable for cultivation and their agricultural use in the unimproved state is limited to summer grazing. Without major arterial drainage,

•The soils of the Millquarter Series may be classified as Regosols, on the basis of their immature profile, or as Gleys, on the basis of their poorly drained condition, or as Regosolic Gleys. In Wexford they were included with the Gleys, in Carlow with the Regosols.

little permanent improvement can be made in these soils because of the lack of a drainage outlet.

Lime and nutrient status is low, and liberal liming and manuring are required for optimum grass production. To utilize the grass fully, controlled grazing is required to avoid poaching damage and to maintain a productive sward.

Profile description and analyses—Appendix I, Table 37.

River Alluvial Soils

Clohamon Series

Soil Character: These soils occur in narrow strips along the basins of the River Slaney and its tributary the Derreen. Topography is flat and elevation ranges from 100 to 400 feet O.D. The soils are derived from non-calcareous river alluvium mainly of granite origin. This series occupies 0.27 per cent (600 acres) of the county. Soils have been mapped by the same series name along the Slaney valley in the Clohamon area of County Wexford* (Gardiner & Ryan, 1964).

The soils of the Clohamon Series are deep, well drained, of loam to sandy loam texture, of low and medium base status and have been classified as Regosols.* The profile is characterised by a relatively uniform brown to dark-brown colour down to the grey, coarse-textured gravels underneath. The surface layer contains 13 to 18 per cent clay, 30 to 40 per cent silt and about 6 to 10 per cent organic matter. Near the rivers the texture becomes much coarser in places. The soil has a good structure and a friable consistence. Mottling prevails below 45 inches. The profile varies in depth from 30 to 60 inches. Roots are abundant in the surface 20 inches and, although the soils are subject to regular flooding, the root system penetrates freely down to 45 inches.

Soil Suitability: The soils of this series exhibit many of the desirable physical characteristics which constitute high quality soils. Though their natural nutrient status is low, they respond well to lime and fertilisers. They could, therefore, be devoted to the production of a wide range of tillage crops or high-yielding pastures. However, their use-range is somewhat limited by the risk of flooding after periods of heavy rainfall. They are probably best suited, therefore, to grass production for which they are potentially excellent.

Profile description and analyses—Appendix I, Table 38.

Kilmannock Series

Soil Character: The soils of this series occur in narrow mud-flats stretching along the basin of the River Barrow from Carlow town in the north to as far south as Goresbridge. The series occupies 0.01 per cent (26 acres) of the county. Similar soils have been described in County Wexford (Gardiner & Ryan, 1964) where the series name originated.

The soils of this series are poorly drained, of slightly peaty clay loam texture and of very high base status. They have been classified as Regosols.* The profile has a very dark greyish-brown surface layer with weak structure, containing up to 40 per

*The Clohamon soils both here and in County Wexford showed an iron enrichment in the subsoil; on this basis they were classified as Brown Podzolics in Wexford. It is now considered that this iron enrichment is not strictly a pedogenetic factor and the soils are more rightly Regosols (immature profile).

cent clay, between 36 and 55 per cent silt and about 20 per cent organic matter. The surface layer overlies heavy-textured grey layers, which have massive structure and plastic consistency. Mottling is evident to a depth of 24 inches where it gives way to a uniformly drab grey colour, indicating more permanent water-logging at this depth. Depth of alluvium is usually greater than 36 inches. Root development is confined to the surface 7 inches.

Soil Suitability: These soils have a limited to very limited use-range. Because of adverse physical conditions and regular flooding, they are unsuitable for tillage crops. Their natural lime and nutrient status is high and with good management and judicious use of nitrogenous fertilisers, in particular, their inherent fertility can be exploited to produce high-yielding summer pastures and meadows. Toxic levels of selenium have been recorded in this soil.

Profile description and analyses—Appendix I, Table 39.

River Burren Series

Soil Character: These alluvial soils occur in the lower portion of the River Burren stretching from Rathoe to Carlow. They occur on flattish relief and at elevations ranging from 160 to 280 feet O.D. The alluvium is of mixed limestone and granite origin. This series occupies 0.26 per cent (580 acres) of the county.

The soils are imperfectly drained, of loam to sandy loam texture and of high base status. They have been classified as Regosols. They are subject to regular flooding. The high base status can be attributed to the base-enriched flood-waters from the surrounding countryside.

The soil profile has a dark-brown to dark greyish-brown surface layer which varies in depth from 9 to 15 inches and has a moderate structure, a clay content of 18 to 24 per cent, a silt content of 30 to 35 per cent and 6 to 10 per cent organic matter. The sub-surface layer is about 20 inches deep and has a drab grey colour with strong mottling and a much heavier texture than in the surface layer; it contains up to 45 per cent clay and 50 per cent silt and displays strong, prismatic structure. Root development is confined to the surface layer.

Soil Suitability: These soils have a somewhat limited use-range. Lime status is high and nutrient levels are generally fairly satisfactory. But their imperfect drainage and the occurrence of flooding renders the soils poorly suitable for cultivation, although in favourable seasons excellent cereal and root crops are obtained. Their optimum agricultural use is undoubtedly in grass production. The grazing season is, however, somewhat curtailed by flooding and poaching hazards, and the latter must be matched by good management if best results are to be obtained.

Profile description and analyses—Appendix I, Table 40.

Lithosol Group

This group consists of skeletal, stony soils, usually of an organic-mineral nature, overlying, in most cases, solid or shattered bedrock. Generally, such soil areas have frequent rock outcrops. Lithosols are most often associated with Podzols and climatic Peats at the higher elevations.

*The soils of the Kilmannock Series may be classified as Regosols, on the basis of their immature profile, or as Gleys, on the basis of their poorly drained condition, or as Regosolic Gleys. In Wexford they were included with the Gleys, in Carlow with the Regosols.

Carrigvahanagh Series
Soil Character: The soils of this series occupy 1.54 per cent (3,420 acres) of the county and are found closely associated with the Blackstairs Series. They occur mainly on moderately steep to steep slopes at the higher elevations on the Blackstairs Mountains, south of Mount Leinster. Elevation ranges from 500 to 1,800 feet O.D. Because of the steep slopes and high elevation, glacial drift is absent and the soil is derived from the underlying granite bedrock. A partial skeletal soil cover with a vegetation characteristic of dry, acid conditions has developed. Outcropping rock and loose boulders are extremely common, covering 50 to 80 per cent of the surface area. The soil consists of a shallow, black turfy layer, which varies in depth from 1 to 10 inches. Base status is extremely low and natural diainage is excessive.
Soil Suitability: The use-range of these soils is extremely limited. As a result of the steep slopes and extreme rockiness, they are only suitable for rough hill grazing. Under present circumstances, little improvement in stock-carrying capacity can be expected. Soil cobalt levels aie very low, a matter meriting attention where the health of grazing stock, particularly sheep, is concerned.
Profile description and analyses—Appendix I, Table 41.

Complexes

Athy Complex
Soil Character: The soils of this complex occupy 9.82 per cent (21,726 acres) of the county. They occur mainly in the Barrow valley, stretching from the northern border of the county continuously to Goresbridge and in isolated patches as far south as Graiguenamanagh. A less extensive area occurs in the Burren River valley and merges with the gravel soils of the Broughillstown Complex in the Roscat district. A narrow belt of the Athy soils also occurs south-east of Ballymoon.

The parent material of these soils consists of calcareous, fluvio-glacial coarse gravels and sands, of Weichsel Age, composed mainly of limestone with a small proportion of sandstone and granite. Elevation, mainly between 150 and 300 feet O.D., may be as low as 50 feet in the vicinity of Graiguenamanagh and as high as 400 feet O.D. in the Ballymoon area. The topography is flattish to undulating, but some areas are hummocky with shaip slope changes ranging from 0° to 12° and occasionally up to 20° as on the steep sides of the Muine Bheag esker. These sharp changes in landscape features are mainly responsible for the variability of soils and the intricate pattern of distribution within the complex. Because of the latter it was not feasible to segregate the different soil components on the scale of mapping employed. Consequently, the soils have been mapped as the Athy Complex.

Four major soils have been recognised within the complex:
(1) *Moderately deep component:* On the flattish to undulating topography and on the lower slopes of the hummocky hills and eskers, moderately deep soils have developed. These are naturally well-drained, friable gravelly sandy loams of high base status; they have been classified as Grey Brown Podzolics. This soil accounts for approximately 70 per cent of the total area of the complex.

The profile is characterised by a dark greyish-brown to dark-brown surface horizon which varies in depth from 10 to 15 inches and overlies a brown to yellowish-brown, leached A2 horizon. This in turn overlies an undulating, dark greyish-brown B horizon of distinct clay accumulation; clay skins are prominent on the ped surfaces. The surface horizon contains 12 to 15 per cent clay and 6 to 12 per cent organic matter: the B2t horizon has 20 to 30 per cent clay. Diagnostic features of this soil are the high content of gravels throughout the profile, the distinct, tonguing A2 horizon, the well-developed textural Bt horizon and the high pH and base status throughout the profile. Structure is moderately well developed. Roots are plentiful in the surface horizon and penetrate freely to the upper portion of the calcareous gravels. Moisture-holding capacity is moderately good, but in prolonged very dry periods a moisture deficit develops.

(2) *Shallow component:* On the crests of the hummocks and higher portions of the eskers, the soils are very shallow, excessively drained, of stony or gravelly, coarse sandy loam texture and of high base status. These have been classified as Brown Earths. They occupy about 20 per cent of the complex.

The profile is characterised by a dark-coloured A horizon which passes directly into the coarse-textured, calcareous parent material. The A horizon varies in depth from 7 to 14 inches, has a well-developed crumb structure and is friable with a moderately well-developed structure and abundant roots. Deep ploughing brings the gravel sub-soil to the surface in many cases. Moisture-holding capacity is poor and a deficit develops in most years.

(3) *Imperfectly-drained component:* On flattish, lowlying areas the soils are imperfectly drained, of sandy loam texture and of high base status; they have been classified as Brown Earths with gleying. Due to their lowlying position, a high water-table affects the lower portions of the profile for the greater part of the winter period causing gleying in this zone. The dark greyish-brown, friable, calcareous A horizon varies in depth from 10 to 16 inches and contains approximately 15 per cent clay and 8 to 10 per cent organic matter. Although root development is largely confined to this horizon, these soils, except in very dry seasons, are not subject to drought due to the proximity of the water-table even in dry periods.

(4) *Poorly drained component:* On the lowest portions of the topography where the water-table is permanently high, the soils are poorly drained, of sandy loam texture and of high base status; they have been classified as Gleys.

The profile is characterised by a very dark-brown, calcareous surface horizon over an intensely gleyed calcareous parent material. Root development is confined to the surface horizon.

Soil Suitability: With the exception of the poorly drained component (Gleys) which comprises approximately 5 per cent of the total area of the complex and is only suitable for summer grazing and meadowing, the Athy soils generally have a wide use-range. They are suited to the production of a range of farm, fruit and vegetable crops. Due to their coarse texture and very friable consistency, they are easily tilled; up to 50 per cent of these soils is devoted to tillage annually. Together with the Kellistown and Borris Series, the Athy soils are responsible for Carlow's reputation as a tillage county.

Liming is necessary to a limited extent only on the moderately deep well-drained soils of the complex. Good responses to fertiliser application are obtained. Potassium 'fixation' is high in the Athy soils and applications of this element must be regular and generous for optimum crop growth. Farmyard manure, apart from being a nutrient source, also enhances the moisture-holding capacity of these light-textured soils.

The shallow component of the complex is subject to drought almost every year, while the deeper well-drained component is prone to a moisture deficit only in very dry periods. Due to the intricate pattern of soil distribution, even within the same

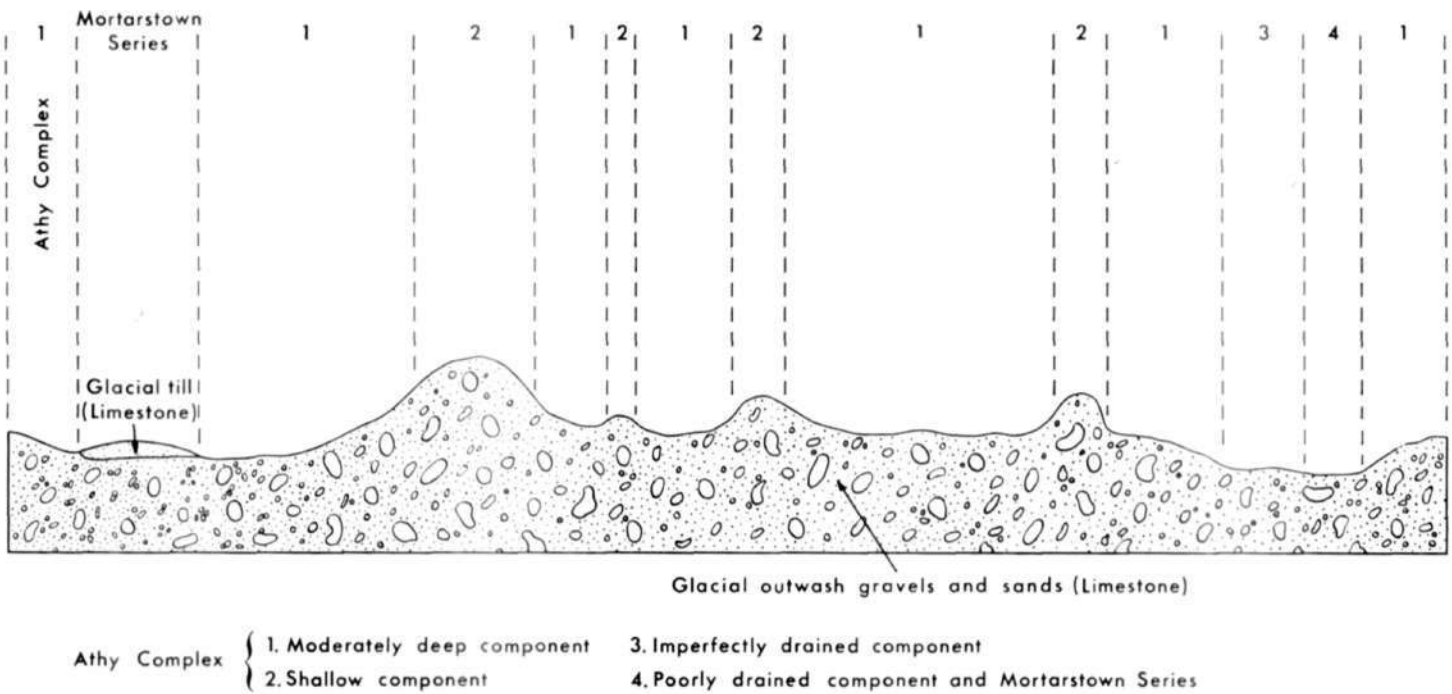

Fig. 17—*Diagrammatic representation of soils of Athy Complex in relation to landscape features and geology.*

field, certain crops mature unevenly; peas, French beans and cereals mature 2 to 3 weeks earlier on the shallow excessively drained soils of the complex.

With the exception of the limited gley component, these Athy soils are suitable for cereal crops and are particularly noted for the proc'uction of high-quality malting barley. Potatoes, swedes, mangels and sugar-beet give excellent yields: sugar content of the beet is usually well above average. Strawberries do well generally but not blackcurrants. These light-textured and friable soils are especially suitable for the growing of carrots, onions, French beans, peas, white turnips, spinach and asparagus; cabbage gives less satisfactory returns. However, the gritty nature of the soils causes some damage to soft peas during harvesting operations. Molybdenum deficiency symptoms (whiptail) in brassica crops, particularly cauliflowers, have been recorded locally. High levels of selenium have been found in leeks and in certain other vegetable crops grown on the imperfectly drained soils of the complex.

There is not much permanent pasture on the Athy soils. Short-term leys, when adequately fertilised, are highly productive and the sward can be utilized very fully. The only serious limitation to output is a moisture deficit in dry seasons.

Profile descriptions and analyses—Appendix I, Tables 42, 43, 44, 45.

Broughillstown Complex

Soil Character: The soils of this complex occupy 2.16 per cent (4,780 acres) and occur mainly in the Slaney River valley and as scattered areas extending from the extreme north of the county through Rathvilly and Tullow, Aghade Bridge to as far south as Bunclody. Geographically these soils are closely associated with those of the Kellistown Series in the north and with those of the Clonegall Series in the south of the county. However, they usually occur at lower elevations: 120 to 200 feet O.D. in the south and 300 to 420 feet O.D. in the northern Rathvilly district.

The parent material consists of calcareous fluvio-glacial outwash and eskery gravels, of Weichsel Age, composed mainly of limestone with an admixture of mica-schist, greenstone (volcanic), granite and sandstone. The topography ranges from flattish to rolling hummocky with slopes varying from 2" to 20°. These sharp changes in landscape features are responsible for the variability of soils and intricate pattern of distribution even down to the field level. On the scale of mapping employed, it was not possible to separate the different soils and hence they have been mapped as a complex. Two principal components have been recognised within the complex:

(1) *Moderately deep component:* On the flattish to gently undulating topography and on the lower slopes of the eskery hummocks, modeiately deep soils have developed. They are well-drained, gravelly coarse sandy loams, of medium to high base status: they have been classified as Brown Earths.

The profile consists of a very friable, dark greyish-brown to brown surface (Ap) horizon, 10 to 14 inches deep and containing 12 to 15 per cent clay and 6 to 10 per cent organic matter. The Ap overlies a very friable, dark yellowish-brown horizon which extends to a depth of 20 to 24 inches. Beneath this layer a thin, dark greyish-brown, tonguing (B) horizon, which has a distinctively well-developed, sub-angular blocky structure, rests on the very coarse, gravelly parent material. Roots are abundant in the surface horizon and penetrate freely down to the parent material. Moisture-holding capacity is moderately good, but in prolonged dry periods a deficit may develop.

(2) *Shallow component:* On the highest portions of the eskery hummocks, the soils

are very shallow, excessively drained, gravelly coarse sandy loams, of high base status; they have been classified as Brown Earths.

The profile is characterised by a dark greyish-brown, friable A horizon which passes directly into the coarse-textured, calcareous parent material. The A horizon varies in depth from 6 to 10 inches, has a well-developed crumb structure and a diffuse rooting system; it contains 10 to 15 per cent clay and 8 to 12 per cent organic matter. Moisture-holding capacity is low and a moisture deficit develops most years.
Soil Suitability: These soils except where very shallow have a wide use-range. They are easily tilled and are well suited to a variety of crops. Good yields of barley, wheat, oats, potatoes, sugar-beet, swedes and mangels are produced; these are particularly good barley soils, but malting barley is not grown to any extent although both yield and quality should be very high. Both yield and quality of sugar-beet are well above average. Carrots give good returns. Due to the intricate distribution pattern of the soils of the complex, peas and French beans ripen unevenly, sometimes in the same field.

For optimum returns from these soils, regular dressings of fertilisers and particularly of potassium are required. Liming is also necessary but only on the deeper soils of the complex. New leys aie highly productive and these soils are noted for early grass production provided the necessary nitrogen is applied over and above the regular manuring. However, grass production can be seriously curtailed by a moisture deficit in mid-season, especially on the more shallow soils (of the eskery hills) during prolonged dry periods.

Profile descriptions and analyses—Appendix I, Tables 46, **47.**

Peats

Peat is found in many scattered areas of limited extent within the county. The two types, basin and hill (or climatic) peat, have been recognised. Peat of a transitional nature between these two well-defined types has been mapped in two areas.

Basin Peat

Basin peat occurs in a few isolated areas associated mainly with the Borris Series. It occupies 0.22 per cent (480 acres) of the county and varies in depth from *2* to 20 feet. The plant succession, in the undisturbed peat, is typical of basin peat deposits; it consists of a basal layer of *Phragmites* peat overlain by wood peat and, at the surface, a hummock and hollow formation of *Sphagnum* and *Eriophorum.* Much of this peat has now been cut over.
Vegetation: The drier peat hags are dominated by *Cal/una vulgaris* (heather), the wetter, cutaway hollows by *Eriophorum angustifolium* (bog cotton) and *Sphagnum* spp. (bogmosses). One of the first colonisers of the bare, cutaway, wet peat is *Juncus bulbosus* (bulbous rush).

Hill or blanket Peat

Hill peat occurs to a limited extent on the Blackstairs Mountains in the south-east of the county. In all it amounts to 0.41 per cent (900 acres) of the county. The depth ranges normally from 2 to 6 feet. Erosion is taking place and, on the steeper slopes, the peat has been completely eroded. The peat is highly humified and uniform throughout the profile.
Vegetation: Mountain bog community, lightly grazed by sheep in summer. *Calluna*

vulgaris (heather) dominates while *Eriophorum vagina turn* (cotton-grass), *Vaccinium myrtillus* (bilberry) and *Empetrum nigrum* (crowberry) are frequent. *Sphagnum* spp. (bogmosses) are abundant in the moss layer.

Transitional Peat

This type of peat occurs in two areas within the county and occupies 0.54 per cent (1,200 acres).

(a) *Castlecomer Plateau.* Here it occurs in local depressions on the plateau at elevations between 940 and 980 feet O.D. Annual rainfall exceeds 40 inches. An undisturbed section consists of a basal layer of *Phragmites* peat, with an intermediate layer of wood peat overlain by an *Eriophorum* and *Scirpus* regeneration complex. Much of this peat has been cut over.

(b) *Hacketslown Area:* The peat here occurs in local valleys usually below the 500 foot contour. Annual rainfall is 45 inches. The peat is usually less than 4 feet deep. Undisturbed sections consist of highly humified peat with *Carex* remains overlying wood peat—Alder and Birch remains with some *Phragmites.* Much of the peat here has been cut over.

Classification of the Soils according to Great Soil Groups

The soil series segregated and mapped in County Carlow are classified in Table V into a number of Great Soil Groups. As far as possible the extent of the county occupied by each group is shown. In Table VI the soils within complexes and the variants are classified into Great Soil Groups; in this case the calculation of individual areas is not feasible.

TABLE V: Classification of main Soil Series in County Carlow into Great Soil Groups and the relative extent of each group

Great Soil Group	Series	Area (acres)	Per cent of *total area
Grey Brown Podzolics	**Ballinabranagh, Kellistown, Mortarstown, Paulstown, Rathvinden**	**47,759**	**21.56**
Brown Earths	**Acaun, Ballindaggan, Ballytarsna, Borris, Keeloge**	**54,059**	**24.40**
Brown Podzolics	**Clonegall, Kiltealy, Knocksquire, Ridge**	**21,229**	**9.58**
Podzols and Reclaimed Podzols	**Ballinagilky, Black Rock Mountain, Blackstairs, Tomard**	**7,720**	**3.48**
Lithosols	**Carrigvahanagh**	**3 420**	**1.54**
Regosols	**Clohamon, Kilmannock, Millquarter, River Burren**	**3,206**	**1.44**
Gleys: Surface-water Gleys	**Castlecomer, Coolnakisha, Moanduff, Parknakyle, Seskinrea**	**12,300**	**5.55**
Gleys: Ground-water Gleys	**Ballinrush, Ballywilliam, Belmount,** Clowater, Greenane, Knockmullgurry, Newtown, Raheenleigh, Toberbride	**42,760**	**19.30**
Peats		2,580	1.17

•Refers to total area of County Carlow minus major water and principal urban areas

TABLE VI: Classification into Great Soil Groups of soils occurring as Complexes and Variants in County Carlow

Complex or Variant	Component Soils	Great Soil Group
Athy Complex	Moderately deep component	Grey-Brown Podzolic
	Shallow component	Brown Earth
	Imperfectly drained component	Brown Earth with gleying
	Poorly drained component	Ground-water Gley
Broughtllstown Complex	Moderately deep component	Brown Earth
	Shallow component	Brown Earth
Kiltealy Shallow Variant		Brown Podzolic
Ridge Flaggy Variant		Brown Podzolic

The combined areas of the Grey Brown Podzolics, Brown Earths and Brown Podzolics, which are mostly arable soils with a high potential, represent more than half of the county. The Gleys, which are poorly drained and difficult to manage, occupy 24.85 per cent. The Podzols, Lithosols and Peats, of limited potential, represent a little over 6 per cent. The Regosols of variable potential represent 1.44 per cent. The remainder of the soils fall into the two complexes Athy and Broughillstown: these are mostly high-quality soils.

CHAPTER V

SOIL SUITABILITY

Introduction

Soil suitability classification is essentially a grouping of soils according to the use or uses to which they are most adaptable, and is based principally on the significance of the more permanent characteristics of the soil. A further step in the suitability classification consists of an assessment of the production potential of each soil, for the normal range of farm and forest crops,* under defined management standards. This provides the essential link between the physical and economic aspects of the use of soils. However, for this purpose reliable quantitative data on the productive capacity of each soil are required; these can only be provided by detailed field experimentation and yield observations, over a number of years, on sample areas representative of the particular soil. Sufficient information of this nature for County Carlow is not so far available. Therefore, the present system of soil suitability evaluation and classification is largely a qualitative, rather than a quantitative, appraisal of the potentialities of the different soils in the county.

Although the physical, chemical and biological properties of the soil merit foremost consideration in assessing soil suitability, environmental factois such as elevation, aspect, local climate, distance from the sea and factors such as accessibility, proximity to markets and consumer demands must also be taken into account. For instance, local features such as exposure to strong winds and late spring frosts can limit forest tree growth no matter how deep and fertile the soils may be. In general statements concerning soil suitability one must bear in mind, therefore, that environmental and other factors can influence considerably the economics of production and hence can modify the use-range to which the soils are otherwise ideally suited.

Furthermore, the concept of land quality has changed radically in recent years. With modern fertiliser technology, natural nutrient fertility problems in soils have become subordinate to physical ones such as defective natural drainage, "heavy" texture and poor structure, which are more difficult and more costly to rectify. Besides, an abundant farm labour supply no longer obtains, and its replacement by mechanisation has drastically altered the feasible cultural and management practices on many soils.

•Productivity ratings for forestry for a number of the soils in County Carlow are given in Appendix V.

Soils—Their General Suitability, Use-range and Major Limitations

The general suitability, use-range and major limitations of the soils of County Carlow are summarised in Table VII. Except in Class E, a number of soil series is included in each suitability class. Even with optimum manurial and management practices, certain differences in overall productive capacity persist between the soils included in each class, as a result of inherent differences between series. Nevertheless, the soils in any one class have sufficient characteristics of importance in their use and productive potential in common to warrant their inclusion in the same suitability class.

In drawing up the suitability classification, only the normal or dominant phase of each soil has been considered. For instance, some of the series placed in Class A may contain small inclusions of soils that are too shallow, too rocky or that occur on slopes too steep for successful cultivation or management. Borris, Clonegall and Ballytarsna Series contain some soils on slopes so steep that mechanical cultivation is not practicable. Limited portions of the Borris Series are so rocky that tillage operations are difficult; conversely, certain parts of the Blackstairs Series are less rocky than the normal. Also, better drained phases of the Coolnakisha, Newtown and Kilmannock Series deserve a higher rating than the series in general, in terms of suitability for tillage and grassland utilization. These enclaves, however, constitute only a small portion of the entire series. Separate consideration of such exceptions within series is beyond the scope of this account. Besides, in any system of classification involving multiple variables, it is not possible to accommodate fully all exceptions without impairing the purpose of the classification. It must be accepted also that certain series placed in one general suitability class may be borderline to a neighbouring class.

The present suitability classification is based largely on a scale of values confined to the relative quality of the soils within the county. Therefore, some of the suitability classes established for the Carlow soils may lose or gain status by reference to a national scale of suitability values.

Suitability Class A

The soils included in this class (Table VII) have a wide use-range and are generally suitable for tillage crops, pasture, meadow and forestry.

The soils of the Kellistown Series have no serious limitations. These friable soils with good natural drainage, "medium-light" texture and moderately good structure are predisposed to the development of a good tilth under normal cultural practices. With regular attention to lime and fertiliser requirements, associated with proper management, they are capable of supporting high levels of production. Their potential for pasture production and utilization throughout the growing season is high; so is their capacity for early grass growth, especially from new leys, with judicious use of fertilisers, particularly nitrogen. Due to "fixation", potassium may be a limiting factor in these soils. The only trace element anomaly observed locally has been associated with soil molybdenum levels (see Trace Element Section—Chapter Vll).

Although the other soils included in this class have certain limitations, they are, nevertheless, of high quality and are generally well suited to tillage cropping, pasture, meadow and forestry. The soils of the Ballinabranagh, Mortarstown, Paulstown and Rathvinden Series are deep and well drained with "medium-heavy" texture and a weak to moderately good structure. With proper management, including regular

TABLE VII: Soil Suitability Classification*

Suitability Class**	Use-range	Type of Limitation***	Series	Percentage of total Area
–				
Suitable for tillage, pasture, meadow and forestry	Wide	Local anomalies in soil molybdenum levels (See chapter VII, page 84)	Kellistown	19.69
139,588 acres (63.02 per cent)		Pastures somewhat liable to poaching	Ballinabranagh, Mortarstown, Paulstown, Rathvinden	1.87
		Moisture deficit in very dry periods	Clonegall	6.10
		Moisture deficit in very dry periods, cobalt deficiency	Acaun, Ballytarsna, Borris	23.38
		Moisture deficit in places in dry periods, crops mature unevenly	Athy Complex, Broughillstown Complex	11.98
B				
Moderately suitable for tillage, pasture and meadow; suitable for forestry	Moderately wide	Particularly low nutrient status; cobalt deficiency; moisture deficit in very dry periods	Kiltealy	2.01
8,865 acres (4.00 per cent)	ficit	High elevations; moisture de- in very dry periods	Ridge	0.70
		Somewhat high elevations and steep slopes; moisture deficit in very dry periods	Ballindaggan, Keeloge	1.02
		Periodic flooding	Clohamon	0.27
~*C*				
Moderately to poorly suitable for tillage; moderately suitable for pasture, meadow and forestry	Somewhat limited	Impeded drainage; adverse physical conditions; liable to poaching	Greenane, Moanduff	146
9,060 acres (4.08 per cent)		Periodic flooding; adverse physical conditions; liable to poaching	River Burren	0.26
		Particularly low nutrient status; impeded drainage; cobalt deficiency; somewhat high elevations	Ballinagilky, Knockmullgurry, Tomard	2.36

*In making this classification a high standard of management (including lime and fertiliser amendments, as required) is assumed.

••Limited areas within series may more exactly fit into one of the other suitability classes.

•••Limitations noted here refer mainly to physical soil problems under existing conditions. Inadequate natural nutrient status is a major limitation in most of the soils and may need liming.

TABLE VII (Continued)

Suitability Class	Use-range	Type of Limitation	Series	Percentage of total Area
D Poorly suitable for tillage; moderately to poorly suitable for pasture and meadow : moderately suitable for forestry 51,866 acres (23.41 per cent)	Limited	Particularly low nutrient status; rockiness; somewhat high elevations; cobait deficiency	Knocksquire (Unsuitable for tillage and meadow)	0.77
		Serious drainage problem; adverse physical conditions; liable to severe poaching	Ballywilliam, Coolnakisha, Newtown, Toberbride	13.54
		Serious drainage problem; adverse physical conditions; liable to severe poaching; high elevations	Castlecomer, Parknakyle	2.17
		Serious drainage problem; adverse physical conditions; liable to severe poaching; periodic flooding	Kilmannock, Millquarter	0.91
		Very serious drainage problem; adverse physical conditions; liable to severe poaching	Ballinrush, Belmount, Clowater, Raheenleigh	4.93
		Very serious drainage problem; adverse physical conditions; liable to severe poaching; high elevations	Seskinrea	1.09
E Unsuitable for cultivation, meadow or intensive grazing; moderately suitable for forestry and extensive grazing 4,160 acres (1.88 percent)	Very limited	Particularly low nutrient status; ironpan formation; impeded drainage; high elevations and moderately steep slopes; cobalt deficiency	Black Rock Mountain	1.88
~~F~ Unsuitable for cultivation, meadow or intensive grazing; mainly unsuitable for forestry; moderately to poorly suitable for extensive grazing	Extremely limited	Particularly low nutrient status; ironpan formation; impeded drainage; high elevations and moderately steep slopes; rockiness; cobalt deficiency	Blackstairs	0.90
5,420 acres (2.44 per cent)		Particularly low nutrient status; high elevations and steep slopes; extreme rockiness	Carrigvahanagh	1.54
Unclassified 2,580 acres (1.17 percent)	—		Basin Peat, Hill Peat, Transitional Peat	**1.17**

attention to lime and fertiliser requirements, they are capable of high levels of production. Although they are generally amenable to cultivation, some difficulty may be encountered locally in producing a desirable tilth in unfavourable seasons. Whereas the structure of these soils in all cases is well developed under pasture it is likely to deteriorate under constant tillage, so care must be given to rotation and to the cultural and management practices that help to maintain structure. Some difficulty can be experienced with crop harvesting also, especially in wet seasons. For grass production these soils have a particularly high potential. The physical constitution of the soils under pasture permits a relatively long grazing season and satisfactory utilization of the fodder, but if unduly overstocked in wet periods or grazed throughout the winter, poaching damage can occur. Early spring growth can be obtained by appropriate fertiliser use.

The soils of the Acaun, Ballytarsna, Borris and Clonegall Series are moderately deep, well drained, "medium-light" textured and friable and have a good structure. Under normal cultural practices a desirable tilth is easily obtained. Apart from being predisposed to a moisture deficit in very dry seasons, they have no other serious limitations. With proper management including regular attention to lime and fertilisers, they are capable of high levels of production, either under tillage crops or pasture. Early spring growth, especially on new leys, is possible with judicious use of nitrogen in the fertiliser programme. Unless adequately manured and managed, permanent pasture is difficult to maintain at a high level of production; the sward is prone to revert to indigenous grasses and weeds. The farming pattern on the Borris and Clonegall Series is marked by the very high concentration of sheep. The Borris soils have inherently low levels of the trace element cobalt; consequent low intake from the grazing causes pining in sheep, particularly in lambs after weaning.

Although small portions of the Athy and Broughillstown Complexes have major limiting factors, these soils in general are of high quality. The soils of the very shallow components of each complex are liable to develop a moisture deficit almost every season, and those of the poorly drained component are limited mainly to grass production. Over 70 per cent of the soils of each of the complexes, however, are suitable for the production of a wide range of farm, fruit and vegetable crops. These light-textured, friable soils are easily cultivated; the area is noted for tillage and particularly for malting barley production. However, uneven ripening in cereal and vegetable crops, related to a variable soil moisture regime, may be a major disadvantage locally. Due to "fixation" in the soil, potassium may be limiting and, for best results in most crops, must be considered a primary nutrient in the fertiliser programme. The potential of these soils for grass production and utilization throughout the season is also high. Early season grazing can be obtained by proper management including the judicious use of fertiliser, particularly nitrogen. On the deeper soils, which constitute 70 per cent of each complex, a moisture deficit is experienced only in very prolonged dry periods.

The soils of Class A are not devoted to any extent to forestry but should prove highly productive under this enterprise.

All the soils in Class A compared to those in the lower classes have a wide use potential and are well adapted to modern farming, including mechanised cultural methods and fertiliser technology. In the past, a major limiting factor to production has been their poor native nutrient supply, and in many cases also their acid conditions. Appropriate fertiliser and lime applications, based on soil analyses and experience of crop requirements on the various soils, easily overcome these problems.

The soils of this class, with the possible exception of the Rathvinden, Ballinabranagh, Paulstown and Mortarstown Series in unfavourable seasons, cultivate easily and can withstand the impact of heavy machinery better than the soils in the other classes; they can support tillage cropping in a well-balanced, well-managed rotation. Pastures on these soils are capable of early growth in spring and can be highly stocked over a prolonged grazing season. These soils, then, offer greater latitude in cropping practice and production than those with more adverse physical properties. Under changing economic and social circumstances they have the great advantage of being highly adaptable to alternative agricultural enterprises; the selection of the most appropriate enterprise will depend largely on prevailing demand and market prices.

The soils of Class A occupy 63 per cent (139,588 acres) of the county; Kellistown, Clonegall and Borris Series together with Athy and Broughillstown Complexes being the main contributors. This means that nearly two-thirds of County Carlow consists of good, arable soils with a wide agricultural use potential and virtually devoid of any serious physical limitation.

Suitability Class B

The soils included in this class (Table VII) have a more limited use-range than those in Class A, and are generally of only moderate suitability for tillage crops, meadow and pasture. For the soils included, the types of limitation vary somewhat.

The Kiltealy soils are limited by particularly low nutrient levels; they require exceptionally high applications of phosphorus. Their lime status is also very low. Even with manuring they give only moderate yields of wheat; in oats and barley manganese deficiency becomes more prevalent with increased use of lime. Soil cobalt levels are low, being a serious problem where livestock health is concerned. These soils are also predisposed to a moisture deficit in very dry periods.

The Ridge Series is limited mainly by elevation while the Ballindaggen and Keeloge soils are limited not only by high elevations but also by steep slopes, which lender farming operations more difficult. Spring sowing is usually very late and harvesting is delayed at these higher elevations. A soil moisture deficit in prolonged very dry periods is a further shortcoming.

The Clohamon Series comprises high-quality soils but periodic flooding detracts from their suitability for arable cropping.

All the soils in this class have a moderately high potential for grass production which can be attained by proper management, including appropriate lime and manurial treatments. However, early season production is difficult on the soils of the higher elevations. Although only the soils of the Ballindaggan and Keeloge Series have been devoted to forestry to any extent, the majority of the soils in this class should be well suited to this enterprise.

The soils of Class B occupy 4 per cent (8,865 acres). Although their use-range is somewhat limited, the general suitability of these soils for normal agricultural purposes is moderately good. If their extent is added to that of Class A, then 67 per cent of the soils of the county may be said to have a capacity for high levels of production without the necessity for artificial drainage or reclamation or for extraordinary cultural and management techniques.

Suitability Class C

The soils included in this class (Table VII) have a somewhat limited use-range. Limitations include defective natural drainage, weak structure, the hazard of periodic flooding, extremely low nutrient status, rockiness and relatively high elevations. They are considered, therefore, to be only of moderate to poor suitability for tillage crops and of moderate suitability for pasture, meadow and forestry.

Production on the soils of the Greenane, Moanduff and River Burren Series is limited by impeded natural drainage and poor physical conditions generally; the River Bun en Series is also subject to periodic flooding. Whereas the structure of these soils is moderately good under grassland, it degenerates rapidly under tillage and a good tilth is difficult to produce especially in wet seasons.

Production on the Knockmullgurry, Ballinagilky and Tomard Series is limited by exceptionally low nutrient status, cobalt deficiency and defective natural drainage; both Ballinagilky and Tomard Series are reclaimed mountain soils (formerly peaty, ironpan Podzols).

Although not devoted to forestry to any extent, the soils of this class should be moderately good for this purpose. However, environmental conditions such as exposure to high winds and late spring frosts might prove to be a considerable limitation in places.

The soils in this class occupy 4.1 per cent (9,060 acres) of the county.

Suitability Class D

The soils included in this class (Table VII) have a limited use-range. Limitations include poor to very poor natural drainage, adverse physical conditions (texture/structure/consistence) and liability to periodic flooding; outcropping rock and high altitude are adverse features in some instances also.

The Knocksquire soils are limited by extensive outcrops of bedrock and by very low nutrient status and cobalt deficiency. The poorly to very poorly drained condition of the Ballywilliam, Newtown, Toberbride, Ballinrush, Belmount, Clowater and Raheenleigh soils is the result mainly of high water-table effects; springs and water-seepage are contributing factors also. The poor to very poor internal drainage of the Castlecomer, Coolnakisha and Seskinrea soils is due mainly to their poorly permeable nature, high silt and clay contents, defective structure, and to the dense, impermeable nature of the underlying parent material. In the Coolnakisha Series water seepage from the Killeshin Hills is also a contributory factor. The soils of the Millquarter and KiLmannock Series, which occupy lowlying positions on the landscape, have a high water-table and are subject to periodic flooding.

In general, then, these soils are of poor suitability for tillage cropping and of moderate to poor suitability for pasture and meadow. The Knocksquire soils are unsuitable for tillage or meadowing whilst the others with their physical defects require more cultivation to produce a suitable tilth compared with the soils in Classes A and B. Furthermore, due to their moisture regime, they are slow to warm up in spring, growth starts late and consequently harvesting is usually delayed also. Mechanical operations, both in spring and autumn, are difficult due to soft ground conditions. Little permanent improvement in the output from these soils can be achieved without artificial drainage. Extensive areas have been drained in recent years. Where the drains were placed at an adequate depth (usually between 36 and 42 inches) and where all springs were tapped, the drainage schemes generally have been very successful; subsequently, with good cultural and management practices, moderately satisfactory tillage crops have been grown.

These soils are best suited to grassland. However, to attain worthwhile production constant attention must be given to lime and fertiliser requirements and, for optimum utilization, grazing management must be of a very high standard. Production is limited in early spring and pastures must be rested during prolonged wet periods to avoid poaching. Therefore, the high mid-season output must be fully exploited by conserving the surplus grass as silage or hay for off-grazing keep.

Few of the soils in this class are devoted to forestry with the exception of the Seskinrea Series where, in recent years, extensive areas have been planted.

The soils in Class D occupy 23.4 per cent (51,866 acres) of the county.

Suitability Class E

The soils in this class (Table VII) have a very limited use-range. The class contains only one series, Black Rock Mountain. Soil suitability is limited mainly by ironpan formations in the soils and by moderately steep slopes and high altitudes. The general nutrient status is very low and native soil cobalt levels are inadequate to meet normal livestock lequirements.

The soils are generally unsuitable for tillage cropping or even intensive pasturing and only of modeiate or poor suitability for extensive grazing. However, stock-canying capacity (mainly sheep) could be greatly increased by applying modern hill-grazing improvement techniques, in the form of fertiliser use and surface regeneration with due attention to cobalt supply. Forestry has been established on a large acreage of these soils, but the range of species grown is resti icted by soil and environmental conditions.

The soils in this class occupy 1.9 per cent (4,160 acres) of the county.

Suitability Class F

The soils included in this class (Table VII) have an extremely limited use-range. They are unsuitable for cultivation or intensive grazing and generally unsuitable for forestry. They are only moderately to poorly suitable for hill-grazing; there is a potential, however, for considerably increased output using modern hill-grazing improvement techniques where feasible. Apart from physical drawbacks, e.g. ironpan formations, rockiness, steep slopes and high elevations, nutrient status is low and cobalt deficiency is a serious problem where livestock health is concerned.

This class occupies 2.4 per cent (5,420 acres) of the county.

Unclassified

This group contains the Basin, Hill and Transitional Peats and constitutes 1.2 per cent (2,580 acres) of the county.

Land-Use Practices

Most of the land-use practices in the County Carlow are well suited to the nature of the soils; there are exceptions, however, where traditional land-use may no longer be the most desirable and often management is such that the true potential of the soils is not nearly being realised. In certain cases also, the possible range of uses on particular soils is wider than that currently practised. It is important to know the alternative uses for which particular soils are suitable in order to cope with changing economic and social circumstances and market demands. On soils where the possible use-range is wide, the particular enterprise to be followed may depend largely on economic circumstances. Classes A and B (Table VII) are in this category and represent 67 per cent of the soils of the county. On the other hand, for the soils of limited to extremely limited use-range (Classes D, E and F—Table VII), which constitute 27.7 per cent of the county, the use adopted will be largely independent of economic circumstances since the inherent character of the soils restricts their use possibilities. Class C soils (Table VII) are intermediate in most of these respects.

Classification of the Soils according to Natural Drainage Condition

The soils have been grouped (Table VIII) into six drainage classes: (a) excessively drained, (b) well drained, (c) imperfectly drained, (d) poorly drained, (e) very poorly drained, and (f) variable drainage. All drainage classes refer to the natural drainage condition of the soil; artificial drainage would upgrade the drainage condition of some of the soils in the lower categories.

The soils in Class (a), which carry a dry heath vegetation, have a moisture deficit for long periods of the year due to excessive run-off of rainfall. The soils in Class (b)

TABLE VIII: Classification of the soils according to natural drainage

Natural Drainage Class	Conditioning Factors	Soils	Percentage of total area
(a) Excessively drained	Rapid run-off	Carrigvahanagh	1.54
(b) Well drained	Moderate to rapid permeability, deep water-table	Acaun, Ballindaggan, Ballytarsna, Borris, Clonegall, Keeloge, Kiltealy, Kiltealy Shallow Variant, Knocksquire, Ridge, Ridge Flaggy Variant	33.98
	Moderate permeability, deep water-table	Ballinabranagh, Kellistown, Mortarstown, Paulstown, Rathvinden	21.56
	Moderate to rapid permeability, periodic very high water-table	Clohamon	0.27
(c) Imperfectly drained	Moderate to slow permeability, water-seepage, deep water-table	Moanduff	0.70
	Moderate permeability, springs and water seepage, seasonal high water-table	Greenane, Knockmullgurry	2.42
	Moderate to slow permeability, periodic very high water-table	River Burren	0.26
	Moderate permeability, deep water-table	Ballinagilky, Tomard	0.70
	Slow permeability (ironpan), deep water-table	Black Rock Mountain, Blackstairs	2.78

TABLE VIII (Continued)

Natural Drainage Class	Conditioning Factors	Soils	Percentage of total area
(d) Poorly drained	Very slow permeability, water seepage, deep water-table	Coolnakisha, Parknakyle	2.80
	Very slow permeability, deep water-table	Castlecomer	0.96
	Slow to very slow permeability, seasonal very high water-table	Kilmannock, Millquarter	0.91
	Moderate permeability, springs and water seepage, seasonal high water-table	Ballywilliam, Newtown, Toberbride	11.95
(e) Very poorly drained	Moderate permeability, springs and water seepage, seasonal high water-table	Ballinrush, Belmount, Clowater, Raheenleigh	4.93
	Very slow permeability, seasonal high water-table	Seskinrea	1.09
(0 Variable drainage	Moderate to rapid permeability, seasonal high water-table in places	Athy Complex	9,82
	Moderate to rapid permeability, deep water-table	Broughillstown Complex	2.16
Unclassified		Basin Peat, Hill Peat,	1.17

can hold sufficient moisture for the normal growth of a wide range of crops throughout the average growing season; in very prolonged dry periods, however, these soils with moderate to rapid permeability are liable to a temporary moisture deficit. In the soils in Class (c) drainage must be improved to attain their full potential, whilst for the soils in Classes (d) and (e) artificial drainage is a basic prerequisite to any form of sustained improvement and higher output. The soils in Class (f) have variable drainage characteristics ranging from excessively drained to poorly drained.

For each drainage class the main factors conditioning the drainage regime of the soils are outlined. For example, in the case of the soils with defective drainage, contributing factors may be water-table, or slow permeability, or both. Methods of artificial drainage to improve these soils must be adapted to the factors responsible, if best results are to be attained.

The extent of occurrence of each drainage class is also given in Table VIII. About 64 per cent of the soils of the county have free internal drainage, of which 56 per cent are in the well-drained categoiy and 8 per cent are either excessively well drained or imperfectly drained. Approximately 23 per cent of the soils are impeded and require aitificial drainage. The remaining 13 per cent comprises the soils of variable drainage, which are mostly well drained (Athy and Broughillstown Series), and the peats which have not been classified.

CHAPTER VI

AGRICULTURAL PATTERN IN COUNTY CARLOW*

General Background

The agricultural economy of County Carlow is based largely on tillage cropping and livestock enterprises—a typical mixed farming system. This farming pattern is fairly uniform throughout the county except in the hilly regions of both the west and south-east. In the western region the soils, because of heavy texture and other adverse physical features, are better suited to grassland than to tillage farming; nevertheless, some cereal and root crops are still cultivated despite poor results. Sheep raising is very limited and the main emphasis is on milk and store cattle production. In the south-eastern region the soils are light textured and free draining and respond well to lime and fertilisers; here the system of farming is based largely on livestock with sheep breeding the important enterprise on many farms.

Except in the hilly regions, cash crops are grown on all farms; these include wheat, barley (both malting and feeding), potatoes, sugar-beet, swedes, peas and French beans. On the smaller holdings, 25 to 30 per cent of the land may be devote' 1 to tillage with the balance under short-rotation pasture. On the larger holdings, 20 to 25 per cent of the land is in tillage with the balance under grass both as short-term and permanent pasture. In June 1965 (Irish Statistical Bulletin XL (4)—C.S.O. Dublin, December 1965) tillage crops occupied 43,700 acres, pasture 108,600 acres and meadow 31,300 acres.

In June 1965 (Irish Statistical Bulletin XLI (1)—C.S.O. Dublin, March 1966) the total number of agricultural holdings exceeding one acre in the county was 3,101. The distribution according to size of holding was as follows: 1 to 5 acres, 332; 5 to 10 acres, 234; 10 to 15 acres, 158; 15 to 30 acres, 422; 30 to 50 acres, 557; 50 to 100 acres, 776; 100 to 150 acres, 342; 150 to 200 acres, 137; 200 to 300 acres, 101; above 300 acres, 42. Therefore, roughly 55 per cent of the total number of holdings (exceeding one acre) are less than 50 acres and only 20 per cent are over 100 acres. Gross agricultural output (including pigs and poultry) for the county in 1960 was valued at £3,855,000; this was equivalent to £17 8s per acre of total land or £22 14s pei acre of crops and pasture.

The total population of County Carlow in 1961 (Census of Population, 1961) was 33,342, of which 7,708 resided in Carlow town. The number gainfully employed in

*This chapter was contributed by Mr. T. Murray, B.Agr.Sc., Chief Agricultural Officer, County Carlow Committee of Agriculture.

the county was 12,447, of which 5,397 or 43 per cent were occupied in agriculture, foiestry and fishing. The 1966 Census of Population records an increase in the county's population to 33,479 of which 7,787 now reside in Carlow town. A high per centage of the working population in the county is still engaged in agriculture but there is a growing tendency for workers to move from agriculture into other occupations. The future will probably see a much smaller force of more skilled workers engaged in farming.

Crops and Pasture

The acreage under tillage declined sharply in the period 1955-65 (Table IX). The decline was much greater in corn than in root and green crops. Wheat acreage fell

TABLE IX: Acres under Crops and Pasture
County Carlow 1955-65*

	1955	1960	1965
Total corn crops	32,080	37,100	30,200
Total root and green crops ...	15,663	15,000	13,500
Hay	27,300	26,400	31,300
Pasture	109,500	90,900	108,600

•Central Statistics Office records

from 21,000 in 1960 to 10,700 in 1965, and the acreage under oats also declined. But there was a significant steady increase in the area under barley, viz. from 6,400 acres in 1955 to 9,600 in 1960, to 14,500 in 1965. In root crops the most significant change was a decline in sugar-beet acreage from 6,000 in 1960 to 4,800 in 1965, even though on average the yield per acre has been rising.

Livestock

Total livestock numbers in the county increased considerably over the period 1955-65 although certain categories of cattle decreased (Table X).

TABLE X: Livestock numbers in County Carlow (1955-65)

	1955	1960	1965
Milch cows	13,100	13,800	17,500
Heifers-in-calf	1,800	2,400	3,500
Other cattle (a) 3 years old and over	5,800	3,700	2,700
(b) 2-3 years old	12,800	12,600	11,300
(c) 1-2 years old	15,400	15,600	18,600
(d) Under 1 year old ...	14,000	13,900	19,000
Total sheep	104,500	138,800	203,600
Total pigs	13,400	18,400	18,000

Cattle

Considering the traditional emphasis on tillage in the county, the increase in the number of dairy cattle is quite remarkable. Farmers have turned to creamery milk production as a means of deriving a more constant income. About 1,000 farmers now supply milk to three creameries in neighbouring County Kilkenny and some 100 are supplying the Dublin liquid milk market and a local pasteurising plant. Milk production and tillage are rated a very good combination where farm income is concerned. A notable feature of the cattle population (Table X) is the reduction in the average age of the "other cattle" on the farms. The Shorthorn, once the dominant breed in the county, is being replaced gradually by the Friesian for milk production; the Hereford is the most popular breed for crossing for beef purposes.

Sheep

The most notable feature of the livestock pictuie is the almost two-fold increase in the sheep population in recent years (Table X). The county has a strong tradition for sheep raising. The marginal lands associated with Mount Leinster and the Blackstairs Mountain carry large breeding flocks of Cheviot and Cheviot x Border Leicester. Ewes from these flocks are bought by farmers in the lowlands where they are crossed with the Down breeds to produce lambs for the meat trade. The fattening of store lambs on catch crops and swedes is a common practice on many tillage farms.

Pigs

Pig numbers in the county remained almost static between 1960 and 1965 (Table X). The fattening of pigs in large units is becoming a specialised line on a limited number of farms. In 1965 recorded breeding sows numbered 2,700, of which two-thirds were in the southern part of the county. A pig-fattening co-operative station operating in County Wicklow but close to Tullow takes weaners from several producers in the area.

Farming Prospects

Tillage cropping should continue to hold its traditional place in the farming pattern of County Carlow in the future; there are extensive areas of suitable soils and the necessary management skills are well established. In 1926 the first Sugar Factory in the country was opened beside Carlow town and sugar-beet has an important place in the cropping pattern on most tillage farms. Wheat, barley, oats, potatoes and the different root crops are extensively grown. Recently some horticultural crops such as peas and French beans have been introduced on a field scale. In 1966, 800 acres of peas and 55 acres of French beans were grown to supply a processing plant at Carlow; as the techniques of growing such crops on this scale improve and as market outlets expand, an extension of this enterprise on many farms is to be expected.

The emphasis on tillage has been responsible to some extent for a longstanding interest amongst the better farmers in lime and fertiliser use, not only for tillage crops but for grasslands also. Since 1949, under the Land Rehabilitation Scheme, 42,500 acres have been reclaimed, and improved drainage has added considerably to the profitability of many farms. Because of the difficulties of hay-saving there is a noticeable change-over to silage as a means of fodder conservation for winter keep. In 1963 some 72 farmers made a total of 13,118 tons of silage; in the 1965 season 150 farmers made 32,000 tons. It is likely that this upward trend will continue although hay will remain the dominant source of fodder for a considerable time to come.

With continued improvement in the standard of farming, livestock numbers will possibly continue to expand in the immediate years ahead, without affecting the current acreage under tillage. The increasing rate of production per acre, a feature of recent years, must be maintained and the per capita output improved if the living standards of farm families are to be enhanced. There are still facets of farm production which are not sufficiently understood, and there are problems in need of a lasting solution; the knowledge provided by the systematic soil survey of the county should provide valuable guidance in the achievement of increased agricultural production.

CHAPTER VII

DISCUSSION OF ANALYTICAL DATA

Samples taken from representative soil profiles in each series were tested in the laboratory. The tests included particle size analysis, cation exchange capacity, total exchangeable bases, pH, organic carbon, total nitrogen, free iron and total neutralising value. From the cation exchange capacity and total exchangeable bases, the per centage base saturation was calculated.

Trace element levels in the more extensive soil series within the county were determined spectrographically; the results are discussed later in this chapter.

X-ray analysis techniques were used to determine the clay mineral composition of some of the more extensive soil series. Findings to date in this study are given later in this chapter.

General Analyses

Particle Size Analysis

The per centages of coarse sand, fine sand, silt and clay in the mineral fraction are determined by particle size analysis. Texture refers to the relative proportions of these soil separates and is discussed in Appendix III. Texture is one of the more important physical properties of the soil: it influences structural development, and factors such as moisture-holding capacity, drainage and tillage properties; resistance to damage by stock and heavy machinery are conditioned by texture and structure. The texture of modal profiles has already been described (Chapter IV).

The relationship between soil parent material, soil texture and type of profile development is well expressed in a number of the soils of County Carlow.

The soils derived from granitic parent materials are invariably coarse textured, e.g. coarse sandy loams. Except where the soils occur at high elevations or where soil-forming factors other than parent material dominate, it is mostly Brown Earths or Brown Podzolics that develop on these parent materials. The soils derived from shale parent materials are generally of a sandy loam texture and "brown-podzolic" in profile character. The soils derived from parent materials mainly of limestone composition are somewhat "heavier" in texture, e.g. loams to clay loams. Clay movement is a significant feature in the profiles of many of these soils and they generally qualify as Grey Brown Podzolics. Carboniferous shales together with some sandstones and flagstones form the parent material of most of the soils on the Castlecomer Plateau. The soils here are relatively heavy in texture, being mostly clay loams; this together with the poor structure is mainly responsible for most of the soils being Gleys.

The coarse texture of the parent materials is responsible for the large proportion of well-drained soils within the county. The poorly drained soils are associated with heavy textured materials, or depressional areas on the landscape, or, at the higher elevations, with an impervious ironpan in the profile.

Cation Exchange Capacity

The cation exchange capacity, in its simplest terms, is an index of the capacity of a soil to adsorb cations such as hydrogen, calcium, magnesium, sodium and potassium. It is an indication of the ability of the soil to provide important nutrients to the growing plant. The exchange capacity is governed chiefly by the organic matter and clay contents of the soil. Soils with high organic matter usually have a high cation exchange capacity (25 to 40 meq/lOOg of soil). The cation exchange capacity of a soil low in, or devoid of, organic matter is generally less than 12 meq/lOOg; here it is conditioned chiefly by the clay fraction.

Light sandy soils containing little organic matter, oi clay, usually have a very low cation exchange capacity and, consequently, a low potential for retaining plant nutrients; hence the necessity for relatively frequent fertiliser dressings on these soils. Heavier textured soils, on the other hand, usually have a high cation exchange capacity and are capable of adsorbing and retaining larger quantities of applied nutrients, especially calcium and potassium; the nutrients are slowly released to meet the needs of growing plants. On such soils, therefore, fertiliser and lime applications can be larger and less frequent.

The cation exchange capacity of the Carlow soils vaiies widely. On the well-drained soils, which are extensively cultivated, values range from 14 to 35 meq/lOOg in the surface horizons, depending on the contents of organic matter and clay. Surface soils rich in organic matter, such as those in some of the podzol, gley and alluvial profiles, usually show the highest values.

Percentage Base Saturation and pH

The base saturation of the exchange complex of a soil is obtained by determining the total exchangeable bases (plant nutrients such as calcium, potassium, sodium, magnesium) and expressing the figure obtained as a percentage of the cation exchange capacity. As such it is an index of the base status of the soil.

The natural base status of a soil is inherited from the parent mateiial but may be modified subsequently by weathering, leaching and other influences including cultural practices. Where the parent material is base-rich and leaching has not been excessive, the rate of lelease of bases by weathering is sufficient to offset losses through leaching, cropping and other outlets and to provide for a high base status profile. However, where rainfall is heavy and evapotranspiration low, or where the coarse nature of the soil permits excessive leaching, or where large amounts of bases are removed by intensive cropping, the base content of a soil may be considerably depleted. Low base status may also be an inherent characteristic of soils related to the acid nature of the parent material.

The base status of acid soils can be improved by liming, the amount necessary being determined by the ability of the soil to adsorb bases—the cation exchange capacity—the prevailing and the desired base status. Certain fertilisers also supplement the base status of the soil. Many of the soils of County Carlow are derived from acid parent materials which, in the normal course of events, would give rise to base-poor soils. The application of lime and manures, however, has maintained pH and base status at a moderately high level in many of these soils. Other soils in the county are derived from base-rich parent materials, e.g. limestone-rich glacial till, but, due to leaching, the bases have often been depleted, especially in the upper horizons. For best results the base status of the soils must be maintained at the desired level.

pH is a measure of soil reaction, i.e. acidity or alkalinity. A soil having a pH of 7.6 to 8.3 is moderately alkaline; pH 7.1 to 7.5, slightly alkaline; pH 7.0, neutral; pH 6.6 to 6.9, nearly neutral; pH 6.0 to 6.5 slightly acid; pH 5.3 to 5.9, moderately acid; pH 4.6 to 5.2, strongly acid; and pH below 4.5, very acid.

It is not intended that the pH and base saturation analyses given for each modal profile (Appendix I) be used as a basis foi lime recommendations. For accurate recommendations random soil sampling and analyses are required. However, the results given reveal the variation in base status with soil depth, and between different soils.

On the basis of pH and parent material the Brown Earths are separated according to base status as follows:

Brown Earths of High Base Status: These soils are usually developed on calcareous parent materials and in their natural (unlimed) state have pH values above 6.2 in the layers below the cultivation zone.

Brown Earths of Medium Base Status: These soils are usually developed on non-calcareous (slightly acid) parent materials and in their natural (unlimed) state have pH values between 5.8 and 6.2 in the layers below the cultivation zone.

Brown Earths of Low Base Status: These soils are usually developed on acid parent materials and in their natural (unlimed) state have pH values below 5.8 in the layers below the cultivation zone. These are more commonly known as Acid Brown Earths.

Total Neutralising Value (T.N.V.)

This is an index of the level of carbonates in a soil. These carbonates modify the solubility of various nutrients. Soils showing positive T.N.V. values in the surface horizons contain adequate or excess neutralising materials and are not in need of liming.

Several soils in the county are derived from limestone-rich parent materials, e.g. Ballinabranagh, Kellistown, Mortarstown, and Newtown Series, Athy and Broughillstown Complexes. Most surface horizons, however, have been leached of carbonates and only in the lower horizons have significant T.N.V.s been recorded. The highest total values, between 35 and 55 per cent, were found in the C horizons of the Athy Complex.

Carbon and Nitrogen

The level of organic carbon indicates the amount of organic matter in a soil (Cx 1.9—organic matter). The content and nature of organic matter are of fundamental importance. Due to its high cation exchange capacity, organic matter is an ideal reservoir of plant nutrients, which are gradually released to meet the requirements of the growing plant. At the same time acid humus enhances the supply by increasing the extraction of nutrients from the mineral fraction of soils. Organic matter creates favourable physical conditions for crop growth: it promotes granulation of structure by reducing plasticity, influences cohesion and increases the water-holding capacity of the soil; in the surface it also influences the temperature of soils and, thus, seasonal growth.

Depending on organic carbon content, soils are classified as follows: over 30 per cent, peats; 20 to 30 per cent, peaty; 10 to 20 per cent, slightly peaty; and those with 7 to 10 per cent are usually referred to as 'organic'. With the terms 'peaty', 'slightly peaty' and 'organic', the mineral textural class is included in the definition of the soil, e.g. peaty sandy loam; slightly peaty clay loam; organic loam. The surface horizon of mineral soils in Ireland normally contains 3 to 7 per cent organic carbon.

Nitrogen, which is normally present in soils in relatively small amounts, is a most important plant nutrient. It is easily leached from the soil and supplies must be replenished constantly. The ratio of carbon to nitrogen (C/N ratio) is a general index of the degree of decomposition of organic matter; a ratio between 8 and 15 is considered satisfactory, and indicates conditions favourable for microbial activity. Ratios higher than 15 are associated with a slower decomposition rate and with the accumulation of raw organic matter or, in more extreme cases, with peat development, and indicate conditions unfavourable for microbial activity.

Soils vary in carbon and nitrogen contents and in their C/N ratio as a result of inherited and environmental conditions, soil drainage and cultural practices. In the well-drained soils in the county, e.g. Brown Earths, Brown Podzolics and Grey Brown Podzolics, where tillage is practised extensively, carbon content ranges between 2 and 6 per cent and nitrogen between 0.2 and 0.5 per cent. Where environmental factors associated with elevation inhibit decomposition, accumulations ranging from 10 to 35 per cent carbon have been found and the C/N ratios are wider than normal.

Free Iron

A localised accumulation of free iron in a profile (Bir horizon), as in brown podzolic and podzol soils, indicates that leaching and podzolizing processes have been operative. On the other hand, a uniform distribution of free iron throughout a profile, as in the Brown Earths, indicates that the soils have not been strongly leached.

Trace Elements

Trace or minor elements are found in varying amounts in most soils; contents for normal agricultural soils range from less than one to several parts per million (Table XI). Anomalous values may be found in seepage areas and in the vicinity of mine workings or ore bodies.

Several trace elements are known to be important in the nutrition of plants and animals, and the soil is the main source of supply. To date those known to be essential for plant growth are copper, manganese, iron, zinc, molybdenum and boron; under special circumstances and for particular plant species, cobalt and selenium may also be necessary. Those necessary for animals are cobalt, copper, manganese, iron, zinc, molybdenum, selenium and iodine. For general agriculture the availability to the plant of a particular trace element may be more important than the total content in the soil; nevertheless, total soil values can provide considerable guidance in predicting likely toxicities or deficiencies. Although the main factor governing the total content of a trace element in any soil is the nature and in particular the mineral composition of the parent material, the distribution within the profile is conditioned by soil-forming processes such as leaching, weathering and organic matter accumulation.

The availability of trace elements is influenced by such factors as soil reaction (pH), drainage status and organic matter content. In most cases availability is reduced by an increase in soil pH; this is particularly true of manganese and to a lesser and varying degree of copper, iron, boron, zinc and cobalt. A major exception is molybdenum, the availability of which is enhanced with an increase in soil pH. Impeded drainage limits soil air, giving rise to reduced forms of some trace elements, particularly iron, cobalt and manganese. The reduced forms of these elements are more

TABLE XI: Trace Elements in Soils

Elements		Normal Range in Soils (ppm)	Average in Soils (ppm)
Tin	(Sn)	1 -10	5
Lead	(Pb)	2-200	30
Gallium	(Ga)	5 -70	40
Molybdenum	(Mo)	0.2-5	2
Vanadium	(V)	20 -500	100
Copper	(Cu)	2 -100	40
Silver	(Ag)	<0.1-1	0.1
Zinc	(Zn)	10 -300	100
Nickel	(Ni)	5 -500	40
Cobalt	(Co)	1 -40	10
Chromium	(Cr)	5 -1,000	100
Titanium	(Ti)	1,000 -10,000	3,000
Manganese	(Mn)	200 -3,000	600

soluble than the oxidised forms, and this is reflected in greater uptake by plants. For instance, a well-drained and a poorly drained soil having the same total content of an element like manganese could be expected to have quite different amounts in the available form.

Leaching of nutrients in free-draining soils can produce trace element deficiencies. These are referred to as "acquired" to distinguish them from "inherited" deficiencies which result from a shortage of the particular element in the parent material of the soil. Acquired deficiencies commonly arise under a podzolization process in soil development; some of the cobalt deficiency in County Carlow soils most probably originated in this manner.

The role of soil organic matter in trace element availability is probably best illustrated by its effect on copper. Organic matter can bind or fix copper very effectively and thereby reduce availability. Organic-rich soils and peats are frequently associated with copper shortage.

The trace element status of a number of soil series in Carlow was investigated. The analytical data for the profiles examined are given in Appendix I. The figures quoted are all total values; spectrographic methods used in determining these values are described later in this chapter. The general trace element levels in the profile reflect the nature of the parent material, whereas the varying contents between soil horizons reflect differences in soil-formation processes. Thus, higher than average values for elements such as tin, and lower than average values for elements such as cobalt, are generally associated with the granitic soils. High molybdenum values are most often associated with limestone-rich parent materials. The relation between shale parent materials and molybdenum content is not so clear; in parts of the country, high molybdenum values are found in soils derived from certain carboniferous shales. It is interesting to note that in the Carlow shales examined, the general level of manganese seems to be lower than in the Wexford shales. Manganese in the

Ordovician Shale of the Clonroche soil in Wexford was 7,000 ppm, whereas the highest value for any parent material examined in Carlow was 1,500 ppm.

The total values given in the tables (Appendix I) can be used to assess the likelihood of nutritional problems. However, it must be stressed that the validity of such predictions is greatest when an element is unusually high or low. A soil with a total cobalt value as low as 1 or 2 ppm would be most likely to yield herbage deficient in this element, while a soil with a total molybdenum value of 10 to 20 ppm should produce vegetation toxic to grazing stock. Studies of availability of the particular element together with herbage analyses are of course frequently necessary to a the trace element status of a soil from the plant and animal nutritional standpoint.

In considering the general trace element pattern, the soil series selected for examination represent the most important Great Soil Groups in the county and are grouped accordingly.

Grey Brown Podzolics

In this group of soils the trace element pattern is generally satisfactory (Appendix I, Tables 1 to 5). However, molybdenum toxicity may become a problem in the Kellistown Series; in the modal profile the surface soil has 4 ppm of this element and the pH is 5.6. Heavy liming of the soil could enhance the availability of molybdenum, leading to increased levels in the herbage and to molybdenosis in grazing stock. On the other hand, symptoms of molybdenum deficiency in brassica crops have been reported locally.

Distribution of the various elements within the profiles is generally fairly uniform. The biggest exception is the Mortarstown Series where there is a rather well-defined increase of lead, gallium, molybdenum, vanadium, copper, nickel and cobalt, in the B2t relative to the surface horizon. The corresponding clay contents are 23 and 42 per cent for the surface and B2t horizons, respectively. However, in the Paulstown Series where the surface horizon has 24 per cent clay and the B2t 43 per cent, except for copper, nickel and cobalt, there is much less evidence of trace element accumulation in the B horizon.

Brown Earths

The total contents of the trace elements in the soils of this group all fall within normal ranges (Appendix I, Tables 6 to 12). However, for some elements there are variations between Series, which largely reflect differences in parent materials. In the Acaun Series manganese occurs at the highest levels for the group. This is due probably to the limestone influence in the parent material of these soils; limestones generally contain more manganese than either granites or sandstones which are the other two components of the parent material. Total manganese is lowest in the Keeloge Series although still falling within the normal range (Table 11); there is a possibility of manganese deficiency in crops, especially after liming of these soils.

The cobalt contents of the upper horizons of the Brown Earths in general tend to be somewhat low, and a deficiency could develop under intensified stocking. The danger of a deficiency is greatest on the Borris Series where levels throughout the profile are rather low.

The distinctly higher tin values apparent in the Ballytarsna and Borris Series are of no importance agriculturally, but they are of interest geochemically and are most probably related to the granitic parent material. Similar trends appeared in the granitic soils in County Wexford (Gardiner & Ryan, 1963).

Agriculturally the two most salient features of the analyses are: (a) general tendency towards low cobalt levels, (b) the possibility of manganese deficiency in the Keeloge Series.

In general trace elements are fairly uniformly distributed throughout the profile of the Brown Earths. Some notable exceptions are the distinct rise in copper, nickel, cobalt and manganese in the C horizon of the Acaun Series and of copper, nickel and cobalt, and of zinc, nickel and cobalt, respectively, in the sub-surface horizons of the Ballindaggan and Ballytarsna Series.

Brown Podzolics

The trace element figures for the Clonegall Series depart little from normal soil levels (Appendix I, Table 13). However, total cobalt contents are marginal and a test for available levels would be necessary to ascertain possible deficiencies. There is little evidence of translocation of elements from the A to the B horizon. But gallium, molybdenum, vanadium, copper, nickel, cobalt, chromium and titanium are distinctly higher in the C horizon than in the upper horizons; the reverse is true for manganese.

The main interest in the Kiltealy Series is the low values for copper, cobalt and manganese (Appendix I, Table 14). Cobalt deficiency in grazing stock is a distinct probability on these soils. Availability studies would be necessary to determine if crop deficiencies due to copper or manganese shortage are likely. The distribution of trace elements within the profile is generally uniform but there is a noticeable drop in chromium, titanium and manganese in the C horizon. Of particular interest in the shallow variant of the Kiltealy Series is the accumulation of tin, lead, gallium, copper, chromium and titanium in the surface horizon.

In the Ridge Series the general levels are normal but some points regarding distribution within the profile are worthy of comment (Appendix I, Table 17). Both cobalt and manganese show a distinct decrease in the B2 horizon; cobalt is highest in the C horizon, and manganese in the A horizon.

In summary, cobalt deficiency would be the most likely trace element problem on these soils except on the Ridge Series where reserves are apparently adequate. Manganese and copper deficiencies may occur sporadically, especially on the Kiltealy soils.

Podzols

In the Ballinagilky Series cobalt, copper, manganese and molybdenum are low (Appendix I. Table 19) and deficiencies of these elements may be expected, especially in the more organic surface soils. Cobalt deficiency would be most serious in sheep farming, manganese and copper deficiencies in cereal growing; but copper shortage might be a limiting factor also in clover establishment in pastures. A molybdenum shortage would affect brassica crops mostly.

In the Blackstairs Series (Appendix I, Table 21) general levels of trace elements are rather similar to those of the Ballinagilky Series and here also the agriculturally important elements cobalt, copper, manganese and molybdenum, are all quite low. The most striking difference between these two soils is the generally lower values in the surface horizon and the sharp increase apparent for most elements between the organic surface and the mineral sub-surface horizons of the Blackstairs profile. To allow for an organic matter content in excess of 50 per cent in the surface of the

Blackstairs profile, and to provide a more valid comparison, the analytical figures should be expressed on an ash rather than a "whole soil" basis.

The Black Rock Mountain soils derived mainly from shale show some interesting differences from the Ballinagilky and Blackstairs Podzols developed on mainly granitic material; the most obvious differences are in the parent materials or C horizons and to a lesser degree in the B horizons (Appendix I, Table 20). Molybdenum, vanadium, copper, chromium and titanium are generally higher, and tin, gallium and zinc lower in corresponding B and C horizons of the Black Rock Mountain profile than in either the Ballinagilky or Blackstairs profiles. The surface horizons again are very low in cobalt and manganese. The organic nature of the surface horizon makes interpretation of the copper and molybdenum figures difficult, as in the Blackstairs profile.

Gleys

In both the Ballywilliam and Belmount Series (Appendix I, Tables 24 and 25) molybdenum, cobalt and manganese are low and deficiencies may arise. Distribution within the profile shows a definite increase particularly of vanadium, zinc, cobalt, chromium and manganese in the lower horizons.

The soils of the Castlecomer and Clowater Series appear to be adequately endowed with trace elements. Copper, zinc and nickel increase with depth in the profile whilst manganese decreases (Appendix I, Tables 26 and 27).

The plough layer of the Coolnakisha Series (Appendix I, Table 28) is particularly low in copper and manganese, and cobalt is marginal in the surface horizon; there is a general increase to satisfactory levels in the lower horizons.

The trace element supply seems quite satisfactory in the Greenane Series (Appendix I, Table 29), but molybdenum and manganese levels tend to be higher than in the other gleys. There is an obvious accumulation of lead, copper, zinc and manganese accompanying the clay accumulation in the B horizon.

The trace element levels in the Moanduff, Newtown and Parknakyle Series in general appear satisfactory except for the rather low copper in the Parknakyle Series (Appendix 1, Tables 31, 32 and 33). In the Moanduff and to a lesser extent in the Newtown and Parknakyle profiles, elements tend to increase in content with depth, but lead is clearly concentrated in the upper horizons of the Newtown and Parknakyle profiles.

In the Gleys in general, the availability of many elements, including molybdenum, cobalt and manganese, is usually greater under the reducing conditions obtaining in these wet soils. Thus where total values for cobalt and manganese are marginal, deficiencies would be less likely than under free-draining conditions. Conversely, molybdenum levels of 2 and 3 ppm, which in freely-drained soils could be disregarded, might conceivably give rise to anomalous levels in herbage, especially when lime is applied.

Regosols (AlluviaIs)

Trace element levels in these soils are apparently satisfactory (Appendix I, Tables 37 to 40) and problems from shortage or excess should not arise. Manganese content declines sharply in the lower horizons of the Kilmannock profile which is not surprising in view of the nature of the parent material (coarse calcareous gravels).

Complexes

Athy Complex: Despite the variable nature of the soils, trace element levels are generally satisfactory and quite uniform throughout the complex. Copper and zinc tend to be concentrated in the upper horizons of the profile in all four component soils (Appendix I, Tables 42 to 45).

Broughillstown Complex: As in the soils of the Athy Complex, the levels for all trace elements are satisfactory here also (Appendix I, Tables 46 and 47). An interesting aside on these soils is that cadmium was detected at a level of around 10 ppm in the (B) horizon of the moderately deep component. This element follows zinc in the geochemical cycle and it is noteworthy that zinc shows comparatively high values in this soil, especially in the (B) horizon. The zinc levels, however, are well within the normal range for soils (Table 11) and would not be a problem agriculturally.

Clay Mineralogy

Clay minerals occur in that size fraction of the soil comprising the smallest inorganic particles; they usually accumulate during the weathering of the parent material under several natural processes. In the analyses (Table XII) the particles less than 0.0014 mm (i.e. 1.4u equivalent spherical diameter) are regarded as the clay minerals. Most of these are irregular, platy crystals which are capable of being identified by X-ray diffraction techniques. Physically, they have the capacity to swell and shrink on hydration and dehydration. Chemically, all are alumino-silicates with cation exchange properties which differ according to the nature of their inter-layer cations and residual surface charges. The clay minerals with their characteristic crystal structure have an important influence on the physics and chemistry of the soil.

The predominant clay minerals are identified here at group level. Semi-quantitative estimates of the relative amounts are made by visual comparison of diffractorgrams of the various specimens treated in the following ways: (a) magnesium and glycerol saturated at 20°C; (b) magnesium saturated and heated to 350^{C}C; (c) potassium saturated at 20°C; (d) potassium saturated and heated to 550°C. The approximate proportions in which the listed mineral groups occur are shown in Table XII. These are not absolute amounts, as no allowance is made for the presence of accessory minerals or amorphous material.

The soils studied here represent the major soil groups occurring in the county. Every clay fraction was found to comprise a collection of clay minerals rather than a single mineral group. Minerals of the mica and vermiculite groups together constitute a significant proportion of the clays examined from almost all the selected soils (Table XII). These are accompanied by varying though usually lesser amounts of the kaolin and montmorillonite groups. Chlorite is detected in small amounts or is absent in nearly all of the profiles studied, and of the primary minerals quartz is present mostly in moderate amounts.

The common occurrence in these soils of two forms of vermiculite is noteworthy; these are designated Vermiculite A and Vermiculite B (Table XII). Vermiculite A is the usual form with a 14°A spacing which on potassium saturation collapses to 10°A. The B-form probably contains non-exchangeable interlayer aluminium (as a hydroxy complex) which inhibits lattice contraction on saturation with potassium. Heating the K-saturated samples at 550°C for 2 hours destroys this hydroxy-complex and permits contraction of the vermiculite layers.

The clay fractions of the grey-brown podzolic soils, Kellistown and Mortarstown

TABLE XII: Clay mineral pattern in some Carlow soils

Series	Depth (in.)	Mica	Chlorite	Kaolinite	Vermiculite A	Vermiculite B	Montmorillonite	Quartz
Kellistown	0 - 7	T	T	T	—	M	—	M
	7 -15	T	—	T	—	M	—	M
	15 -18	M	T	M	—	M	—	M
	18 -38	M	—	T	M	T	M	M
	Below 38	M	T	M	—	—	M	M
Mortarstown	0 -10	T		T	M		M	M
	10 -22	M	—	T	M	—	T	M
	Below 22	M	—	T	M	—	—	M
Ballindaggan	0 - 7	A	M	M				M
	7 -13	A	M	M	—	—	—	M
	Below 13	A	M	M	—	—	—	M
Borris	0 -12	M		M	M	M		M
	12 -28	M	T	T	M	M	—	M
	Below 28	M	T	T	T	—	—	T
Clonegall	0 -11	M	T	M	M	M	T	M
	11 -23	M	T	M	M	M	—	M
	Below 23	M	T	A	M	M	—	M
Kiltealy	0 - 8	M	T	M	—	T	—	M
	8 -13	M	T	M	M	M	—	T
	13 -22	M	T	M	M	M	—	M
	Below 22	A	T	A	T	T	—	M
Ridge	0 -11	M			A	M	M	M
	11 -18	M	—	—	A	M	T	M
	Below 18	A	T	T	M	M	T	M
Black Rock Mountain	0 - 2	T	T	—	T	—	—	T
	2 - 7	A	T	—	M	T	—	A
	7 - 9	A	—	—	M	T	—	A
	9 -21	M	M	T	M	T	—	M
	Below 21	M	—	T	T	M	—	M
Castlecomer	0 - 8	M	T	T	D	A	—•	M
	8 -35	A	T	T	A	M	—	M
	Below 35	D	—	T	A	—	—	M
Athy Complex Moderately deep component	0 - 3 *	T	—	T	M	M	M	T
	34-14	T	—	T	M	M	M	T
	14 -23	T	T	T	M	M	T	T
	23 -27	T	T	T	M	M	T	T
	27 -28	M	—	T	M	M	—	T
	Below 28	M	T	T	M	M	—	T
Shallow component	0 -11	T		T	M	M	T	T
	Below 11	T	—	T	M	M	M	T

TABLE XII (Continued)

Series	Depth (in.)	Mica	Chlorite	Kaolin-ite	Ver-miculite A	B	Mont-morillonite	Quartz
Broughillstown Complex	0 - 6	A	T	T	M	—	T	M
Moderately	6 -11	A	—	T	M	M	—	M
deep	11 -20	M	—	T	—	A	T	M
component	20 -23	M	—	T	M	A	—	M
	Below 23	M	—	T	M	M	—	A
Shallow	0 - 8	M		T	M	M	T	M
component	Below 8	M	—	M	M	M	—	M

Legend: Trace (T): 0 to 5 per cent; Abundant (A): 20 to 50 per cent;
Moderate (M): 5 to 20 per cent; Dominant (D): Over 50 per cent;
Absent: —

Series (Table XII), consist principally of vermiculite with somewhat lesser amounts of the mica group. Montmorillonite occurs also in both soils but in the Kellistown Series is confined to the lower horizons of the profile.

The clay fractions of the Brown Earths of the Ballindaggan*and[T]Borris Series (Table XII) are largely composed of either the mica or vermiculite group minerals together with lesser though variable amounts of chlorite and kaolinite. The particularly high mica content and the consistently moderate distribution of chlorite and kaolinite in the Ballindaggan soil coupled with the absence of vermiculite and montmorillonite are noteworthy. In the Borris profile the vermiculite group is well represented, but the mica content is lower and neither the chlorite nor kaolin groups are so abundant as in the Ballindaggan Series.

The clay mineral content of the brown podzolic soils, Clonegall, Kiltealy and Ridge Series (Table XII), follows a similar pattern to that of the Brown Earths with the mica and vermiculite groups predominating. Vermiculite is most dominant in the Ridge Series and least in the Kiltealy Series. Kaolinite is virtually absent in the Ridge profile but occurs in moderate to abundant amounts in the Clonegall and Kiltealy soils. Small amounts of montmorillonite occur in the Ridge profile only. *f{*

Black Rock Mountain Series (Table XII) representing the Podzols, except in the surface organic layer, has a clay fraction dominated by the mica and vermiculite groups with little or no chlorite or kaolinite. Quartz is most abundant in these soils.

The Castlecomer Series representing the gley soils is dominated by mica and vermiculite, which occur at higher levels than in the soils of any of the other Great Soil Groups studied. Here the relationship between the mica and vermiculite distribution down the piofile is striking, one decreasing as the other increases. Both chlorite and kaolinite contents are low.

In the soils of the Athy Complex the content of montmorillonite is greater in the upper than in the lower horizons; mica distribution shows the opposite trend. Vermiculite is well represented throughout the profiles. The chlorite content of these soils is very low or entirely absent and kaolinite only occurs in trace amounts. In the Broughillstown soils by comparison the mica group is much better represented in the clay fraction but montmorillonite is almost entirely absent; the patterns for vermiculite, chlorite and kaolinite are quite similar to those for the Athy soils.

Summary of Analytical Methods

Analytical methods used in the various laboratory tests were as follows:

Particle Size Analysis: Determined by the International Pipette Method as described by Kilmer and Alexander (1949), using sodium hexametaphosphate as dispersing agent.

Cation Exchange Capacity: Determined by the method of Mehlich (1948). Soil was leached with buffer red $BaCl_2$ to displace exchangeable cations, Ba displaced by $CaCl_2$, and K_2Cr0_4 was used in the colorimetric estimation.

Total Exchangeable Bases: Extracted by method of Mehlich (1948). Ca, Na and K. estimated flamephotometrically, Mg by titan yellow method.

pH: Determined on a 1:2 soil/water suspension using a glass electrode.

Total Neutralizing Value: Determined on a HC1 extract using phenolphthalein as indicator and titrating against NaOH. $CaC0_3$ was used as a 100 per cent standard.

Organic Carbon: Estimated by the Walkley-Black dichromate oxidation method as described by Jackson (1958), modified for colorimetric estimation. Values were read off on a Spekker Absorptiometer using Orange Filter No. 607. A recovery factor of 1.1 was used.

Total Nitrogen: Estimated by a modification of the method of Piper (1950) by digesting soil with coned H_2S0_4 using selenium as a catalyst, distilling into boric acid and titrating with HCI.

Free Iron: Extracted with bufferred sodium hydrosulphite (Mehra and Jackson, 1960). Fe determined colorimetrically using o-phenanthroline.

Trace Element Analyses: Carried out spectrographically by methods described by Nichol and Henderson-Hamilton (1964). Total analyses are semi-quantitative in nature, i.e. accurate to about +40 per cent of the amount present. This method, which is very rapid, has been used extensively in soil analysis and is of value in revealing major differences between soils (Mitchell, 1948).

X-ray Diffraction: The separation of clays for X-ray diffraction analysis was carried out by standard sedimentation methods (Mackenzie, 1956) and the less than 1.4u fraction was used.

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APPENDIX 1

PROFILE DESCRIPTIONS AND ANALYSES

Ballinabranagh Series—Modal Profile

Location:	Ballinabranagh, Carlow; *12/1 I 7
Topography:	Undulating
Slope:	3°
Altitude:	225 feet O.D.
Drainage:	Well drained
Parent Material:	Dense, calcareous, soliflucted drift material composed of chert, flagstone, limestone, sandstone and shale
Great Soil Group:	Grey Brown Podzolic

Horizon	*Depth (in.)*	*Description***
Ap	0-9/10	Loam; dark greyish-brown to brown (10 YR 4/2-4/3); weak, fine and medium granular structure; friable to (wet) slightly plastic; plentiful roots; clear, smooth boundary to:
A2	9-20/30	Loam; pale-brown to brown (10 YR 6/3-5/3); weak, fine granular structure; friable; plentiful roots; clear, wavy boundary to:
B2t	20-70/75	Loam to clay loam; brown (10 YR 4/3-5/3) with many, fine, faint mottles and some black manganese blotches; weak, medium sub-angular blocky structure; wet, plastic; clay skins; sparse roots in upper 10 inches; abrupt, wavy boundary to:
C	Below 70	Stony clay loam to loam; brown (10 YR 5/3); structureless; wet, plastic; no roots; calcareous

Vegetation: *Lolio-Cynosuretum,* typical Sub-ass. High quality, well manured, reseeded grassland dominated by *Lolium perenne* (perennial rye-grass), *Poa trivialis* (rough-stalked meadow-grass) and *Trifolium repens* (white clover).

*Grid Reference

**The procedure mostly followed is that described in the *Soil Survey Manual* (U.S. Dept. Agric. Handbook No. 18, Washington D.C. 1951). Colour designations are according to the Munsell Colour Notation. Colour, structure and consistence arc measured on the moist soil unless otherwise stated

TABLE 1: Ballinabranagh Series

Horizon	Particle size analysis of mineral fraction				PH	Cation Exchange			Organic Fraction			Free iron %	T.N.V. %
	Coarse sand %	Fine sand %	Silt %	Clay %		C.E.C. meq/lOOg	**T.E.B.** mcq/lOOg	Base sat. %	**c%**	N %	C/N		
Ap	21	19	40	20	5.2	17.7	6.9	39	2.4	0.22	**10.9**	1.7	0.0
A2	19	20	44	17	6.4	9.4	5.6	60	0.4	nd	-	1.6	0.0
B2t	20	16	38	26	6.6	14.2	**11.0**	77	0.3	nd	-	1.8	0.0
C	22	16	35	27	8.0	9.3	-	Sat	0.3	nd	-	1.5	5.5

Coarse Sand 2.0-0.2 mm; Fine Sand 0.2-0.05 mm; Silt 0.05-0.002 mm; Clay <0.002 mm diameter size
C.E.C.=Cation Exchange Capacity; T.E.B. =Total Exchangeable Bases; C/N Ratio=Carbon/Nitrogen Ratio;
T.N.V. =Total Neutralising Value; nd^ not determined

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	3	20	8	2	65	20	<1	100	25	10	50	2000	1200
A2	3	20	10	3	130	35	<1	100	50	15	75	2000	850
B2t	2	15	12	3	100	35	<1	100	50	15	60	2000	1000
C	2	17	15	2	100	35	<1	100	40	17	50	1500	1200

Sn =Tin
Pb =Lead
Ga =Ga!lium
Mo = Molybdenum

V =Vanadium
Cu = Copper
Ag = Silver
Zn =Zinc
Ni = Nickel

Co = Cobalt
Cr =Chromium
Ti = Titanium
Mn = Manganese
ppm=parts per million
< =less than

Kellistown Series—Modal Profile

Location:	Busherstown, Carlow; 8/1 Z 4
Topography:	Undulating
Slope:	2-3°
Altitude:	300 feet O.D.
Drainage:	Well drained
Parent Material:	Calcareous, non-tenaceous glacial till, of Weichsel Age, composed mainly of limestone with a smaller percentage of granite and sandstone
Great Soil Group:	Grey Brown Podzolic

Horizon	*Depth (in.)*	*Description*
An	0-7	Sandy loam; dark greyish-brown to brown (10 YR 4/2-4/3); moderate, fine granular structure; friable; abundant roots:
A12	7-15	Similar to above horizon; abrupt, smooth boundary to:
A2	15-18/20	Gritty sandy loam; yellowish-brown (10 YR 5/4); weak, fine granular structure; firm to very firm *in situ;* plentiful roots; clear, wavy boundary to:
B2t	18-38	Sandy loam to loam; dark yellowish-brown (10 YR 4/4); moderate, medium sub-angular blocky structure; wet plastic; sparse roots; clay skins abundant; abrupt, smooth boundary to:
	Below 38	Gravelly sandy loam; yellowish-brown (10 YR 5/4); structureless; friable; no roots; calcareous

Vegetation: *Lolio-Cynosuretum,* typical Sub-ass. Old pasture. High quality, vigorously growing sward composed mainly of *Lolium perenne* (perennial rye-grass) and *Trifolium repens* (white clover). The most common and troublesome weed is *Cirsium arvense* (creeping thistle).

TABLE 2: Kellistown Series

	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Horizon	**Coarse sand %**	**Fine sand %**	**Silt %**	**Clay %**	**pH**	**C.E.C. meq/lOOg**	**T.E.B. meq/lOOg**	**Base sat. %**	**c%**	**N %**	**C/N**	**Free iron %**	**T.N.V. %**
A n	32	25	29	14	5.6	16.0	5.8	36	2.2	0.23	9.6	0.8	0.0
A12	29	27	30	14	5.9	11.9	3.8	32	1.1	0.14	7.9	1.0	0.0
A2	38	21	28	13	5.9	6.2	3.2	52	0.4	nd	-	0.6	0.0
B2t	35	20	27	18	6.9	8.2	7.0	85	0.3	nd	-	0.8	0.0
C	38	20	27	15	8.6	5.2	—	Sat.	0.3	nd	-	0.3	6.7

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
A n	8	25	20	4	75	40	<1	150	50	12	75	5000	1000
A12	7	20	15	2	75	20	<1	125	50	15	50	5000	1000
A2	10	20	15	2	75	25	<1	150	75	12	50	2500	1000
B2t	8	40	20	2	75	50	<1	100	75	15	50	3000	2000
C	8	25	20	3	100	50	<1	75	75	15	75	4000	1000

Mortarstown Series—Modal Profile

Location:	Little Church Field, Oakpark, Carlow; 2/4 P 3
Topography:	Undulating
Slope:	2°
Altitude:	220 feet O.D.
Drainage:	Well drained
Parent material:	(alcarcous, non-tenaceous till, of Weichsel Age, composed mainly of limestone
Great Soil Group:	Grey Brown Podzolic

Horizon	*Depth (in.)*	*Description*
Ap	0-9/10	Loam; brown to dark-brown (10 YR 4/3); weak to moderate, medium granular structure; friable; plentiful roots; clear, smooth boundary to:
B2t	9-22/26	Clay to clay loam; yellowish-brown (10 YR 5/4); coarse prismatic breaking to strong, medium angular blocky structure; wet, plastic; plentiful roots; clay skins prominent; abrupt, wavy boundary to:
	Below 22	Gravelly clay loam; brown to pale-brown (10 YR 5/3-6/3); structureless; firm *in situ;* no roots; calcareous

Vegetation: *Centaureo-Cynosuretum,* typical Sub-ass. Reseeded pasture. Modeiately good perennial rye-grass-white clover sward with traces of the poverty indicator species—*Hypochaeris radicata* (cat's ear) and *Senecio jacobea* (ragweed).

TABLE 3: Mortarstown Seiies

Horizon	Particle size analysis Coarse sand %	Fine sand %	Silt %	fraction Clay %	pH	Cation Exchange C.E.C. meq/100g	T.E.B. meq/100g	Base sat. %	Organic Fraction C %	N %	C/N	Free iron %	T.N.V. %
Ap	28	14	35	23	6.3	16.0	nd		2.3	0.22	10.5	1.8	0.0
Bat	11	11	36	42	7.3	10.6	nd		0.9	nd		2.6	1.3
C	28	12	32	28	8.0	4.0	nd		0.6	nd		1.1	33.2

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	5	20	10	1	50	10	<1	200	75	12	75	2000	2000
B2t	4	30	20	2	100	20	<1	200	125	20	100	2500	2000
C	3	20	15	2	100	10	<1	100	100	25	100	5000	1500

Paulstown Series—Modal Profile

Location:	Grange Lower, Gowran, Kilkenny; 21/3 P 23
Topography:	Undulating to rolling
Slope:	4-5°
Altitude:	150 feet O.D.
Drainage:	Well drained
Parent material:	Calcareous till, of Wcichsel Age, composed of limestone with some shale and sandstone
Great Soil Group:	Grey Brown Podzolic

Horizon	*Depth (in.)*	*Description*
An	0-9	Loam; brown to dark-brown (10 YR 4/3) with many, distinct root mottles; moderate, weak, fine to medium sub-angular blocky structure; friable; abundant roots; clear, smooth boundary to:
A12	9-20/25	Loam to clay loam; yellowish-brown (10 YR 5/4); moderate to weak, fine and medium sub-angular blocky structure; friable; plentiful roots; gradual, wavy boundary to:
B2t	20-52	Clay; yellowish-brown (10 YR 5/8) with many, fine, distinct manganese blotches; moderate, medium blocky structure; wet, plastic; clay skins prominent; sparse roots; abrupt, smooth boundary to:
	Below 52	Gravelly clay loam; brown (10 YR 5/3); structureless; friable to (wet) slightly plastic; no roots; calcareous

Vegetation: *Centaureo-Cynosuretum,* Sub-ass. of *Galium verum.* Reseeded meadow. Tall, leafy sward composed mainly of *Lolium perenne* (perennial rye-grass), *Agrostis stolonifera* (creeping bentgrass), *Phleum pratense* (timothy) and the clovers *Trifo/ium repens, T. pratense* and *T. duhium.*

TABLE 4: Paulstown Series

Horizon	Particle size analysis of mineral fraction				pH	Cation Exchange			Organic Fraction			Free iron %	T.N.V. %
	Coarse sand %	Fine sand %	Silt %	Clay %		C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	C%	N %	C/N		
A n	22	22	32	24	6.2	14.4	nd	–	2.1	0.17	12.4	2.3	0.0
A12	17	22	35	26	7.5	7.2	nd	-	0.7	nd	-	2.9	0.0
B2t	9	17	31	43	7.8	9.4	nd	-	0 6	nd	-	4.0	0.0
C	19	23	29	29	8.0	4.4	nd	-	0.6	nd	-	3.0	13.6

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
A n	10	40	20	2	150	50	<1	100	60	20	100	2500	2000
A12	5	40	20	3	150	40	<1	150	75	20	100	5000	2000
B2t	4	25	25	3	150	75	<1	100	100	25	100	2500	2500
C	5	20	20	2	100	40	<1	75	60	15	75	2500	2500

Rathvinden Series—Modal Profile

Location:	Ballyknockan, Leighlinbridge; 12/3 Y 21
Topography:	Undulating
Slope:	6°
Altitude:	160 feet O.D.
Drainage:	Well drained
Parent Material:	Compact, calcareous drift composed of a mixture of limestone till and soliflucted Carboniferous shales, sandstone and flagstones, with outwash gravel influence
Great Soil Group:	Grey Brown Podzolic

Horizon	*Depth {in.)*	*Description*
An	0-7	Stony sandy loam; dark greyish-brown (10 YR 4/2); moderate, fine and medium granular structure; friable; burnt lime nodules present; plentiful roots; weakly calcareous in places; gradual, smooth boundary to:
A12	7-14/15	Similar to above horizon but with less organic matter; clear, smooth boundary to:
AI3	14-24	Stony sandy loam; brown to dark-brown (10 YR 4/3); weak, fine granular structure; friable; plentiful roots; weakly calcareous; clear, smooth boundary to:
B2t	24-36/44	Stony sandy clay loam; yellowish-brown (10 YR 5/4); moderate, fine and medium sub-angular blocky structure; firm to (wet) plastic; sparse roots; clay skins present; non-calcareous; clear, wavy boundary to:
B/(	Below 36	Stony loam; brown to pale-brown (10 YR 5/3-6/3); structureless; firm *in situ;* no roots; calcareous

Vegetation: *Lolio-Cynosuretum,* typical Sub-ass. Reseeded meadow. Good quality, dense sward dominated by *Lolium perenne* (perennial rye-grass), *Poa trivialis* (rough-stalked meadow-grass) and *Trifoliwn repens* (white clover).

TABLE 5: Rathvinden Series

Horizon	Particle size analysis of mineral fraction				pH	Cation Exchange			Organic Fraction			Free iron %	T.N.V. %
	Coarse sand %	Fine sand %	Silt %	Clay %		C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	c%	N %	C/N		
A n	35	20	27	18	6.3	26.3	17.1	65	5.1	0.34	15.0	1.6	0.0
A12	35	20	26	19	7.3	21.1	19.7	93	2.5	0.22	11.4	1.5	0.0
A13	33	20	28	19	7.7	17.6	16.6	94	2.0	0.17	11.8	1.5	0.0
B2t	28	20	28	24	7.9	12.6	19.9	86	0.5	nd	-	1.5	nd
B/C	30	16	31	23	8.2	10.2	—	Sat.	0.5	nd	—	1.2	18.3

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
A n	7	40	9	2	85	35	<1	130	45	13	45	1800	1500
A12	8	45	10	3	65	35	<1	100	45	15	50	2000	1700
A13	3	20	10	2	60	30	<1	120	50	10	50	2000	1700
Bat	3	25	10	3	70	50	<1	100	50	10	50	2000	2000
B/C	3	25	25	3	100	50	<1	75	75	20	75	4000	2000

Acaun Series—Modal Profile

Location:	Haroldstown, Rathvilly; 9/1 B-C 22
Topography:	Hummocky
Slope:	0°
Altitude:	300 feet O.D.
Drainage:	Well drained
Parent Material:	Calcareous gravels, of Saale Age (?), composed of a mixture of granite, limestone, mica-schist and sandstone
Great Soil Group:	Brown Earth (of high base status)

Horizon	*Depth (in.)*	*Description*
An	0-8	Coarse sandy loam; dark-brown (10 YR 3/3); moderate, fine granular structure; very friable; plentiful roots; gradual, smooth boundary to:
A12	8-16/19	Similar to above horizon; clear, wavy boundary to:
(B)	16-26/35	Gravelly coarse sandy loam; yellowish-brown (10 YR 5/4); weak, fine granular structure; very friable; plentiful roots; worm casts of A12 present; clear, wavy boundary to:
	26 %	Gravelly coarse sand; light yellowish-brown (10 YR 6/4); structureless; friable; no roots; non-calcareous; gradual, diffuse boundary to:
IIC	Below 96	Gravelly coarse sand; pale-grey; structureless; friable; no roots; calcareous

Vegetation: *Centaureo-Cynosuretum,* Sub-ass. of *Galium verum.* Old pasture. Moderately growing, heavily grazed sward dominated by *Agrostis tenuis* (bentgrass), *Cynosurus cristatus* (crested dog's tail), *Festuca rubra* (red fescue) and *Plantago lanceolata* (plantain). The naturally high base status is indicated by the presence of *Galium verum* (lady's bedstraw) and *Trisetum flavescens* (golden oat-grass).

TABLE 6: Acaun Series

	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	PH	C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	c%	N %	C/N	Free iron %	T.N.V. %
A n	48	17	23	12	6.9	58.0	17.0	29	3.3	0.25	13.2	1.2	0.0
A12	50	15	24	11	7.5	16.7	13.5	81	2.2	0.14	15.7	1.2	0.0
(B)	57	12	22	9	7.9	10.2	7.7	75	1.3	0.07	18.6	1.0	0.0
C	nd	nd	nd	nd	7.8	4.3	-	Sat.	0.5	nd	-	0.4	2.8
IIC	nd	nd	nd	nd	8.4	4.2	—	Sat.	0.5	nd	-	0.4	12.3

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
A n	0	60	12	1	60	15	<1	85	20	8	45	1750	1500
A12	8	50	12	2	80	15	<1	100	15	8	50	2000	1700
(B)	4	50	12	2	80	15	<1	100	30	8	60	2000	1700
C	5	65	20	2	85	30	<1	100	50	15	60	1700	2500
IIC	4	75	25	2	75	30	<1	75	60	15	60	1000	2000

Ballindaggan Series—Modal Profile

Location:	Ballypierce, Bunclody; 21/1 D-E 2-3
Topography:	Rolling to steeply rolling
Slope:	18°
Altitude:	700 feet O.D.
Drainage:	Well drained
Parent Material:	Local shale with some mica-schist in places
Great Soil Group:	Brown Earth (of low base status)

Horizon	*Depth (in.)*	*Description*
Ap	0-7/8	Loam; reddish-brown (5 YR 4/3-4/4); strong, medium crumb structure; friable; abundant roots; abrupt, smooth boundary to:
(B)	7-13/16	Shaly loam; yellowish-brown (10 YR 5/6); weak, fine granular structure; very friable; plentiful roots; clear, wavy boundary to:
C	Below 13	Shaly sandy loam; olive (5 YR 4/3-5/3); structureless; friable; non-calcareous; plentiful roots in upper portion; schist fragments abundant

Vegetation: *Centaureo-Cynosuretum*$_y$ typical Sub-ass. Reseeded pasture. Rather poorly growing sward dominated by *Trifolium repens* (white clover), *Loliuni perenne* (perennial rye-grass), *Holcus lanatus* (Yorkshire fog) and *Agrostis tenuis* (bentgrass).

TABLE 7: Ballindaggan Series

Horizon	Particle size analysis of mineral fraction				Cation Exchange				Organic Fraction				
	Coarse sand %	Fine sand %	Silt %	Clay %	pH	C.E.C. meq/lOOg	T.E.B. mcq/lOOg	Base sat. %	C %	N %	C/N	Free iron %	T.N.V %
Ap	15	18	43	24	5.6	35.2	8.9	25	6.4	0.51	12.5	3.3	
(B)	30	19	42	9	5.7	29.1	3.7	13	2.4	0.21	11.4	2.3	
C	42	19	35	4	6.0	13.4	2.1	16	1.3	0.13	10.0	0.9	

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	6	20	15	<1	80	8	<1	70	8	4	50	3000	1000
(B)	3	12	12	<1	80	15	<1	75	20	9	45	1750	750
C	3	15	15	1	75	40	<1	100	35	17	50	2000	850

Ballindaggan Series—Forest Profile

Location:	Ballypierce Forest, Bunclody; 21/1 D–E 2
Topography:	Rolling to steeply rolling
Slope:	20°
Altitude:	750 feet O.D.
Drainage:	Well drained
Parent Material:	Local shale bedrock
Great Soil Group:	Brown Earth (of low base status)

Horizon	*Depth* (*in.*)	*Description*
O1	0–½	Partly decomposed plant remains: dark reddish-brown (5 YR 3/2); abrupt, smooth boundary to:
A1	½–6½/7	Organic loam; reddish-brown (5 YR 4/4); strong, medium crumb structure; friable; abundant roots; excrement of worms and insects abundant; abrupt, wavy boundary to:
(B)	6½–14/19	Shaly loam; yellowish-brown (10 YR 5/4–5/6); weak, fine granular structure; very friable; plentiful roots; clear, wavy boundary to:
C	Below 14	Shaly sandy loam; olive (5 Y 4/3); structureless; loose friable; plentiful roots in upper portion; schist fragments very common

Vegetation: Dry *Calluna* heath. In contrast to the adjoining cultivated fields on the same series this area is covered by a dense growth of *Ulex europaeus* (gorse), *Calluna vulgaris* (heather) and *Rubus fruticosus* agg. (bramble). Trees of *Picea sitchensis* (sitka spruce) have recently been planted and are growing well among the indigenous heath flora.

TABLE 8: Ballindaggan Series—Forest Profile

	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	pH	C.E.C. mcq/lOOg	T.E.B. meq/lOOg	Base sat. %	C%	N %	C/N	Free iron %	T.N.V. %
Oi	nd	nd	nd	nd	5.1	58.6	7.9	13	18.1	1.0	18.1	2.8	–
Ai	12	20	45	23	5.4	36.6	3.1	8	8.8	0.57	15.4	3.3	-
(B)	18	19	46	17	5.5	30.4	2.2	7	1.9	0.22	8.6	3.1	-
C	33	22	40	5	5.6	12.0	1.9	16	1.0	0.10	10.0	1.1	-

Ballytarsna Series—Modal Profile

Location:	Granite Quarry, Graiguenaspiddoge, Carlow 12/2 R 29
Topography:	Rolling
Slope:	12-15°
Altitude:	400 feet O.D.
Drainage:	Well drained
Parent Material:	Granite weathered *in situ*
Great Soil Group:	Brown Earth (of low base status)

Horizon	*Depth (in.)*	*Description*
Ai	0-9	Rocky sandy loam; dark-brown (10 YR 3/3); moderate, fine granular structure; very friable; abundant roots; quartz grains bleached; clear, smooth boundary to:
(B)	9-18	Rocky sandy loam; yellowish-brown (10 YR 5/6); weak, fine granular structure; very friable; plentiful roots; gradual, wavy boundary to:
	18-20/28	Non-continuous horizon; rocky, gravelly coarse sand (weathered granite); light yellowish-brown (2.5 Y 6/4); structureless; dry, hard *in situ;* sparse roots; non-calcareous; abrupt boundary to:
R		Granite bedrock

Vegetation: *Centaureo-Cynosuretum,* Sub-ass. of *Galium verum.* Old pasture. The sward is typical dry grassland type and is dominated by *Agrostis tenuis* (bentgrass), *Anthoxanthum odoratum* (vernal grass) and *Festuca rubra* (red fescue). The species of poor, dry grassland, *Linum catharticum* (purging flax), *Ranunculus bulbosus* (bulbous buttercup) and *Trisetum Jlavescens* (golden oat-grass) occur in trace amounts. *Pteridhun aquilinum* (bracken) is invading vigorously from the sod fences.

TABLE 9: Ballytarsna Series

	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	*pH	C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	C %	N %	C/N	Free iron %	T.N.V. %
Ai	34	27	28	il	5.9	17.7	6.9	39	3.6	0.32	11.3	1.2	
(B)	46	24	23	7	6.3	9.4	4.5	48	0.8	nd		0.8	
C	77	11	9	3	6.8	4.4	2.8	64	0.6	nd		0.1	

*Exalted pH values due to liming

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ai	13	35	17	2	65	13	<1	35	20	6	45	1750	650
(B)	10	40	20	2	75	10	<1	50	40	15	150	2500	750
C	20	20	40	1	25	20	<1	25	40	15	20	1500	250

Bonis Series—Modal Profile

Location:	Milltown, Garyhill; 20/1 J 2-3
Topography:	Rolling
Slope:	10-12°
Altitude:	400 feet O.D.
Drainage:	Well drained
Parent Material:	Compact, non-calcareous glacial till, of Saale Age, composed of granite with some chert
Great Soil Group:	Brown Earth (of low base status)

Horizon	*Depth (in.)*	*Description*
Ap	0-12/13	Coarse sandy loam; dark-brown (10 YR 3/3); moderate, fine and medium granular structure; friable; plentiful roots; clear wavy boundary to:
(B)	12-28/36	Coarse sandy loam; strong-brown (7.5 YR 5/8); weak, fine granular structure; very friable; plentiful roots; worm casts of Ap present; gradual, irregular boundary to:
	Below 28	Bouldery, coarse loamy sand to sandy loam; light yellowish-brown (10 YR 6/4); structureless; dry, hard *in situ;* no roots; non-calcareous

Vegetation: *Centaureo-Cynosuretum,* typical Sub-ass. Old pasture. Rather poorly growing, heavily grazed sward with much *Agrostis tenuis* (bentgrass), *Festuca rubra* (red fescue) and *Ranunculus repens* (creeping buttercup). There are many poverty indicator-species in the sward, notably *Centaurea nigra* (knapweed), *Hypochaeris radicata* (cat's ear), *Luzula campestris* (field woodrush) and *Lotus corniculatus* (birdsfoot trefoil).

TABLE 10: Borris Series

	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	*pH	C.E.C. meq/lOOg	T.E.B. mcq/lOOg	Base sat. %	C %	N %	C/N	Free iron %	T.N.V. %
Ap	51	21	18	10	6.0	20.3	7.1	35	3.3	0.24	13.8	0.7	
(B)	54	21	17	8	5.0	13.9	2.6	19	0.9	nd		0.7	
C	58	19	17	6	5.2	6.3	3.0	48	0.3	nd	-	0.4	

•Relatively high surface pH due to recent liming

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	30	35	50	<1	25	20	<1	65	9	5	25	1750	650
(B)	20	25	50	1	50	20	<1	75	25	5	40	2000	200
C	25	40	60	1	25	8	<1	100	15	4	10	1000	200

Bonis Series—Weakly podzolised variant

Location:	Ballyknockerumpin, Glynn, 26/4 C 4
Topography:	Rolling
Slope:	2-3°
Altitude:	250 feet O.D.
Drainage:	Well drained
Parent Material:	Compact, non-calcareous glacial till, of Saale Age, composed of granite with some chert.
Great Soil Group:	Brown Podzolic

Horizon	*Depth (in.)*	*Description*
Ap	0-12/13	Coarse sandy loam; dark greyish-brown to dark-brown (10 YR 4/2-3/3); moderate, fine granular structure; friable; plentiful roots; clear, wavy boundary to:
B2	12-23/27	Coarse sandy loam; yellowish-brown (10 YR 5/4) with portions dark-brown (7.5 YR 4/4); weak, fine granular structure; very friable; plentiful roots; worm casts of Ap horizon present; gradual, irregular boundary to:
	Below 23	Bouldery coarse sandy loam; very pale-brown (10 YR 7/4); structureless; dry, hard *in situ;* no roots; non-calcareous

Vegetation: Not examined.

TABLE 11: Borris Series—Weakly podzolised variant

Horizon	Particle size analysis of mineral fraction				Cation Exchange				Organic Fraction				
	Coarse sand %	Fine sand %	Silt %	Clay %	*pH	C.E.C. mcq/lOOg	T.E.B. meq/lOOg	Base sat. %	C%	N%	C/N	Free iron %	T.N.V. %
Ap	45	21	23	II	5.8	15.6	4.1	26	2.4	0.21	11.4	0.8	
B2	39	21	29	II	6.4	13.4	5.2	39	1.0	0.10	10.0	1.0	
C	44	25	23	8	6.5	4.6	2.7	59	0.2	nd	-	0.2	

•Exalted pH values in the lower horizons due to bygone liming

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	15	50	30	1	50	20	<1	50	15	6	40	2000	1000
B2	10	20	25	1	75	30	<1	75	40	10	75	3000	300
C	8	50	25	1	50	20	<1	50	40	12	40	[illegible]	250

Kccloge Series—Modal Profile

Location:	Bunnagagole, Oldleighlin; 15/2 0 14
Topography:	Steeply sloping
Slope:	1
Altitude:	750 feet O.D.
Drainage:	Well drained
Parent Material:	nmil'erous shale bedrock
Great Soil Group:	Brown Earth (of low to medium base status)

iorizon	*Depth (in.)*	*Description*
Ap	0-11/12	Loam; dark-brown (10 YR 3/3); strong, medium crumb structure; friable; abundant roots; clear, wavy boundary to:
(B)	11-19/21	Shaly loam; yellowish-brown (10 YR 5/8); weak, fine granular structure; very friable; plentiful roots; clear, wavy boundary to:
	Below 19	Shaly sandy loam; light olive-grey (2.5 Y 5/4); structureless; firm *in situ;* no roots; non-calcareous

Vegetation: *Centaureo-Cynosuretum,* Sub-ass. of *Galium verum.* Old, moderate quality grassland. The sward is dominated by *Agrostis tenuis* (bentgrass), *Anthoxanthum odoratum* (vernal grass) and *Cynosurus cristatus* (crested dog's tail). In the heavily grazed parts *Bellis perennis* (daisy) is very conspicuous.

TABLE 12: Keeloge Series

	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	pH	C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	C%	N%	C/N	Free iron %	T.N.V. %
Ap	10	22	45	23	5.5	35.2	11.4	32	6.2	0.42	14.8	1.8	
(B)	35	15	36	14	5.9	17.2	3.9	44	1.6	0.12	13.3	1.9	
C	40	15	31	14	5.4	6.0	2.3	28	0.1	nd	-	1.6	

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	3	20	9	<1	65	13	<1	40	20	6	65	3000	420
(B)	2	15	10	<1	40	20	<1	100	25	6	60	2000	250
C	2	15	15	<1	50	25	<1	75	30	8	75	2500	400

Clonegall Series—Modal Profile

Location:	Ballyshancarragh, Kildavin; 17/4 S 35
Topography:	Rolling
Slope:	12-13°
Altitude-	300 feet *O.D.*
Drainage:	Well drained
Parent Material:	Non-calcareous, non-tenaceous glacial till, of Saale Age, composed of shale, granite and some mica-schist
Great Soil Group:	Brown Podzolic

Horizon	*Depth {in.)*	*Description*
Ap	0-8/11	in to sandy loam; dark greyish-brown (10 YR 4/2); strong, fine and medium granular structure; friable; abundant roots; abrupt, wavy boundary to:
B2	8-23/28	ni to sandy loam; yellowish-brown (10 YR 5/6); weak, fine granular structure; very friable; plentiful roots; clear, wavy boundary to:
C	Below 23	Sandy loam; grey (10 YR 6/1) with few, coarse, prominent yellowish-brown (10 YR 5/8) mottles; structureless; friable; no roots; non-calcareous

Vegetation: *Centaureo-Cynosuretum,* typical Sub-ass. Old pasture. The well grazed sward is dominated by *Agrostis tenuis* (bentgrass), *Festuca rubra* (red fescue), *Holcus lanatus* (Yorkshire fog) and *Trifolium repens* (white clover). There are small amounts of the poverty indicator-species *Crepis capillaris* (smooth hawk's-beard), *Lcontodon taraxacoides* (hairy hawbit) and *Ho/cus mollis* (creeping soft-grass) also present.

TABLE 13: Clonegall Series

Horizon	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
	Coarse sand %	Fine sand %	Silt %	Clay %	*pH	C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	C%	N%	C/N	I ree iron %	T.N.V. %
Ap	32	19	34	15	6.4	25.7	7.2	28	3.9	0.34	11.5	1.8	
B2	33	16	36	15	6.3	18.8	4.0	21	1.7	0.20	8.5	2.3	
C	36	14	44	6	6.4	6.2	2.6	42	0.7	nd		1.6	

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•Relatively high pH due to previous liming

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	5	12	18	1	55	20	1	70	20	5	35	1800	1200
B2	4	12	20	1	55	35	<1	90	20	5	45	1800	1200
C	4	15	40	2	100	75	<1	75	50	15	75	3000	500

Kiltealy Series—Modal Profile

Location:	Dranagh Upper, Glynn; 26/2 S-T 20
Topography:	Rolling
Slope:	5°
Altitude:	450 feet O.D.
Drainage:	Well-drained
Parent Material:	Granitic till of Saale Age
Great Soil Group:	Brown Podzolic

Horizon	*Depth (in.)*	*Description*
Ap	0-8	Coarse sandy loam; very dark-brown (10 YR 2/2); moderate, fine and medium granular structure; very friable; plentiful roots; charcoal present; gradual, smooth boundary to:
A12	8-13/14	Very dark greyish-brown (10 YR 3/2); otherwise similar to Ap; abrupt, wavy boundary to:
B2	13-22	Coarse sandy loam; dark reddish-brown (5 YR 3/4); moderate, fine granular structure; very friable; plentiful roots; worm casts of Ap present; gradual, wavy boundary to:
B/C	22-33/37	Course sandy loam; light yellowish-brown (10 YR 6/4) with streaks of strong-brown (7.5 YR 5/6); looks like banded B horizon; strong-brown streaks have weak, fine granular structure and are friable while the light yellowish-brown portion has similar structure but is firm *in situ;* sparse roots; gradual, wavy boundary to:
	Below 33	Rocky coarse sandy loam; light yellowish-brown (10 YR 6/4); structureless; compact *in situ;* no roots; non-calcareous

Vegetation: *Centaureo-Cynosuretum,* typical Sub-ass. Old pasture. Rather poorly growing sward dominated by *Agrostis tenuis* (bentgrass) and *Anthoxanthum odoratwn* (vernal grass). The acidophile moss, *Rhytidiadelphus squarrosus,* is very abundant in the moss layer.

TABLE 14: Kiltealy Series

Horizon	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
	Coarse sand %	Fine sand %	Silt %	Clay %	*PH	C.E.C. meq/lOOg	**T.E.B.** meq/lOOg	Base sat. %	C%	N %	C/N	Free iron %	T.N.V. %
Ap	41	29	22	6	6.9	29.6	nd	–	3.3	0.29	11.4	0.6	–
A12	46	25	21	8	6.3	24.6	nd	-	1.6	0.15	10.7	**0.7**	-
Ba	54	21	21	4	6.6	10.6	nd	-	0.6	nd	-	0.6	-
B/C	48	12	23	7	6.4	13.4	nd	-	**0.7**	nd	-	1.0	-
C	62	26	11	1	6.6	3.6	nd	-	0.1	nd	—	0.2	-

•Exalted pH values due to liming

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	6	25	12	1	20	10	<1	70	7	2	20	1000	210
A12	8	25	20	1	25	7.5	<1	40	10	2	20	1000	250
B2	12	20	15	<1	25	7	<1	40	10	3	20	1000	250
B/C	7.5	18	15	1	25	7	<1	40	10	4	20	1100	175
C	7.5	25	15	<1	20	6	<1	40	10	4	7.5	800	125

Kiltealy Series-Shallow Variant—Modal Profile

Location:	Marley, Borris; 24/4 H-I 18
Topography:	Rolling
Slope:	5-7°
Altitude:	530 feet O.D.
Drainage:	Well drained
Parent Material:	Shallow cover of granitic glacial till and shattered granite over granite bedrock
Great Soil Group:	Brown Podzolic

Horizon	*Depth (in.)*	*Description*
Ap	0-7/11	Rocky coarse sandy loam; very dark-brown (10 YR 2/2); moderate, fine granular structure; friable; plentiful roots; portions of B2 present due to worm activity; gradual, wavy boundary to:
B2	7-14/18	Rocky coarse sandy loam; dark yellowish-brown (10 YR 4/4); weak, fine granular structure; very friable; plentiful roots; worm casts of Ap present; abrupt, wavy boundary to:
	14-22	Rock\ coarse loamy sand; light yellowish-brown (10 YR 6/4); structureless; compact *in situ;* sparse roots; non-calcareous; abrupt boundary to:
		no bedrock

Vegetation: Similar to that on Kiltealy Series.

TABLE 15: Kiltealy Series—Shallow Variant

Horizon	Particle size analysis of mineral fraction: Coarse sand %	Fine sand %	Silt %	Clay %	*pH	Cation Exchange: C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	Organic Fraction: C%	N%	C/N	Free iron %	T.N.V. %
Ap	46	24	20	10	5.4	29.0	3.2	II	4.2	0.32	13.1	0.7	
B2	48	24	18	10	6.2	33.4	5.5	16	2.2	0.22	10.0	1.0	
C	55	22	19	4	6.2	8.8	1.7	19	0.4	nd	-	0.4	

•Relatively high pH values due to liming

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	12	30	20	1	20	17	<1	20	9	3	20	1000	320
B2	7	7	10	<1	22	8	<1	35	7	2	8	800	220
C	6	6	10	1	20	7	<1	45	7	3	5	750	110

Knocksquire Series—Modal Profile

Location:	Knockroe, Ballymurphy; 23/3 H 27
Topography:	Moderately steep to steep
Slope:	22°
Altitude:	725 feet O.D.
Drainage:	Well drained
Parent Material:	Granite bedrock
Great Soil Group:	Brown Podzolic

Horizon	*Depth (in.)*	*Description*
A1	0-7	Rocky coarse sandy loam; very dark greyish-brown (10 YR 3/2); moderate, fine and very fine granular structure; very friable; abundant roots; abrupt, smooth boundary to:
B2	7-26/28	Rocky coarse sandy loam; dark yellowish-brown (10 YR 4/4-3/4) with patches of pale-brown (10 YR 6/3); weak, fine granular structure; very friable; plentiful roots; abrupt, irregular boundary to:
C	Below 26	Granite bedrock

Vegetation: *Pteridium* heath. Well grazed grassy patches alternate with patches dominated by *Pteridium aquilinum* (bracken). The grasses *Agrostis tenuis* (bentgrass), *Holcus lanatus* (Yorkshire fog) and *Poa pratensis* (smooth-stalked meadow-grass) are important components of the sward both in the grass and bracken-dominant patches.

TABLE 16: Knocksquire Series

Horizon	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
	Coarse sand %	Fine sand %	Silt %	Clay %	pH	C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	C%	N%	C/N	Free iron %	T.N.V. %
Ai	50	20	21	9	4.8	23.2	nd		3.8	0.22	17.3	0.7	
B2	48	14	27	II	5.0	19.0	nd		2.0	0.12	16.7	0.8	

Ridge Scries—Modal Profile

Location:	Ridge, Oldleighlin; 11/1 Y-Z 31
Topography:	Rolling
Slope:	8-10°
Altitude:	825 feet O.D.
Drainage:	Well drained
Parent Material:	Carboniferous Shale bedrock
Great Soil Group:	Brown Pod/.olic

Horizon	*Depth (in.)*	*Description*
Ai	0-11/12	Clay loam; dark-brown (10 YR 4/3-3/3); moderate, medium granular structure; friable; burnt lime fragments present throughout horizon; plentiful roots; abrupt, wavy boundary to:
B2	11-18/26	Loam; strong-brown (7.5 YR 5/6); weak, fine granular structure; very friable; plentiful roots; gradual, irregular boundary to:
	Below 18	Shaly sandy loam; light olive-brown (2.5 Y 5/4); structureless; firm *in situ;* no roots; non-calcareous

Vegetation: *Centaureo-Cynosuretum*, typical Sub-ass. Old, moderate quality grassland in which *Agrostis tenuis* (bentgrass), *Cynosurus cristatus* **(crested dog's tail),** *Holcus lanatus* **(Yorkshire fog),** *Lolium pcrcnnc* **(perennial rye-grass) and *Trifolium*** *rcpens* (white clover) are conspicuous.

TABLE 17: Ridge Series

Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	pH	C.E.C. meq/lOOg	T.E.B. meq/IOOg	Base sat. %	C%	N%	C/N	Free iron %	T.N.V. %
	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Ai	12	13	45	30	5.4	31.8	8.8	28	3.9	0.39	10.0	1.9	
B2	27	II	40	22	5.4	12 8	1.3	10	0.8	nd		2.7	
C	47	10	28	15	5.2	10.0	2.0	20	0.1	nd		1.8	

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ai	4	25	10	1	85	30	<1	80	20	10	50	2000	1300
B-;	2	10	10	1	75	10	<1	75	15	5	60	2000	250
C	3	15	15	<1	65	35	<1	80	35	15	75	2000	750

Ridge Series—Flaggy Variant

Location:	Bannagagole, Oldleighlin; 15/2 M 14
Topography:	Rolling
Slope:	**12°**
Altitude:	800 feet O.D.
Drainage:	Well drained
Parent Material:	Carboniferous flagstone bedrock
Great Soil Group:	Brown Podzolic

Horizon	*Depth (in.)*	*Description*
Ai	0-5	Flaggy loam; dark-brown (10 YR 3/3); strong, medium granular structure; friable; abundant roots; clear, smooth boundary to:
B2	5-14	Flaggy loam; yellowish-red (5 YR 4/8); weak, fine granular structure; very friable; abundant roots; gradual, smooth boundary to:
B3	14-19/20	Very flaggy loam; yellowish-brown (10 YR 5/8); weak, fine granular structure; friable; sparse roots; abrupt, irregular boundary to:
	Below 19	Flagstone bedrock

Vegetation: *Centaureo-Cynosuretum,* typical Sub-ass. Old pasture of moderate quality in which *Agrostis tenuis* (bentgrass) and *Trifolium repens* (white clover) are the dominant grass and clover. *Lolium perenne* (perennial rye-grass) and *Dactylis glomerata* (cock's foot) are present in small amount.

TABLE 18: Ridge Series—Flaggy Variant

	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction			
Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	*pH	C.E.C. mcq/lOOg	T.E.B. meq/lOOg	Base sat. %	C%	N%	C/N	Free iron ?
Ai	11	29	40	20	6.3	29.2	11.7	40	5.3	0.34	15.6	1.8
B2	21	24	40	15	5.4	14.4	1.7	**12**	**1.7**	0.12	14.2	2.2
B3	23	18	48	11	5.1	6.8	0.6	9	0.5	nd	-	1.2

*Exalted pH in surface horizon due to recent liming

Ballinagilky Series—Modal Profile

Location:	Knockdramagh, Myshall; 20/1 G 16
Topography:	Rolling
Slope:	4-5°
Altitude:	500 feet O.D.
Drainage:	Well drained
Parent Material:	Non-calcareous, non-tcnaceous glacial till, of Saale Age, composed of granite
Great Soil Group:	Reclaimed Podzol

Horizon	*Depth (in.)*	*Description*
Ap	0-10/I2J	Organic coarse loamy sand; very dark-brown (10 YR 2/1); moderate, fine and medium granular structure; friable; abundant roots; bleached quartz grains very prominent; cultivation and worm activity has obliterated original A2; abrupt, tonguing boundary to:
B2i(irh)	(ironpan)	Non-continuous ironpan, *I* inch thick; dark reddish-brown (5 YR 2/2); abrupt, broken boundary to:
B22(irh)	10-20/30	W sandy loam; colour mixture of strong brown (7.5 YR 5/6) with smaller pockets and streaks of dark reddish-brown (5 YR 2/2) and reddish-brown (5 YR 4/4); weak, fine granular structure; very friable; plentiful roots; clear, tonguing boundary to:
	Below 20	amy sand to sandy loam; very pale-brown (10 YR 7/4); structureless; dry, hard; no roots; non-calcareous

Vegetation: *Centaureo-Cynosuretum,* typical Sub-ass. Pasture a few years reseeded. Moderately growing, heavily grazed sward dominated by *Trifolium repens* (white clover) with *Agrostis tenuis* (bentgrass), *Bellis perennis* (daisy), *Holcus lanatus* (Yorkshire fog) and *Lolium perenne* (perennial rye-grass) also abundant. There are traces of the poverty indicator-species *Rumex acetosella* (sheep's sorrel), *Biennis mollis* (soft brome) and *l.uzula campestris* (field woodrush).

TABLE 19: Ballinagilky Series

Horizon	Particle:size analysis of mineral fraction: Coarse sand %	Fine sand %	Silt %	Clay %	PH	Cation Exchange: C.E.C. meq/lOOg	T.E.B. mcq/lOOg	Base sat. %	Organic Fraction: C%	N %	C/N	Free iron %	T.N.V. %
Ap	54	20	23	3	5.5	38.4	8.3	22	8.4	0.43	19.5	0.4	–
B2i(irh)	nd	nd	nd	nd	nd	37.8	6.1	16	4.0	0.14	28.6	3.3	-
B22(irh)	51	19	17	13	5.8	49.2	6.3	13	4.1	0.19	21.6	1.3	-
C	56	20	17	7	5.7	8.9	2.4	27	0.6	nd	—	0.2	-

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I race Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo		Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	15	40	40	< 1	40	7	< 1	40	20	4	17	1500	200
B2(irh) (ironpan)	20	35	35	< 1	45	20	< 1	45	12	2	20	1800	120
B22(irh)	15	15	40	< 1	40	8	< 1	40	8	2	17	1000	110
C	20	20	50	< 1	40	10	< 1	100	15	5	25	1500	200

Black Rock Mountain Series—Modal Profile

Location:	Knockendrane, Borris; 20/3 F 16
Topography:	Steeply rolling
Slope:	15-18°
Altitude:	1150 feet O.D.
Drainage:	Impeded
Parent Material:	Shale bedrock
Great Soil Group:	Peaty ironpan Podzol

Horizon	*Depth (in.)*	*Description*
Oi	0-2	Peat; partly decomposed organic
02	2-7	Peat; black (10 YR 2/1); cloddy tending towards moderate, fine granular structure; firm *in situ;* abundant roots; abrupt, smooth boundary to:
A2g	7-9/14$	Sandy loam; dark-grey (10 YR 4/1); weak, fine granular structure; friable; plentiful roots—root mat above ironpan; abrupt, tonguing boundary to:
B2i(irh) (ironpan)	-	Dark reddish-brown (5 YR 2/2); hard continuous ironpan; ^-i inch thick; abrupt, tonguing boundary to:
B22(ir)	9-21/25	Sandy loam to loam; strong brown (7.5 YR 5/8); weak, fine granular structure; very friable; sparse roots; gradual boundary to:
	Below 21	Very shaly sandy loam; light olive-brown (2.5 Y 5/4); structureless; friable; no roots; non-calcareous

Vegetation: *Ericeto-Caricetum* binervis Br.—Bl. sTx. 1952. Sheep-grazed heath dominated by *Calluna vulgaris* (heather) with *Erica cinerea* (bell-heather) common. The only grasses present are *Festuca ovina* (sheep's fescue), *Sieglingia decumbent* (heath-grass) and *Nardus stricta* (mat grass) and these in very small amount.

TABLE 20: Black Rock Mountain Series

Horizon	Particle size analysis of mineral fraction				pH	Catiion Exchange			Organic Fraction			Free iron %	T.N.V. %
	Coarse sand %	Fine sand %	Silt %	Clay %		C.E.C. meq/lOOg	T.E.B. mcq/lOOg	Base sat. %	C%	N %	C/N		
Oi	nd	nd	nd	nd	4.4	98.4	6.1	6	36.X	1.8	20.4	0.7	–
O2	nd	nd	nd	nd	4.6	88.8	1.3	15	24.0	0.95	25.3	1.7	-
A2g	36	22	32	10	4.7	22.0	0.9	4	4.6	0.23	20.0	1.0	-
B2i(irh)													
(ironpan)	nd	nd	nd	nd	nd	46.0	0.4	1	4.7	0.24	19.6	7.4	-
B22(ir)	25	28	34	13	4.9	19.6	1.0	5	2.2	0.23	9.6	3.6	-
C	38	29	30	3	5.3	14.4	0.7	5	0.7	nd	-	1.6	-

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Or	10	10	2	1	8	15	<1	35	4	1	7	30	10
O2	3	20	7	<1	35	15	<1	20	5	<1	25	1200	80
A2g	7	20	15	2	100	6	<1	40	12	2	65	5000	250
B2(irh)													
(ironpan)	1	10	10	2	100	20	<1	30	8	3	80	3000	140
B22(ir)	8	25	20	2	120	25	<1	50	10	5	65	2500	250
C	7	15	20	2	100	40	<1	50	30	15	65	3500	220

Blackatairs Series—Modal Profile

Location:	Carlow/Wexford border; 13/4 D 20
Topography:	Steeply rolling
Slope:	15-18°
Altitude:	900 feet O.D.
Drainage:	Impeded
Parent Material:	Granite bedrock
Great Soil Group:	Peaty ironpan Podzol

Horizon	*Depth (in.)*	*Description*
Or	0-1*	partly decomposed plant remains; very dark-brown (10 YR 2/1); clear, smooth boundary to:
O2	If-7	iv -decomposed plant remains; black (10 YR 2/1) with many whitish quartz grains; clear, smooth boundary to:
A2g	7-12/20	Coarse sandy loam; dark greyish-brown (10 YR 4/2); weak, fine granular structure; friable; roots concentrated above pan—many decomposed roots; abrupt, irregular boundary to:
B-i(irh) (ironpai		Hard, continuous ironpan, £-} inch thick; dark reddish-brown (5 YR 2/2); abrupt, tonguing boundary to:
B22(ir)	12-23/24	Loamy coarse sand; yellowish-brown (10 YR 5/6-4/4); weak, line granular structure; very friable; sparse roots; gradual, smooth boundary to C horizon
B22(h)		Occurs in small pockets in above horizon. Loamy coarse sand; dark reddish-brown (5 YR 3/3); weak, fine granular structure; very friable; sparse roots
	Below 23	(intty coarse sandy loam; light yellowish-brown (10 YR 6/4); structureless; firm *in .situ;* no roots; non-calcareous

Vegetation: *Pteridium* heath. Tall fronds of *Pteridium aquilinum* (bracken) make an almost closed canopy under which small amounts *of Agrostis canina* (brown bent-grass), *Anthoxanthum odoratum* (vernal grass) and *Potentilla erecta* (tormentil) grow feebly.

TABLE 21: Blackstairs Series

Horizon	Particle size analysis of mineral fraction: Coarse sand %	Fine sand %	Silt %	Clay %	PH	Cation Exchange: C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	Organic Fraction: C%	N %	C/N	1 ree iron %	T.N.V. /o
Oi	nd	nd	nd	nd	4.0	68.8	4.5	7	26.8	1.28	20.9	0.5	–
O2	nd	nd	nd	nd	4.1	68.0	1.9	3	26.7	1.26	21.2	0.5	-
A2g	50	20	23	7	4.6	28.9	0.5	2	4.3	0.55	7.8	0.2	-
B2i(irh) (ironpan)	nd	nd	nd	nd	nd	37.8	0.5	1	3.6	0.22	16.4	5.3	-
B22(ir)	50	27	20	3	4.9	20.3	1.0	5	1.6	0.11	14.5	0.9	-
B22(h)	nd	nd	nd	nd	nd	30.4	1.5	5	3.2	0.16	20.0	1.6	-
C	50	22	21	7	5.0	6.1	1.0	16	0.3	nd	-	0.3	—

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Oi	7	25	14	<1	20	•I	<1	25	4	<1	8	500	50
O2	10	25	20	1	20	10	<1	20	5	2	10	1800	70
A2g	12	40	45	<1	45	35	<1	45	8	3	35	2000	170
B2i(irh) (ironpan)	8	35	35	<1	65	45	<1	45	8	4	35	1700	170
B22(ir)	5	20	20	<1	40	20	<1	40	4	<1	15	2300	160
B22(h)	10	40	55	1	70	20	<1	45	18	7	35	6500	220
C	15	75	40	1	75	20	<1	75	25	15	40	2000	750

Tomard Series—Modal Profile

Location:	Tomard, Carlow; 11/2 A 23
Topography:	Undulating
Slope:	3^°
Altitude:	980 feet O.D.
Drainage:	Imperfectly drained
Parent Material:	Carboniferous flagstone bedrock
Great Soil Group:	Gleyed Podzol

Horizon	*Depth (in.)*	*Description*
Ap	0-7	Slightly peaty silt loam; very dark-brown (10 YR 2/2); weak, fine to medium granular structure; friable; plentiful roots; abrupt, smooth boundary to:
B2g	7—11/12	Silt loam; speckled colour of brown (10 YR 5/2) with strong brown (7.5 YR 5/8); weak, fine granular structure; friable; plentiful roots; clear, wavy boundary to:
B3g	11-18J/20	Loam to silt loam; light olive-grey (5 Y 6/2) with many, prominent strong-brown (7.5 YR 5/6) mottles; weak, tine granular structure; friable; plentiful roots; gradual, wavy boundary to:
Cg	18£-26	Flaggy sandy loam; light olive-grey (5 Y 6/2) with many, medium distinct yellowish-brown (10 YR 5/4) mottles; structureless; firm *in situ;* no roots; non-calcareous
R	Below 26	Flagstone bedrock

Vegetation: *Centaureo-Cynosuretum,* typical Sub-ass. Reseeded meadow. Grass growth is moderate but very uneven. The sown species *Lolium perenne* (perennial rye-grass), *Phleum pratense* (timothy) and *TrifoHum repens* (white clover) are being replaced by *AgTOStis tenuis* (bentgrass), *Anthoxanthum odoratum* (vernal grass) and *Ilo/eus lanatus* (Yorkshire fog).

TABLE 22: Tomard Series

Horizon	Particle size analysis of mineral fraction				*pH	Cation Exchange			Organic Fraction			Free iron %	T.N.V. %
	Coarse sand %	Fine sand %	Silt %	Clay %		C.E.C. meq/lOOg	**T.E.B.** mcq/lOOg	Base sat. %	C%	N %	C/N		
Ap	7	19	51	23	6.6	52.6	22.6	43	11.9	0.70	17.0	1.7	–
Bag	10	16	51	23	5.0	32.9	3.2	10	3.1	0.34	9.1	2.9	–
B38	20	14	49	17	5.1	18.6	1.6	9	1.3	0.13	10.0	2.4	–
Cg	45	12	34	9	5.1	15.9	1.6	10	0.4	nd	-	1.4	-

•Exalted pH in the surface horizon due to liming

Ballinrush Series—Modal Profile

Location:	Kilbride, Ballon; 17/2 K 20-21
Topography:	Flattish
Slope:	0°
Altitude:	290 feet O.D.
Drainage:	Very poorly drained
Parent material:	Calcareous, non-tcnaccous glacial till, of Weichsel Age, composed of granite and limestone
Great Soil Group:	Peaty Gley

Horizon	*Depth (in.)*	*Description*
Oi	0-8/11	sandy loam; black (10 YR 2/1); decomposed plant remains; abrupt, wavy boundary t<
A/Cg	8-27/40	Coarse sandy loam; grey (5 Y 6/1) with many, coarse greyish-brown (10 YR 5/2) blotches; massive tending towards weak, medium sub-angular blocky structure; firm to very firm *in situ;* sparse roots; calcareous; clear, tonguing boundary to:
Cg	Below 27	Stony, loamy coarse sand; grey (5 Y 5/1); structureless; friable; no roots; calcareous

Vegetation: Not examined.

TABLE 23: Ballinrush Series

	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	pM	C.E.C. meq/!00g	T.E.B. meq/IOOg	Base sat. %	C%	N%	C/N	Free iron %	T.N.V. %
Oi	42	19	32	7	6.0	118.8	55.6	47	25.8	1.30	19.8	1.6	0.0
A/Cg	44	27	22	7	7.5	4.9		Sat.	0.1	nd		0.6	7.2
Cg	61	18	16	5	7.6	3.8	-	Sat.	0.2	nd		0.3	3.2

Ballywilliam Series—Modal Profile

Location:	Nashe's Quarter, Hacketstown; 4/4 N 4
Topography:	Flattish depressions and concave slopes
Slope:	3-4°
Altitude:	400 feet O.D.
Drainage:	Poorly drained
Parent Material:	Non-calcareous, non-tenaccous glacial till, of Saale Age, composed of granite with some chert
Great Soil Group:	Podzolic Gley

Horizon	*Depth (in.)*	*Description*
Ai	0-10	Coarse sandy loam; dark greyish-brown (10 YR 4/2); weak, fine granular structure; wet, slightly plastic; abundant rush *(Juncus)* roots; abrupt, wavy boundary to:
A2g	10-15/17	Loamy coarse sand to coarse sandy loam; light brownish-grey (2.5 Y 6/2) with many, prominent, yellowish-brown (10 YR 5/4-5/6) mottles; weak, fine granular structure; friable; some rush roots; clear, wavy boundary to:
Btg	15-30/34	Coarse sandy loam; light brownish-grey (2.5 YR 6/2) with abundant, prominent, yellowish-brown (10 YR 5/4-5/6) mottles; structureless, tending towards weak, medium granular; firm *in situ;* sparse roots; clear, wavy boundary to:
Cg	Below 30	Coarse sandy loam; grey (7.5 YR 6/0); structureless; firm *in situ;* no roots

Vegetation: *Senecioni-Juncetum acutiflori.* Poor, rushy, old pasture. The sward is dominated by moisture indicator-species such as *Juncus acutiflorm* **(jointed rush).** *./. effusus* (soft rush), *Myosotis scorpioides* **(water forget-me-not)** and *(ilyceria fiuitans* (floating sweet-grass) which are able to endure the regular poaching which occurs.

TABLE 24: Ballywilliam Series

Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	PH	C.E.C. meq/lOOg	T.E.B. meq/lOOg	Mast' sat. %	c%	N %	C/N	Free iron %	T.N.V. %
	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Ai	51	20	20	8	5.3	11.0	nd	–	2.7	0.21	12.9	0.4	–
A2g	57	20	18	5	5.6	1.0	nd	-	0.5	nd	-	0.2	-
Btg	36	20	34	10	5.8	1.4	nd	-	0.3	nd	-	0.4	-
Cg	51	19	21	9	5.0	1.4	nd	-	0.1	nd	-	0.2	—

11 ace FJements—total content (ppm)

1 lorizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ai	5	20	15	< 1	30	8	< 1	40	20	4	40	2000	150
A2g	4	15	10	< 1	35	15	< 1	50	15	4	35	2000	150
Btg	4	20	15	< 1	65	8	< 1	75	30	10	50	2000	250
Cg	6	25	20	< 1	50	15	< 1	75	25	8	30	1700	200

Be/mount Series—Modal Profile

Location:	Brown Bog, Hacketstown; 4/4 C 22
Topography	Flattish
Slope:	2-3°
Altitude:	450 feet O.D.
Drainage:	Very poorly drained
Parent Material:	Non-calcareous, non-tcnaceous glacial till, of Saale Age, composed of granite with some chert
Great Soil Group:	Peaty Gley

Horizon	*Depth (in.)*	*Description*
Oi	0-10/11	Peaty loamy sand; very dark-brown (10 YR 2/2); abundant roots; abrupt, smooth boundary to:
Ag	10-18	Gritty, coarse sandy loam; light brownish-grey (10 YR 6/2) with many, medium, distinct yellowish-brown (10 YR 5/6) mottles; structureless tending towards weak, fine granular; firm *in situ;* sparse roots; gradual, smooth boundary to:
A/Cg	18-36	Coarse sandy loam; grey (5 Y 5/1-6/1) with many, medium distinct yellowish-brown (10 YR 5/6) mottles; structureless; firm *in situ;* sparse roois; gradual, smooth boundary to:
Cg	Below 36	Gritty coarse sand; grey (5 Y 6/1); structureless; friable; no roots; non-calcareous

Vegetation: Wet heath. Rough grassland, transitional between wet grassland and bog. At present being drained, ploughed and reseeded. True grassland species are rare in the untouched sward. *Juncus acutiflorm* (jointed rush) and *.V/< cisa pratensis* (devil's bit) are plentiful. There are tufts *of Juncus squarrosus* (heath rush) and *Narcius stricta* (mat-grass) here and there. *Sphagnum spp.* (bogmosses) are abundant in the moss layer.

TABLE 25: Belmount Series

Horizon	Particle size analysisi of mineral fraction				PH	Cation Exchange			Organic Fraction			Free iron %	T.N.V. %
	Coa isc- sand %	Fine sand %	Silt %	Clay %		C.E.C. mcq/lOOg	**T.E.B.** mcq/lOOg	Base sat. %	c%	N %	C/N		
Oi	nd	nd	nd	nd	5.3	63.2	**11.5**	18	**21.4**	0.86	**24.9**	0.3	–
Ag	42	23	27	8	6.1	3.9	2.8	72	0.6	nd	-	0.1	-
A/Cg	**44**	20	28	8	6.5	4.1	3.5	85	0.4	nd	-	0.1	-
Cg	84	8	5	3	6.4	2.1	1.8	86	0.3	nd	-	0.3	-

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Oi	2	10	10	<1	20	10	<1	10	7	2	2d	90	50
Aig	3	15	8	<1	40	3	<1	50	20	5	40	1500	100
A/Cg	3	20	15	<1	75	10	<1	75	30	8	60	2000	170
Cg	6	20	20	1	35	10	<1	75	20	8	35	2000	170

Castlecomer Series—Modal Profile

Location:	Seskinrea, Oldlcighlin; 11/2 T 1
Topography:	Undulating
Slope:	2-3°
Altitude:	800 feet O.D.
Drainage:	Poorly drained
Parent Material:	Dense, tenaceous, non-calcareous solifluctcd drift, of Saale Age, composed of Carboniferous shale, sandstone and flagstone
Great Soil Group:	Gley

Horizon	*Depth (in.)*	*Description*
Ai	0-8/10	Organic clay loam; very dark-brown (10 YR 2/2); weak, medium granular structure; wet, slightly plastic; abundant roots; abrupt, wavy boundary to:
(B)g	8-35/41	Clay loam; grey (2.5 Y 6/0) with many, medium, distinct yellowish-brown (10 YR 5/4) mottles; coarse prismatic breaking into coarse blocky structure; wet, plastic; sparse roots; clear, smooth boundary to:
Cg	Below 35	Gritty clay loam; speckled, olive brown (2.5 Y 4/4) and grey (2.5 Y 6/0) colour; structureless; wet, plastic; no roots; non-calcareous

Vegetation: *Junco-Molinietum.* Old, very poor quality grassland with an abundance of moisture indicator-species such as *Juncus effusus* **(soft rush), *Lychnis*** *flos-cuculi* **(ragged robin) and** *Senecio squaticus* **(marsh ragworth). There are also many indicators of low fertility present such** as *Sieglingia* ***decumbens*** **(heath-grass),** *Hypochaeris* ***radicata*** **(cat's ear) and *Carex spp.* (sedges).**

TABLE 26: Castlecomer Series

Horizon	Panicle size analysis of mineral traction				pH	Cation Exchange			Organic Fraction				
	Coarse sand %	Fine sand %	Silt %	Clay %		C.E.C. meq/lOOg	T.E.B. mcq/lOOg	Base sat. %	C %	N %	C/N	Free iron %	T.N.V. %
Ai	11	25	37	27	5.2	67.4	15.5	23	8.9	0.46	19.3	1.2	
(B)g	11	20	40	29	5.3	12.1	5.3	44	0.4	nd		1.4	
Cg	16	16	39	30	5.9	13.2	7.7	58	0.6	nd		2.4	

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ai	5	15	10	I	80	10	<1	40	20	8	50	2000	650
(B)g	2	15	12	<1	85	17	<1	50	30	10	50	2000	100
Cg	1	15	15	2	100	25	<1	75	35	10	60	2000	250

(lowater Series—Modal Profile

Location:	Killerig, Tullow; 8/2 C 1
Topography:	1 kit
Slope:	0
Altitude:	320 feet O.D.
Drainage:	Verj poorly drained
Parent Material:	Calcareous, non-tenaccous glacial till, of Weiehsel Age, composed of limestone with some granite and sandstone
Great Soil Group:	Peaty Gley

Horizon	*Depth (in.)*	*Description*
Oi	0-8/11	l'cai\ loam} sand; black (10 YR 2/1); decomposed plant remains; clear, wavy boundary to:
A/Cg	8-24/25	Stony, gritty sandy loam; grey (5 Y 5/1-6/1); structureless tending towards weak, medium sub-angular blocky; compact *in situ;* no roots; calcareous; clear, wavy boundary to:
Cg	Below 24	Stony sandy loam; grey (5 Y 5/1-6/1); structureless; firm; no roots; calcareous

Vegetation: *Molinietalia* community. Little gra/cd wet grassland reverting to Alder woodland. The jointed rush, *J uncus acutiflorus*, is absolutely dominant. There aie many other moisture-loving species present in small amounts, including the rather rare *Epipactis palustris* (marsh helleborinc orchid).

TABLE 27: Clowater Scries

Horizon	Particle size analysis of mineral fraction				pH	Cation Exchange			Organic I i				
	Coarse sand %	Fine sand %	Silt %	Clay %		C.E.C. mcq/lOOg	T.E.B. mcq/lOOg	Base sat. %	C%	N%	C/N	Free iron %	T.N.V. %
Oi	nd	nd	nd	nd	6.5	99.2	47.2	48	21.6	1.51	14.3	0.5	0.0
A/Cg	34	30	27	9	7.7	7.7		Sat.	0.6	nd		0.1	19.8
Cg	50	19	23	8	8.1	7.1		Sat.	0.5	nd		0.1	21.2

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Oi	5	25	12	< 1	35	25	<1	35	20	5	35	1750	750
A/Cg	4	25	20	I	75	30	<1	75	50	15	100	6000	250
Cg	5	20	15	2	100	25	<1	100	75	20	100	4000	400

Coolnakisha Series—Modal Profile

Location:	i. Oldfeighlin; 11/4L28
Topography:	I lilttish to undulating
Slope:	3°
Altitude:	250 feet O.D.
Drainage:	Poorly drained
Parent Material:	I tense, calcareous, soliflucted drift material composed of limestone, chert, flagstone, sandstone and shale
Great Soil Group:	Pod/olised Gle>

Horizon	*Depth (in.)*	*Description*
Ap	0-8/9	Silt loam to loam; greyish-brown (10 YR 5/2) with many, fine, prominent reddish-brown (5 YR 4/4) mottles; weak, medium granular structure; wet, plastic; plentiful roots; clear, wavy boundary to:
B2(ir)g	8-16/18	Silt loam to loam; light yellowish-brown (10 YR 6/4) with many, medium, prominent brownish-yellow (10 YR 6/8) mottles; coarse prismatic breaking to weak, medium to coarse sub-angular blocky structure; wet, plastic; sparse roots; gradual, wavy boundary to:
B/CgC	16-29/34	Gritty loam; grey (5 Y 6/1) with common, coarse, prominent reddish-yellow (10 YR 6/6) mottles; structureless tending towards weak, coarse sub-angular blocky; wet, plastic; no roots; clear, tonguing boundary to:
Cg	Below 29	Stony gritty loam; grey (5 Y 5/1) with few coarse, prominent mottles; structureless; wet, sticky; no roots; calcareous; within the C horizon non-continuous layers of friable, gravelly sandy loam occur

Vegetation: *Molinietalia* community. Old pasture. Neglected rushy sward composed of clumps of *Juncus inflexus* (glaucous rush) and *J. conglomerate* in a grassy matrix mainly of *Agrostis tenuis* (bentgrass), *Anlhoxantliuin odoratum* (vernal grass), *FestUCQ rubra* (red fescue) and *Carex nigra* (common sedge).

TABLE 28: Coolnakisha Series

Horizon	Particle size analysis of mineral fraction				PH	Cation Exchange			Orga nic Fraction				
	Coarse sand %	Fine sand %	Silt %	) %		C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	C%	N %	C/N	Free iron %	T.N.V. %
Ap	7	18	50	25	5.2	21.2	4.8	23	6.1	0.35	17.4	1.5	0.0
Ba(ir)g	8	17	50	25	5.8	12.1	4.9	40	0.8	nd	-	2.4	0.0
B/Cg	16	23	45	16	6.7	13.8	12.0	87	0.7	nd	-	1.8	0.0
Cg	22	22	42	14	8.2	10.3	-	Sat.	0.6	nd	—	1.7	4.9

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	2	12	6	45	4	<1	50	17	5	45	2200	90
B2(ir)g	2	15	10	60	10	<1	65	25	12	50	2500	200
B/Cg	3	15	12	75	35	<1	70	50	15	65	2300	300
Cg	3	8	15	50	30	<1	50	35	10	65	3000	170

Greenane Series—Modal Profile

Location:	Busherstown, Carlow; 7/2 Y 35
Topography:	Flattish
Slope:	**1-2°**
Altitude:	300 feet O.D.
Drainage:	Imperfectly drained
Parent Material:	Calcareous, non-tenaceous glacial till, of Weichsel Age, composed of limestone with a smaller percentage of granite and sandstone
Great Soil Group:	Podzolic Gley

Horizon	*Depth (in.)*	*Description*
Ai	0-8/13	Sandy loam; dark-brown (10 YR 3/3); weak, fine angular structure; friable; plentiful roots; clear, wavy boundary to:
Batg	8-20/25	Sandy clay loam; dark yellowish-brown (10 YR 4/4) with many, fine and medium, distinct mottles; weak, medium sub-angular blocky structure; friable; sparse roots; clear, wavy boundary to:
Cg	Below 20	Stony sandy loam; yellowish-brown (10 YR 5/4-5/6) with many, fine, distinct light olive-grey (5 Y 6/2) mottles; structureless; friable; no roots; calcareous

Vegetation: *Centaureo-Cynosuretum*, Sub-ass. *of Juncus effusus.* Old pasture. Because of continuous heavy grazing this pasture has the appearance of being well drained. Three rush species, *Juncus articulatus, J. injiexus* and *J. effusus* are present in a stunted form. The dominant species are *Cynosurus cristatus* (crested dog's tail), *Plantago lanceolata* (plantain) and *Trifolium repens* (white clover) all of which are favoured by heavy grazing.

TABLE 29: Greenane Series

	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	*pH	C.E.C. meq/IOOg	T.E.B. meq/lOOg	Base sat. %	C%	N%	C/N	Free iron %	T.N.V. %
Ai	30	23	30	17	7.6	13.0	12.2	94	1.8	0.18	10.0	0.9	0.0
Batg	25	23	28	24	7.0	9.6	6.5	68	0.4	nd		1.1	0.0
Cg	31	23	28	18	8.6	4.4	10.3	Sat.	0.2	nd		0.4	32.0

•Exalted **pH** in surface horizon due to recent liming

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ai	8	30	20	3	75	25	<1	125	50	20	60	4000	1500
B2tg	8	40	15	2	75	50	1	150	75	15	50	2000	2000
Cg	3	20	20	3	100	40	<1	75	100	25	50	5000	1500

Knockmullgurry Series—Modal Profile

Location:	Knockmullgurry, Ballymurphy; 25/1 H 4
Topography:	I lattish to undulating
Slope:	
Altitude:	390 feet O.D.
Drainage:	Imperfectly drained
Parent Material:	Non-calcareous, non-tenaceous granitic till, of Saale Age
Great Soil Group:	Gley

iorizon	*Depth (in.)*	*Description*
Ap	0-8	Coarse sandy loam; very dark-brown (10 YR 2/2); moderate, fine granular structure; very friable; plentiful roots:
A12	8-KH/16	Similar to above horizon but somewhat less organic matter; abrupt, wavy boundary to:
(A2)g	10J-16/18	Coarse sandy loam; greyish-brown (2.5 YR 5/2) with many, medium, distinct light yellowish-brown (2.5 Y 6/4) mottles and very dark-brown worm casts from A horizon above; moderate, fine and very fine granular structure; friable; sparse roots; clear, smooth boundary to:
*(B)mg	16-36/40	use sandy loam; pale-yellow (2.5 Y 7/4) with many, large, diffuse yellowish-brown (10 YR 5/8) mottles and few, dark-red (2.5 YR 3/6) mottles; moderate, fine granular structure; very firm *in situ* (indurated); no roots; clear, wavy boundary to:
C	Below 36	me loamy sand; pale-yellow (2.5 YR 7/4); structureless; firm *in situ;* no roots; non-calcareous

o

Vegetation: *Centaureo-Cynosuretum,* typical Sub-ass. Reseeded pasture. The heavily grazed sward is completely dominated by *Trifolium repem* (white clover). Ptesent in lesser abundance are *Festuca rubra* (red fescue), *Lolium multiflorum* and *L. perenne* (rye-grass) and *Holcus lanatus* (Yorkshire fog).

*m=indicatcs induration or cementation

TABLE 30: Knockmullgurry Series

Horizon	Particle size analysis of mineral fraction				*pH	Cation Exchange			Organic Fraction			Free iron %	T.N.V. %
	Coarse sand %	Fine sand %	Silt %	Clay%		C.E.C. meq/100g	T.E.B. meq/100g	Base sat. %	C%	N %	C/N		
Ap	48	13	27	11	5.6	29.2	nd	–	5.0	0.35	14.3	0.4	–
A12	47	16	26	11	6.1	21.8	nd	-	4.6	0.25	18.4	0.6	–
(A2)g	47	17	26	10	5.9	6.8	nd	-	1.1	0.06	18.3	0.3	–
(B)mg	54	20	19	7	6.0	2.6	nd	-	0.5	nd	-	0.2	–
C	75	10	7	8	5.7	nd	nd	-	0.5	nd	-	0.3	-

•Relatively high pH levels in solum due to liming

Moanduff Series—Modal Profile

Location:	Tomard, Leighlinbridge; 12/1 Q 1
Topography:	Undulating
Slope:	3-5°
Altitude:	250 feet O.D.
Drainage:	Imperfectly drained
Parent Material:	Dense, calcareous, solifluctcd drift material composed of a mixture of limestone, chert, flagstone and shale
Great Soil Group:	Gley

Horizon	*Depth (in.)*	*Description*
Air	0-6	Loam; dark greyish-brown (10 YR 4/2); weak, fine and medium granular structure; friable; plentiful roots; gradual, smooth boundary to:
A12	6-13	Loam; greyish-brown (10 YR 5/2); weak, fine and medium granular structure; friable; burnt lime nodules present; plentiful roots; clear, smooth boundary to:
(B)g	13-33/35	Stony loam; light olive-grey (5 Y 6/2) with many, medium, prominent yellowish-brown (10 YR 5/8) mottles; weak, medium sub-angular blocky structure; wet, plastic; sparse roots; clear, wavy boundary to:
Cg	Below 33	Stony loam to clay loam; light olive-grey (5 Y 6/2) with common, medium, prominent yellowish-brown (10 YR 5/8) mottles; structureless; wet, sticky; no roots

Vegetation: *Centaureo-Cynosuretum,* typical Sub-ass. Old pasture. The sward is dominated by *Agrostis tenuis* (bentgrass) while *Cynosurus cristatus* (crested dog's tail) and *Holcus lanatus* (Yorkshire fog) are abundant. There are small, local patches of *Jwuu.s effusui* (soft rush).

TABLE 31: MoandufT Series

Horizon	Particle size analysis of mineral fraction				pH	Cation Exchange			Organic Fraction			Free iron %	T.N.V. %
	Coarse sand %	Fine sand %	Silt %	> %		C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	c%	N %	C/N		
Ai i	15	23	39	23	5.8	30.	18.3	61	5.4	0.45	12.0	1.5	0.0
A12	15	23	40	22	6.4	17.0	13.4	79	2.2	0.15	14.7	1.0	0.0
(B)g	15	19	44	22	7.3	14.6	14.5	99	0.6	nd	-	2.3	0.0
Cg	18	19	36	27	8.3	10.0	—	Sat.	0.5	nd	-	1.5	9.4

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
A n	3	17	9	1	90	20	<1	100	25	9	40	1750	200
A12	2	10	8	1	50	10	<1	75	25	8	60	2000	200
(B)g	2	15	10	2	100	25	<1	75	50	10	75	2500	350
Cg	2	25	10	2	100	25	<1	65	50	15	75	2300	650

Newtown Series—Modal Profile

Location:	Graiguenaspiddoge, Ballon; 12/2 S 33
Topography:	Flattish
Slope:	3°
Altitude:	300 feet O.D.
Drainage:	Poorly drained
Parent Material:	Calcareous, non-tenaceous glacial till, of Weichsel Age, composed mainly of limestone with some granite and sandstone
Great Soil Group:	Podzolic Gley

Horizon	*Depth (in.)*	*Description*
Ai	0-7	Organic sandy loam; dark greyish-brown (10 YR 4/2); weak, fine granular structure; friable; abundant roots; clear, smooth boundary to:
Batg	7-17/22	Sandy loam tending to sandy clay loam; light brownish-grey (2.5 Y 6/2) with many, coarse, prominent yellowish-brown (10 YR 5/6) mottles; massive tending to weak, medium granular structure; firm (hard when dry); sparse roots; gradual, smooth boundary to:
B/Cg	17-35/37	Stony sandy loam; grey (5 Y 5/1) with many, coarse, prominent yellowish-brown (10 YR 5/6) mottles; structureless; firm; sparse roots; calcareous; gradual, smooth boundary to:
Cg	Below 35	Stony sandy loam; grey (5 Y 5/1) with many, distinct, coarse mottles; structureless; firm; no roots; calcareous. Pockets of friable, gravelly loamy sand material occur in this horizon

Vegetation: *Molinietalia* community. Little grazed, wet grassland dominated by *Juncus acutiflorus* (jointed rush).

TABLE 32: Newtown Series

	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Horizon	Coarse sand %	Fine sand %	**Silt** %	< toy %	pll	C.E.C. meq/lOOg	**T.E.B.** meq/lOOg	Base sat. %	**c%**	N %	C/N	Free iron %	T.N.V. /o
Ai	34	25	27	14	5.9	23.2	18.6	so	7.0	0.55	12.8	0.3	0.0
B2tg	33	21	27	18	7.3	10.2	8.4	82	0.8	nd	-	1.6	0.0
B/Cg	35	23	27	15	8.1	6.7	-	Sat.	0.3	nd	-	0.9	20.0
Cg	36	23	25	16	8.2	4.3	-	Sat.	0.5	nd	-	0.6	21.5
Pocket in Cg	72	8	13	7	8.4	3.6	—	Sat.	0.6	nd	-	0.4	28.4

I race Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ai	10	40	20	2	75	15	< 1	75	30	X	50	2000	200
Batg	8	25	15	2	100	20	< 1	100	40	10	50	1500	250
B/Cg	10	20	25	2	100	50	< 1	100	75	20	60	200	300
Cg	8	20	20	2	75	40	< 1	100	75	20	50	2500	600

Parknakyle Series—Modal Profile

Location:	Parknakyle, Oldleighlin; 11/4
Topography:	Strongly sloping
Slope:	12'
Altitude:	700 feet O.D.
Drainage:	Poorly drained
Parent Material:	I >entt, tcnaceous, non-calcareous soliflucted drift composed of Carboniferous sandstone, shale, flagstone and chert
Great Soil Group	Pod/olic Gley

Horizon	*Depth (in*	*Description*
An	0-7	Sandy clay loam; brown (10 YR 5/3) to yellowish-brown (10 YR 5/4) with many, fine, yellowish-red (2.5 YR 4/6) mottles; weak, fine granular structure; wet, plastic; plentiful roots; clear, smooth boundary to:
A12	7-11	Loam tending to clay loam; light brownish-grey (2.5 Y 6/4); weak, fine granular structure; wet, slightly plastic; moderate root supply; many flaggy stones present; clear, smooth boundary to:
B2tg	11-27/30	Clay loam; light-grey (5 Y 7/2) with many, medium, distinct reddish-yellow (7.5 YR 6/8) mottles; weak, coarse prismatic structure; wet, plastic; many flaggy stones present; sparse roots; gradual, wavy boundary to:
Cg	Below 27	Stony loam; yellowish-brown (10 YR 5/4) with light-grey (5 Y 7/2) and yellowish-brown (10 YR 5/8) monies and black manganese blotches; structureless; wet, plastic; no roots; non-calcareous.

Vegetation: *Junco-Molinietum.* Old, poorly-growing rushy pasture, the dominant rush being *Juncus acutiflorus* (jointed rush). There are many other moisture indicator-species present including *Filipendula ulmaria* (meadow-sweet), *Galium pa lust re* (marsh bedstraw) and *Carex ovalis* (oval sedge).

TABLE 33: Parknakyle Series

Horizon	Particle size analysis of mineral fraction				PH	Cation Exchange			Organic Fraction			Free iron %	T.N.V. /o
	Coarse sand %	Fine sand %	Silt %	Clay %		C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	c %	N %	C/N		
A n	16	34	25	25	5.6	26.8	nd	–	3.5	0.44	8.0	2.4	–
A12	14	23	37	26	5.2	13.4	nd	-	1.6	0.14	11.4	3.1	-
B2tg	9	20	40	31	5.3	7.2	nd	-	0.4	nd	—	3.3	-
Cg	20	26	33	21	5.3	7.6	nd	-	0.4	nd	_	31.	-

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
A n	4	40	10	1	70	7	<1	45	10	8	45	2000	220
A12	3	70	20	1	75	5	<1	50	15	10	40	2000	300
B2tg	3	15	15	1	40	10	<1	80	20	7	50	2000	170
Cg	2	15	10	1	60	20	<1	70	30	10	40	2000	250

Raheenleigh Series—Modal Profile

Location:	Scskinnamaddra, Borris; 20/3 E-F 13
Topography:	dope
Slope:	10°
Altitude:	600 feet O.D.
Drainage:	Very poorly drained
Parent Material:	Non-calcareous, non-tenaceous glacial till, of Saale Age, composed of shale and granite
Great Soil Group:	Peaty Gley

Horizon	*Depth (in.)*	*Description*
Oi	**0-9/10**	Peaty (partly decomposed plant root remains); very dark-brown (10 YR 2/2); wet, mucky; plentiful rush *(Juncus)* roots; clear, smooth boundary to:
A/Cg	9-18/20	Sandy loam; grey (7.5 YR 5/0-6/0); structureless tending towards weak, fine granular; compact; sparse rush roots; gradual, wavy boundary to:
Cg	Below 18	Shaly loamy sand to sandy loam; grey (7.5 YR 5/6) with many, prominent, yellowish-brown mottles (10 YR 5/6); structureless; compact; no roots; non-calcareous

Vegetation: *Junco-molinietum.* Wet, partly abandoned rushy *{Juncus acutifiorus)* pasture. As evidence of the very low soil fertility *Sieglingiu decumbens* (heath-grass), *Molinia coerulea* (Purple moor-grass) and *Succisa pratensis* (devil's bit) are abundant.

TABLE 34: Raheenleigh Series

Horizon	Particle size analysis of mineral fraction				pH	Cation Exchange			Organic Fraction			Free iron %	T.N.V. %
	Coarse sand %	Fine sand %	Silt %	Clay %		C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	C%	N%	C/N		
Oi	nd	nd	nd	nd	5.1	80.8	18.0	22	26.7	1.32	20.2	0.4	
A/Cg	38	30	28	4	5.7	4.6	2.0	43	0.9	nd		0.1	
Cg	46	28	22	4	6.0	2.9	2.2	76	0.5	nd		0.8	

Seskinrea Series—Modal Profile

Location:	Baunreagh, Oldleighlin; 15/1 M 32
Topography:	Flattish to undulating
Slope:	2-3°
Altitude:	850 feet O.D.
Drainage:	Very poorly drained
Parent Material:	Dense, tenaeeous, non-calcareous soliflucted drift composed of Carboniferous shale, sandstone and Hags tone
Cireat Soil Group:	Peaty podzolic Gley

Horizon	*Depth {in.)*	*Description*
Oi	0-5/6	Peaty clay loam; very dark-grey (10 YR 3/1); weak, fine sub-angular blocky structure; wet, plastic; many rush roots; abrupt, wavy boundary to:
A2g	6-11	Coarse sandy loam; light-grey (10 YR 6/1) with many, coarse, prominent yellowish-brown (10 YR 5/8) mottles; weak, fine sub-angular blocky structure; wet, slightly plastic; sparse roots; gradual, smooth boundary to:
B2tg	11-36/38	Stony clay loam to loam; grey (2.5 Y 6/1) with very many, coarse, prominent yellowish-brown and yellowish-red (10 YR 5/8 and 5 YR 4/8) mottles; structureless tending towards weak, coarse prismatic; wet, plastic; sparse roots; gradual, smooth boundary to:
B/Cg	Below 36	Stony gritty clay loam; grey (2.5 Y 6/0) with many, medium, prominent yellowish-brown (10 YR 5/8) mottles; structureless; wet, plastic; no roots; non-calcareous

Vegetation: *Junco-Molinietum.* Old, wet meadow dominated by *Juncus acutifiorus* (jointed rush), *J. efiusus* (soft rush) and *Carex spp.* (sedges).

TABLE 35: Seskinrea Series

Horizon	Particle size analysis of mineral fraction				PH	Cation Exchange			Organic Fraction				
	Coarse Band %	Fine sand %	Silt %	Clay %		C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	c%	N %	C/N	I ree iron %	T.N.V. /o
Oi	nd	nd	nd	nd	4.6	71.0	9.6	14	23.6	1.0	23.6	1.6	_
A2g	37	23	29	11	5.3	4.7	0.6	13	0.4	nd	-	0.2	-
B2tg	14	18	41	27	5.4	8.2	2.6	32	0.3	nd	-	1.9	-
B/Cg	16	16	39	30	5.9	13.2	7.7	58	0.2	nd	_	-	-

Toberbride Series—Modal Profile

Location:	Ballinacrea, Myshall; 17/3 C 36
Topography:	I lattish
Slope:	**1-2°**
Altitude:	320 feet O.D.
Drainage:	Poorly drained
Parent Material:	iicons, non-tcnaceous glacial till, of Wcichscl Age, composed of limestone and granite
Great Soil Group:	Podzofic Gley

Horizon	*Depth (in.)*	*Description*
Ai	0-6/7	Organic coarse sandy loam; dark greyish-brown (10 YR 4/2) with many, fine, distinct yellowish-red (5 YR 4/8) mottles; moderate, medium and fine granular structure; friable; plentiful roots; clear, smooth boundary to:
A2g	6-8/9	Sandy loam; light-grey (10 YR 7/2); weak, fine granular structure; firm; sparse roots; clear, wavy boundary to:
B2tg	8-16/20	Loam to sandy clay loam; olive-grey (5 Y 4/2) with common, medium, prominent strong-brown (7.5 YR J 6) mottles; weak, medium sub-angular blocky structure; firm; sparse roots; clear, wavy boundary to:
Cg	Below 16	Gritty sandy loam; light olive-grey (5 Y 6/2) with many, medium, prominent yellowish-brown (10 YR 5/6) mottles; structureless; no roots; calcareous

Vegetation: *Junco-Molinictum.* Very wet grassland, transitional to swamp. The principal species present are *Carex echinata* (star sedge), *Juncus* *acutifiorus* (jointed rush), *Sicglingia* ***decumbens*** **(heath-grass) and** *Succisa praiensis* (devil's **bit). The actual grass content of the sward is about 10 per cent.**

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a*

TABLE 36: Toberbride Series

Horizon	Particle size analysis of mineral fraction				pH	Cation Exchange			Orgainic Fraction				
	Coarse sand %	Fine sand %	Silt %	Clay %		C.E.C. mcq/lOOg	T.E.B. meq/100g	Base sat. %	C %	N %	C/N	Free iron %	T.N.V. %
Ai	47	15	26	12	5.8	24.4	5.3	21	9.7	0.53	18.3	0.4	—
A2g	59	14	19	8	5.4	5.5	1.9	35	0.8	nd	-	0.3	-
B2tg	35	15	29	21	5.3	7.7	5.3	69	0.1	nd	-	1.9	-
Cg	53	13	21	13	8.4	5.1	5.5	Sat.	0.1	nd	-	0.6	5.1

Mil/quarter Series—Modal Profile

Location:	Rosslee, Myshall; 17/3 B 10
Topography:	Flat
Slope:	0°
Altitude:	290 feet O.D.
Drainage:	Poorly drained—subject to flooding
Parent Material:	Lake alluvium
Great Soil Group:	Regosol

Horizon	***Depth (in.)***	*Description*
	0-6	Slightly peaty, silty clay loam; grey rown (10 YR 5/2) with few, medium, prominent yellowish-red (5 YR 4/8) mottles especially along root channels; weak, fine granular structure; wet, sticky; abundant roots; gradual, smooth boundary to:
	6-18	Organic silt loam; greyish-brown (2.5 Y 5/2) with many, coarse, prominent yellowish-red (5 YR 4/8) mottles; coarse prismatic tending towards massive structure; wet, plastic; rush roots only; clear, smooth boundary to:
	18-45	Silt loam; grey (2.5 Y 6/0); structureless; wet, plastic; no roots; non-calcareous

Vegetation: *Centaureo-Cynosuretum*, typical Sub-ass. Old pasture. The sward is dominated by *Agiostis tenuis* (bentgrass). Both *Cirsium arvense* (creeping thistle) and *C. palustre* (marsh thistle) are common weeds.

TABLE 37: Millquarter Series

	Particle size analysis of mineral traction					Cation Exchange			Organic Fraction				
Depth (in.)	Coarse sand %	Fine sand %	Silt %	Clay %	pH	C.E.C. meq/lOOg	T.E.B. mcq/lOOg	Base sat. %	C%	N%	C/N	Free iron %	T.N.V %
0 - 6	4	7	56	33	5.0	47.0	4.0	9	11.7	0.86	13.6	0.7	
6-18	2	8	64	26	5.6	43.4	9.0	21	8.0	0.41	19.5	0.8	
18^15	5	27	57	11	6.2	10.0	6.5	65	0.0	nd		0.4	

Trace Elements—total content (ppm)

Depth (in.)	Sn	Pb	Oa	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
0 - 6	17	50	30	I	70	20	<1	150	35	30	50	1500	350
6-18	17	50	35	1	60	20	<1	40	35	12	60	1750	600
18-45	8	25	40	1	100	30	<1	25	100	35	100	4000	500

Clohamon Series—Modal Profile

Location:	Co. Wicklow; 37/1 S-T 22
Topography:	Flat
Slope:	0°
Altitude:	280 feet O.D.
Drainage:	Well drained—subject to regular flooding
Parent Material:	River alluvium
Great Soil Group:	Regosol

Horizon	*Depth {in.)*	*Description*
	0-20	Loam; brown to dark-brown (10 YR 4/3); moderate, fine and medium granular structure; very friable; abundant roots; non-calcareous; clear, smooth boundary to:
	20-35	Sandy loam; dark-brown (10 YR 3/3); moderate, fine granular structure; very friable; plentiful roots; non-calcareous; clear, smooth boundary to:
	35-45	Sandy loam; yellowish-brown to dark yellowish-brown (10 YR 5/4-4/4); weak, fine granular structure; very friable; plentiful roots; non-calcareous; clear, smooth boundary to:
	45-59	loam; brown to dark-brown (10 YR 4/3) with many, fine, faint mottles; weak, fine granular structure; wet, slightly sticky; sparse roots; non-calcareous; abrupt, smooth boundary to:
	Below 59	v gravels; calcareous

Vegetation: *Lo/io-Cynosuretum,* typical Sub-ass. Old pasture. Dense, moderately good quality grass sward, the principal contributing species being *Agrostis tenuis* (bentgrass), *Festuca rubra* (red fescue). *Lolium perenne* (perennial rye-grass) and *Ho/cus lanatus* (Yorkshire fog).

TABLE 38: Clohamon Series

Depth (in.)	Particle size analysis of mineral traction				pH	Cation Exchange			Organic Fraction			Free iron %	T.N.V. %
	Coarse sand %	Fine sand %	Silt %	Clay %		C.E.C. meq/IOOg	T.E.B. meq/IOOg	Base sat. %	C%	N %	C/N		
0-20	12	37	38	13	5.9	24.2	9.1	38	3.2	0.29	II.ii	1.8	—
20-35	29	35	26	10	5.5	10.5	2.7	26	1.1	0.10	11.0	1.7	-
35^5	13	48	28	12	5.5	10.0	2.9	29	0.6	nd	-	2.2	-
45-59	17	30	41	12	5.6	25.1	3.7	15	1.5	nd	12.5	3.2	-
Below 59	-	-	—	-	—	-	—	—	—	-	-	-	-

I race Elements—total content (ppm)

Depth (in.)	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
0-20	15	25	40	1	75	25	<1	75	25	15	50	4000	2000
20-35	8	30	25	1	50	20	<1	75	20	17	40	2500	2500
35^15	10	35	20	1	50	10	<1	100	10	15	35	1500	2500
45-59	8	35	20	2	60	15	<1	85	20	20	45	2000	3200

Kilmannock Series—Modal Profile

Location:	Rathallin, Muine Bheag; 16/1 K-L 10
Topography:	Flat
Slope:	0°
Altitude:	130 feet O. D.
Drainage:	Poorly drained—subject to regular flooding
Parent Material:	Riser alluvium
Great Soil Group:	Regosol

Horizon	*Depth (in.)*	*Description*
	0-7	Slightly peaty silty clay loam; very dark greyish-brown (10 YR 3/2); weak, fine granular structure; wet, sticky; abundant roots; calcareous; clear, smooth boundary to:
00		
	7-14	Clay loam; greyish-brown (10 YR 5/2); weak, coarse prismatic collapsing to massive structure; wet, sticky; sparse roots; non-calcareous; clear, smooth boundary to:
	14-24	Clay loam; grey (5 Y 5/1) with abundant, coarse, prominent brownish-yellow (10 YR 6/8) mottles; coarse prismatic to massive structure; wet, sticky; sparse roots; non-calcareous; clear, smooth boundary to:
	24-44	Clay loam to loam; grey (5 Y 5/1); structureless; wet, sticky; no roots; very slightly calcareous:
-	Below 44	Coarse, calcareous gravels

Vegetation: Not examined.

TABLE 39: Kilmannock Series

Depth (in.)	Particle size analysis of mineral fraction: Coarse sand %	Fine sand %	Silt %	Clay %	PH	Cation Exchange: C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	Organic Fraction: c%	N %	C/N	Free iron %	T.N.V. /o
0- 7	3	5	54	38	7.7	**32.0**	–	Sat.	10.4	0.90	11.6	1.9	11.4
7-14	11	18	40	31	7.5	35.2	34.2	97	3.3	0.45	7.3	2.5	0.0
14-24	7	25	35	33	7.8	13.2	-	Sat.	0.4	nd	-	3.8	0.0
24-^4	5	28	40	27	7.6	24.0	—	Sat.	0.4	nd	-	0.6	3.5

Trace Elements—total content (ppm)

Depth (in.)	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	**Mn**
0- 7	5	15	5	1	50	18	<1	90	25	15	35	1500	2500
7-14	3	20	12	1	70	12	<1	100	25	9	50	1500	2500
14-24	3	20	10	2	90	8	1	75	30	8	65	2000	400
24-44	3	20	15	1	120	5	<1	90	40	10	75	2000	75

River Burren Series—Modal Profile

Location:	Moyle, Car low; 7/4 I 35
Topography:	1 lal
Slope:	0°
Altitude:	200 feet O.D.
Drainage:	Imperfectly drained—subject to regular flooding
Parent Material:	River alluvium
Great Soil Group:	Regosol

Horizon	*Depth (in.)*	*Description*
^	0-14	Loam; dark-brown to dark greyish-brown (10 YR 3/3-4 friable; abundant roots; non-calcareous; gradual, smooth boundary to:
	14-33	Silty clay; olive-grey (2.5 Y 5/2) to greyish-brown (5 Y 5/2) with many, medium, prominent yellowish-red (5 YR 4/8) mottles; coarse prismatic structure; firm; sparse roots; non-calcareous; clear, smooth boundary to:
-	Below 33	Loamy coarse sand; pale-olive (5 Y 6/3) with many, coarse prominent yellowish-brown (10 YR 5/6) mottles and black manganese blotches; structureless; friable; no roots; non-calcareous

Vegetation: *Lolio-Cynosuretum;* old grassland, used for silage. The sward is composed of a small number of species and lacks both perennial rye-grass and white clovei. It is dominated by *Agrostis tenuis* (bentgrass), *Holcus lanutus* (Yorkshire fog), *Ranunculus repens* (creeping buttercup) and *Agrostis stolonifera* (creeping bentgrass).

TABLE 40: River Burren Series

Depth (in.)	Particle size analysis of mineral fraction: Coarse sand %	Fine sand %	Silt %	Clay %	pH	Cation Exchange: C E C meq/lOOg	T E B meq/lOOg	l$;isc sat. %	Organic Fraction: C%	N%	C/N	Free iron %	T N.V. '%
0-14	16	35	30	19	7.8	32.0	27.6	86	3.2	0.40	8.0	1.8	0.0
14-33	2	3	51	44	7.8	32.6	24.5	75	2.1	0.20	10.5	1.8	0.0
Below 33	37	42	16	5	7.9	6.7	5.2	78	0.0	nd		0.8	0.0

I i ice Elements—total content (ppm)

Depth (in.)	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
0-14	8	20	20	2	50	30	< 1	75	30	10	50	2000	850
14-33	7	20	17	<1	65	30	<1	150	35	10	45	1500	175
Below 33	7	25	15	1	50	15	<1	85	30	10	35	1700	400

Carrigvahanagh Series—Modal Profile

I ocation:	iiivahanagh, Blackstairs Mountains; 26/2 W 27
Topography:	Steeply sloping
Slope:	6°
Altitude:	900 feet O.D.
Drainage:	Imperfectly Drained
Parent Material:	Granite bedrock
Great Soil Group:	Lithosol

Horizon	*Depth (in.)*	*Description*
	0-8	Peal and stones; black (10 YR 2/1); partial cover only—up to 80 per cent rock outcrops; abrupt, wavy boundary to:
		Granite bedrock and rock fragments

Vegetation: Dry *Calluna* heath. In the pockets of soil between the granite boulders *Calluna vulgaris* (heather), *Vaccinium niyrtillus* (bilberry) and *Deschampsia caespitosa* (tufted hair-grass) grow vigorously in company with many other acidophile heath species.

TABLE 41: Carrigvahanagh Series

£}

Depth (in.)	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
	Coarse sand %	Fine sand %	Silt %	Clay %	pH	C.E.C. meq/IOOg	T.E.B. mcq/lOOg	Base sat. %	C%	N%	C/N	Free iron %	T.N.V. %
0- 8					4.3	88.8	nd		23.X	0.87	27.3		

A thy Complex—moderately deep component—modal profile

Location:	Gravel Pit, near Manager's Residence, Agricultural Institute, Oakpark, Carlow
Topography:	Undulating
Slope:	2-3
Altitude:	200 feet O.D.
Drainage:	Well drained
Parent Material:	Calcareous, fluvio-glacial gravels, of Weichscl Age, composed mainly of limestone with a very small proportion of sandstone and granite
Great Soil Group:	Grey Brown Podzolic

Horizon	*Depth (in.)*	*Description*
An	0-3 *h*	Gravelly sandy loam; very dark greyish-brown (10 YR 3/2); moderate, fine and very fine granular Structure; very friable; bleached quartz grains; non-calcareous; abundant roots; clear, smooth boundary to:
A12	3H4/15	elly sandy loam; dark-brown (10 YR 3/3); moderate, fine and medium granular Structure; friable; bleached quart/, grains; non-calcareous; plentiful roots; clear, smooth boundary to:
A2	14-23/28	Coarse sandy loam (few gravels); brown to dark yellowish-brown (10 YR 4/3-4/4); weak, very fine granular structure; very friable; many worm channels lined with material from A.I2; plentiful roots; non-calcareous; abrupt, wavy boundary to:
B2t	23-27/35	Gritty sandy clay loam; dark greyish-brown to brown (10 YR 4/2-4/3); moderate, medium sub-angular blocky structure; wet, slightly plastic; plentiful roots; non-calcareous; clear, smooth boundary to:
B_3	27-28/39	Gritty sandy loam; brown to dark-brown (10 YR 4/3); weak, fine granular structure; very friable; sparse roots; weakly calcareous; abrupt, tonguing boundary to:
	Below 28	Gravelly coarse sand; grey (5 Y 5/1); structureless; loose; no roots; strongly calcareous with bands of secondary calcium carbonate present

Vegetation: *Centaureo-Cynosuretum,* typical Sub-ass. Reseeded pasture. Moderately growing sward composed mainly of *Poa triviaiis* (rough-stalked meadow-grass) and *Trifolium repens* (white clover). *Lolium perenne* (perennial rye-grass) contributes about 10 per cent of the total cover.

TABLE 42: Athy Complex—moderately deep component

	Particle si/e analysis of mineral fraction					Cation Exchange			Organic Fraction				
Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	PH	C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	c%	N %	C/N	Free iron %	T.N.V. %
A n	34	23	28	15	fi.y	24.9	21.4	86	4.8	0.47	10.2	2.2	0.0
Ai -	34	24	27	15	7.5	16.0	15.7	98	1.5	0.20	7.5	1.5	0.0
A2	46	20	24	10	7.4	7.3	-	Sat.	0.4	nd	-	1.1	0.0
U.t	38	15	23	24	7.5	13.8	13.5	98	0.6	nd	-	1.8	0.0
B3	42	31	13	15	7.4	8.0	-	Sat.	0.1	nd	-	0.9	0.4
C	nd	nd	nd	nd	8.5	1.9	-	Sat.	0.0	nd	-	0.4	51.4

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
A n	7	25	17	2	65	65	1	150	40	9	4.^	1300	2000
A.I3	8	25	20	2	75	35	< I	175	75	15	50	2000	3000
A2	5	20	10	2	75	25	< 1	75	100	20	100	3000	1500
B2t													
B3	5	25	20	2	150	25	< 1	150	125	15	75	2500	2000
C	3	15	8	2	75	25	< 1	_	100	25	50	2000	1000

Athy Complex - shallow component modal profile

Location:	Slate Sheds North, Agricultural Institute, Oakpark, Carlow
Topography:	Humniocky
Slope:	2
Altitude:	200 feet O.D.
Drainage:	Excessively drained
Parent Material:	Calcareous, fluvio-glacial gravels, of Weichsel Age, composed mainly of limestone with very small proportions of sandstone and granite
Great Soil Group:	Brown Earth (of high base status)

Horizon	*Depth* (//;.)	*Description*
Ap	0-11/14	Gravelly, coarse sandy loam; brown to dark brown (7.5 YR 4/2); moderate, tine crumb structure; verj friable; abundant roots; calcareous; clear, wavy boundary to:
	Below II	\ell> coarse sand; light olive-grey (5 Y 6/2); structureless; loose; good root development in top 9 inches; calcareous—bands of secondary calcium carbonate present

Vegetation: *Lolio-Cynosuretum,* typical Sub-ass. Reseeded pasture. The sward is dominated by *Dactylisglomerata* (cocksfoot), *Lolium perenne* (perennial rye-grass), *Poa trivialis* and *P. pratensis* (meadow-grasses) and *Trifo/iuni repens* (white clover).

TABLE 43: Athy Complex—shallow component

Horizon	Particle size analysis of mineral fraction				pH	Cation Exchange			Organic Fraction			Free iron %	T.N.V. %
	Coarse sand %	Fine sand %	Silt %	Clay %		C.E.C. meq/lOOg	T.E.B. meq/lOOg	Base sat. %	C %	N %	C/N		
Ap	46	21	18	15	7.4	23.8		Sat.	3.4	0.4	8.5	1.0	12.0
C	nd	nd	nd	nd	8.1	4.0		Sat.	0.9	nd		0.4	40.1

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cl	Ti	Mn
Ap	7	20	17	3	85	35	<1	85	65	12	85	3500	1200
C	3	20	8	I	75	25	<1	75	50	10	50	2000	1500

A thy Complex—imperfectly drained component—modal profile

Location:	Ninety-Eight Field, Agricultural Institute, Oakpark, Carlow
Topography:	I lattish
Slope:	0
Altitude:	190 feet O.D.
Drainage:	Imperfectly drained
Parent Material:	Calcareous, fluvio-glacial gravels, of Weichsel Age, composed mainly of limestone with very small proportions of sandstone and granite
Great Soil Group:	Brown Earth with gleying (high base status)

Horizon	*Depth (in.)*	*Description*
Ap	0-10/l2i	Sandy loam; very dark greyish-brown (10 YR 3/2); moderate, fine granular structure; very friable; good root development; calcareous; clear, smooth boundary to:
A/Cg	10-34	Gravelly sandy loam; dark-grey (5 Y 4/1); structureless; friable; sparse roots; calcareous; gradual, smooth boundary to:
Cg	Below 34	Gravelly loamy sand; grey (5 Y 5/1); structureless; friable; no roots; calcareous

Vegetation: *Lolio-Cynosuretum*, typical Sub-ass. Reseeded pasture. Only a small number of species are present. The sward is composed of *Agrostis stolonifcra* (creeping bentgrass), *Lolium pcrcnne* (perennial rye-grass), *Ph/cuni pratense* (timothy), *Poa trivialis* (rough-stalked meadow-grass) and *Trifolium repens* (white clover).

Table 44: Athy Complex—imperfectly drained component

	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	pH	C.E.C. meq/lOOg	T.E.B. mcq/lOOg	Base sat. %	C%	N%	C/N	Free iron %	T.N.V. %
Ap	39	27	19	15	7.8	25.8	23.7	92	4.1	0.33	12.4	0.6	4.3
A/Cg	55	20	15	10	7.9	6.0	nd	Sat.	0.6	nd		0.2	7.0
Cg	69	13	9	9	8.4	1.8	nd	Sat.	0.3	nd		0.3	55.1

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	5	20	7	2	90	17	<1	90	45	9	65	3500	450
A/Cg	5	10	15	2	75	8	<1	50	50	8	50	2000	100
Cg	I	5	4	I	74	8	<1		30	3	40	1500	900

Athy Complex—poorly drained component—modal profile

Location:	Bog Field, Agricultural Institute, Oakpark, Carlow
Topography:	Flat
Slope:	0°
Altitude:	180 feet O.D.
Drainage:	Poorly drained
Parent Material:	Calcareous, fluvio-glacial gravels, of Weichsel Age, composed mainly of limestone with small proportions of sandstone and granite
Great Soil Group:	Gley

Horizon	*Depth (in.)*	*Description*
A	0-13/17	Sandy loam; very dark brown (10 YR 2/2); weak, fine and medium granular structure; friable; plentiful roots; calcareous; abrupt, wavy boundary to:
Cg	Below 13	Gravelly loamy sand; grey (5 Y 5/1); structureless; friable; no roots; calcareous

Vegetation: *Senecioni-Juncetum acutiflori;* Wet pasture. It poaches very easily, even in summer, and this is indicated by the frequency of *Juncus bufonius* (toad rush). The total vegetation cover is only about 60 per cent and this is made up mainly of *Agrostis stolonifera* (creeping bentgrass), *Carex hirta* (hairy sedge), *Festuca pratensis* (meadow fescue), *Juncus articulatus* (jointed rush) and *Ranunculus repens* (creeping buttercup).

TABLE 45: Athy Complex—poorly drained component

	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	pH	C.E.C. meq/lOOg	T.E.B. meq/IOOg	Base sat. %	*C%*	N%	C/N	Free iron %	T.N.V. %
A	57	17	15	11	7.7	26.8		Sat.	4.5	0.37	12.2	0.4	12.5
Cg	36	43	II	10	8.4	2.6		Sat.	0.3	nd		0.2	35.6

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
A	4	20	20	2	130	35	<1	80	65	12	65	4000	650
Cg	5	8	8	1	75	20	<1		75	15	50	4000	250

Broughillstown Complex—moderately deep component—modal profile

Location:	Broughillstown, Rathvilly, 4/1 F 5
Topography:	Hummocky
Slope:	5°
Altitude:	400 feet O.D.
Drainage:	Well drained
Parent Material:	Calcareous, fluvio-glacial gravels, of Weichsel Age, composed of limestone with mica-schist, greenstone, granite and sandstone
Great Soil Group:	Brown Earth (medium-high base status)

iorizon	*Depth (in.)*	*Description*
Apr	0-6	Gravelly sandy loam; dark greyish-brown (10 YR 4/2); strong, fine granular structure; very friable; abundant roots; gradual, smooth boundary to:
Ap2	6-11/12	Similar to above horizon but less organic matter and colour is brown to dark-brown (10 YR 4/3); abrupt, wavy boundary to:
A/B	11-20/24	Gravelly sandy loam; dark yellowish-brown (10 YR 4/4); strong, fine granular structure; very friable; plentiful roots; clear, wavy boundary to:
•(B)	20-23/27	Gravelly sandy loam; very dark greyish-brown (10 YR 3/2); strong, medium sub-angular blocky structure; friable; plentiful roots; abrupt, wavy boundary to:
C	Below 23	Gravelly coarse sand; light yellowish-brown (10 YR 6/4); structureless; loose; plentiful roots in upper 9 inches; calcareous

Vegetation: *Lolio-Cynosuretum,* typical Sub-ass. Reseeded pasture. Moderately growing sward dominated by *Trifolium repens* (white clover), *Holcus lanatus* (Yorkshire fog) and *Lolium perenne* (perennial rye-grass).

*This horizon is a fras B (or Beta) horizon which is one enriched in biological remains

TABLE 46: Broughillstown Complex—moderately deep component

Horizon	Particle size analysis of mineral Traction				PH	Cation Exchange			Organic Fraction			Free iron %	T.N.V. /o
	Coarse sand %	Fine sand %	Silt %	Clay %		CE.C. meq/lOOg	T.E.B. meq/IOOg	Base sat. %	C%	N %	C/N		
Api	42	19	27	12	6.0	17.6	9.5	54	3.5	0.24	14 6	1.1	0
Ap.:	43	17	25	15	6.4	14.6	9.4	64	1.7	0.17	10.0	1.1	0
A/B	37	19	31	13	6.4	7.9	4.9	62	0.4	nd	-	1.2	0
(B)	63	7	19	11	6.5	7.5	4.8	64	0.3	nd	-	1.3	0
C	90	6	2	2	8.2	3.0	—	Sat.	0.2	nd	-	0.3	33.5

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Api	5	60	10	2	65	15	< 1	150	50	10	50	2000	2800
Api	5	60	15	2	75	25	< 1	170	50	10	75	1800	2500
A/B	4	50	8	2	50	15	< 1	150	65	15	75	1800	2200
*(B)	3	60	10	3	100	35	< 1	200	100	15	85	1500	4000
C	2	10	8	1	50	25	< 1	—	50	10	30	1600	1200

*Contains 10 ppm Cd

Broughillstown Complex—shallow component—modal profile

Location:	Broughillstown, Rathvilly; 4/1 E4
Topography:	llummocky
Slope:	0°
Altitude:	400 feet O.D.
Drainage:	Exccssi\elv drained
Parent Material:	Calcareous, fluvio-glacial gravels, of Weichsel Age, composed of limestone with mica-schist, greenstone, granite and sandstone
Great Soil Group:	Brown Earth (of high base status)

Horizon	*Depth (in.)*	*Description*
Ap	0-8/10	Gravelly sandy loam; very dark greyish-brown (10 YR 3/2); strong, fine crumb structure; very friable; abundant roots; weakly calcareous; clear, wavy boundary to:
	Below 8	Gravelly coarse sand; light brownish-grey; structureless; loose; plentiful roots in upper 9 inches; calcan

Vegetation: *Lolio-Cynosuretum,* typical Sub-ass. Reseeded pasture. Vigorously growing, leafy sward dominated by *Lolium pcrennc* (peiennial rye-grass) and *Trifo/ium repens* (white clover).

TABLE 47: Broughillstown Complex—shallow component

Horizon	Particle size analysis of mineral fraction					Cation Exchange			Organic Fraction				
	Coarse sand %	Fine sand %	Silt %	Clay %	pH	C.E.C. meq/IOOg	T.E.B. mcq/lOOg	Base sat. %	C%	N%	C/N	Free iron %	T.N.V. %
Ap	46	16	26	12	7.6	27.8		Sat.	4.3	0.38	11.3	1.2	2.0
C	82	II	5	2	S.I	2.6		Sat.	0.6	nd		0.3	34.0

Trace Elements—total content (ppm)

Horizon	Sn	Pb	Ga	Mo	V	Cu	Ag	Zn	Ni	Co	Cr	Ti	Mn
Ap	6	25	12	I	40	20	<1	130	30	8	35	1500	2000
C	I	5	8	I	50	12	<1		35	7	50	2000	1000

APPENDIX II

SOILS AND PARENT MATERIALS

In Table 1 the soils recognised and mapped in the county are grouped according to similarities in parent materials. As such these groups closely approximate soil associations (see Chapter III, page 15). Such a grouping may be important in terms of inherent nutrient fertility and particularly in relation to inherited trace element levels in the soils.

TABLE I: Soil Series of County Cailow grouped according to Geological Parent Materials

Parent Material	Soils
Glacial till of Weichsel Age composed mainly of limestone	Mortarstown
Glacial till of Weichsel Age composed of limestone with some granite and sandstone	Kellistown, Greenane, Newtown, Clowater
Glacial till of Weichsel Age composed of limestone, with some shale and sandstone	Paulstown
Glacial till of Weichsel Age composed of granite and limestone	Toberbride, Ballinrush
Glacial till of Saale Age composed of granite with some chert	Borris, Knockmullgurry, Ballywilliam, Belmount
Glacial till of Saale Age composed of shale and granite	Clonegall, Raheenleigh
Glacial till of Saale Age composed mainly of granite	Kiltealy, Kiltealy Shallow Variant, Ballinagilky
Soliflucted drift of Saale Age composed of Carboniferous shale, sandstone and flagstone	Castlecomer, Parknakyle, Seskinrea
Mixture of soliflucted drift of Saale Age and glacial till of Weichsel Age, composed of limestone, chert, shale, sandstone and flagstone	Ballinabranagh, Moanduff, Coolnakisha
Mixture of soliflucted drift of Saale Age and glacial till and fluvio-glacial gravels of Weichsel Age; composed of limestone, shale, sandstone and flagstone	Rathvinden

TABLE 1 (continued:) Parent Materials

Parent Materials	Soils
Fluvio-glacial gravels of Weichsel Age composed mainly of limestone with some sandstone and granite	Athy Complex
Fluvio-glacial gravels of Weichsel Age composed of limestone with granite, greenstone, mica-schist and sandstone	Broughillstown Complex
Fluvio-glacial gravels of Saale Age (?) composed of limestone, mica-schist, granite and sandstone	Acaun
Granite bedrock	Knocksquire, Ballytarsna, Blackstairs, Carrigvahanagh
Carboniferous shale bedrock	Ridge, Keeloge
Carboniferous flagstone bedrock	Ridge Flaggy Variant, Tomard
Shale with mica-schist in places	Ballindaggan, Black Rock Mountain
Lake alluvium, base-poor	Millquarter
River alluvium, base-rich	River Burren, Kilmannock
River alluvium, base-poor	Clohamon

APPENDIX III

DEFINITION OF TERMS USED IN PROFILE DESCRIPTIONS*

Texture

Soil texture refers to the relative proportions of the various size particles in the mineral fraction of a soil. More specifically, it refers to the relative proportions of clay, silt and sand in the mineral material of less than 2 millimeters in diameter. Texture, which is one of the more important of the soil's physical characteristics, influences such factors as moisture retention, drainage and tilling properties of soils, their resistance to damage by stock and heavy machinery, and earliness of crop growth.

Classes of texture are based on different combinations of sand, silt and clay; the proportions of these are determined by mechanical analyses in the laboratory. The basic textural classes in order of increasing proportions of the finer separates are sand, loamy sand, sandy loam, loam, silt-loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay and clay. Definitions of the basic classes in terms of clay (less than 0.002 mm.), silt (0.002 to 0.05 mm.) and sand (0.05 to 2.0 mm. diameter size) are presented in graphic form (Figure 18).

Field Estimation of Soil Textural Class

The estimation of soil textural class is made in the field by feeling the moist soil between the fingers. The field estimation is checked in the laboratory. In arriving at an estimation in the field the following considerations are taken into account.

Sand: Sand is loose and single grained. The individual grains can readily be seen and felt. Pressed when moist, a weak cast may be formed which easily crumbles when touched.

Sandy loam: A sandy loam contains much sand but has adequate silt and clay to make it somewhat coherent. If squeezed when moist, a cast can be formed that bears careful handling without breaking.

Loam: A loam has roughly equal proportions of sand, silt and clay. If squeezed when moist, a cast is formed which can be handled quite freely without breaking.

5/7/ *loam:* A silt-loam comprises a moderate amount of sand, a relatively small amount of clay with over half the particles of silt size. A cast can be formed which can be freely handled without breaking, but when moistened and squeezed between thumb and finger it does not 'ribbon' but gives a broken appearance.

Clay loam: A clay loam contains more clay than a loam and usually breaks into

•The terms and definitions used here are essentially those of the Soil Survey Manual, U.S.D.A. Handbook No. 18, Washington, D.C., 1951.

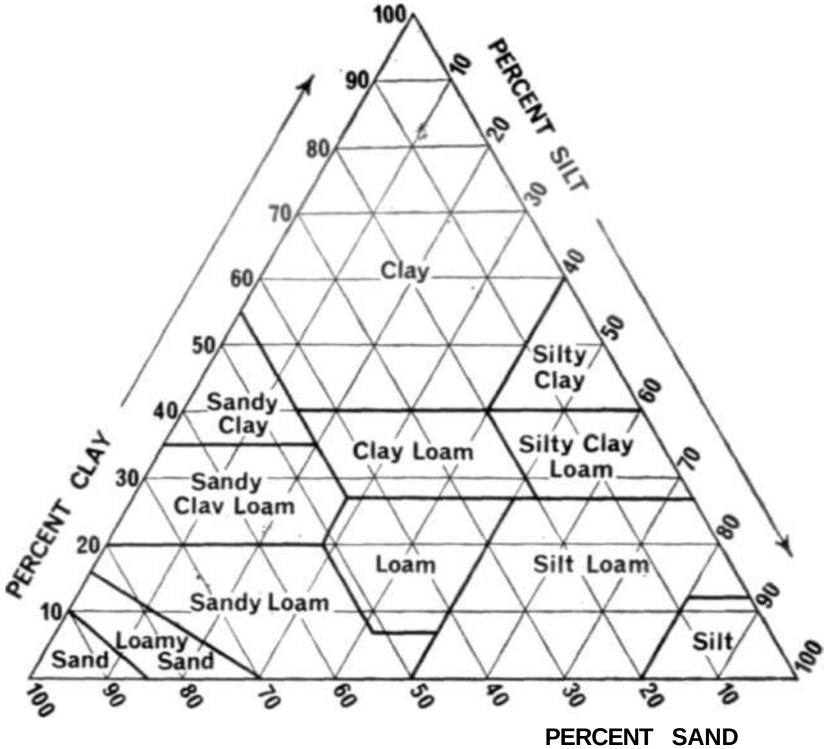


Fig. 18—*Chart showing the percentages of clay (less than 0.002 mm) silt (0.002 to 0.05 mm) and sand (0.05 to 2.0 mm) in the basic soil texture classes (After Soil Survey Manual, U.S.D.A, Handbook No. 18, Washington, D.C., 1951).*

clods or lumps that are hard when dry. In the moist state it is plastic and can be formed into a cast which can withstand considerable handling. When kneaded in the hand, it does not crumble readily, but tends to work into a heavy compact mass.

General terms		*Basic soil texture class*
Sandy Soils	Coarse-textured soils	Sands Loamy sands
	Moderately coarse-textured soils	Sandy loams
Loamy Soils	Medium-textured soils	Loams Silt loams Silts
	Moderately fine-textured soils	Clay loams Sandy clay loams Silty clay loams
Clayey Soils	Fine-textured soils	Sandy clays Silty clays Clays

Clay: A clay has a preponderance of the finer particles, contains more clay than a clay loam and usually forms hard lumps or clods when dry, but is quite plastic and sticky when wet. When pinched out between thumb and finger in the moist state it forms a long, flexible 'ribbon'.

General Grouping of Soil Texture Classes

Often it is convenient to refer to texture in terms of broad groups of textural classes. Although the terms 'heavy' and 'light' have been used for a long time in referring to fine and coarse textured soils, respectively, the terms are confusing as they do not bear any relation to the weight of soil; the terms arose from the relative traction power required for ploughing. An outline of acceptable terms is as follows:

Structure

Soil structure refers to the aggregation of primaiy soil particles into compound particles, which are separated from adjoining aggregates by surfaces of weakness. An individual natural soil aggregate is called a ped.

The productivity of a soil and its response to management depend on its structure to a large extent. Soil structure influences pore space, aeration, drainage conditions, root development and ease of working. Soils with aggregates of spheroidal shape have a greater pore space between peds, are more permeable, and are more desirable generally than soils that are massive or coarsely blocky.

Field descriptions of soil structure note the shape and arrangement, the size, and the distinctness and durability of the aggregates. Shape and arrangement of peds are designated as **type** of soil structure; size of peds, as **class;** and degree of distinctness, as **grade.**

Type

There are four primary types of structure:

(a) Platy—with particles arranged around a plane and faces generally horizontal.

(b) Prismlike—with particles arranged around a vertical line, and bounded by relatively flat vertical surfaces.

(c) Blocklike—with particles arranged around a point and bounded by relatively flat or curved surfaces giving a general block-like appearance. The ped surfaces here are accommodated to adjoining aggregates.

(d) Spheroidal—with particles arranged around a point and bounded by curved or very irregular surfaces that are not accommodated to the adjoining aggregates.

Each of the last three types has two subtypes.

Under prismlike, the two subtypes are prismatic (without rounded upper ends) and columnar (with rounded ends). The two subtypes of block-like are angular blocky (with sharp-angled faces) and subangular blocky (with rounded faces). Spheroidal is subdivided into gianular (relatively non-porous) and crumb (very porous).

Class

Five size classes are recognised in each type. The size limits of these vary for the four primary types given. A type description is generally qualified by one of the following class distinctions: very fine, fine, medium, coarse, very coarse.

Grade

Grade is the degree of aggregation or strength of the structure. In field practice, it is determined mainly by noting the durability of the aggregates and the relative proportions of aggregated and non-aggregated material when the aggregates are disturbed or gently crushed.

Terms for grade of structure are as follows:

0. *Structureless*—No observable aggregation. This condition is described as massive if coherent, and single grain if noncoherent.

1. *Weak*—Poorly formed indistinct peds which when disturbed break down into a mixture comprising some complete peds, many broken units and much non-aggregated material.

2. *Moderate*—Many well-formed, moderately durable peds that are not so apparent in the undisturbed soil. When disturbed, however, a mixture of many complete peds, some broken peds and a little non-aggregated material is evident.

3. *Strong*—Structure characterised by peds that are well formed in undisturbed soil, and that survive displacement to the extent that when disturbed, soil material consists mainly of entire peds, with few broken peds and little non-aggregated matei ial.

The appiopriate terms describing type, class, and grade of structure are combined in that order to give the structural description *e.g.* moderate, medium, sub-angular blocky; weak, fine crumb.

Porosity

Porosity of a soil is conditioned by the shape, size and abundance of the various crevices, passages and other soil cavities, which are included under the general name of soil pores. In this bulletin, porosity refers mainly to the voids between the soil structural units which is strictly the structural porosity. Soil porosity is influenced largely by type of structure; it is also influenced by rooting and by the acthity of earthworms and other macro-organisms.

Porosity determines, to a large extent, the permeability rate in the soil and the air to water ratio prevailing and is thus of considerable importance with regard to soil aeration and drainage regime.

Consistence

Soil consistence is an expression of the degree and kind of cohesion and adhesion, or the resistance to deformation and rupture that obtains in a soil. Interrelated with texture and structure, and strongly influenced by the moisture condition of the soil, this characteristic is most important in developing a good tilth under cultivation practices. On account of the strong influence of moisture regime, the evaluation of soil consistence is usually considered at three levels of soil moisture—wet, moist and dry.

Consistence When Wet

A. Stickiness: Stickiness expresses the extent of adhesion to other objects. To evaluate this feature in the field, soil material is pressed between thumb and finger and its degree of adhesion noted. Degrees of stickiness are expressed as follows;

0. Non-sticky: On release after pressure, practically no soil material adheres to thumb or finger.

1. Slightly sticky: After pressure, soil material adheies to thumb and finger but comes off one or the other rather clearly.

2. Sticky: After pressure, soil material adheres to both thumb and finger and tends to stretch somewhat and pull apart rather than pull free from either digit.

3. Very sticky: After pressure, soil material adheres strongly to both thumb and finger and is decidedly stretched when they are separated.

B. *Plasticity:* Plasticity is the ability to change shape continuously under applied stress, and to retain the impressed shape on removal of the stress. To evaluate in the field, the soil material is rolled between thumb and finger to form a 'wire'.

0. Non-plastic—no wire formable.
1. Slightly plastic—wire formable; soil mass easily deformed.
2. Plastic—wire foimable; moderate pressure required to deform soil mass.
3. Very plastic—wire formable; much pressure required to deform soil mass.

Consistence When Moist

To evaluate in the field, an attempt is made to crush in the hand a mass of soil that appears moist.

0. Loose—Non-coherent.

1. Very friable—Soil material crushes under very gentle pressure but tends to cohere when pressed together.

2. Friable—Soil material crushes easily under gentle to moderate pressure between thumb and finger, and tends to cohere when pressed together.

3. Firm—Soil material crushes under moderate pressure between thumb and finger, but resistance is distinctly noticeable.

4. Very firm — Soil material crushes under strong pressure but is barely crushable between thumb and finger.

Consistence When Dry

To evaluate, an air-dry mass of soil is broken in the hand.

0. Loose—Non-coherent.

1. Soft—Soil is fragile and breaks to powder or individual grains under very slight pressure.

2. Hard—Soil can be broken easily in the hands but it is barely breakable between thumb and finger.

3. Very hard—Can normally be broken in the hands, but only with difficulty.

Cementation

Cementation of soil material refers to a brittle, hard consistence caused by various cementing substances. Different degrees of cementation occur.

1. Weakly cemented: Cemented mass is hard but brittle and can be shattered in the hand.

2. Strongly cemented: Cemented mass is brittle but harder than that which can be shattered in the hand; it is easily shattered by hammer.

3. Indurated: Very strongly cemented; brittle; does not soften when moistened and is so extremely hard that a sharp blow with a hammer is required for breakage.

APPENDIX IV

CLASSIFICATION OF COUNTY CARLOW SOILS ACCORDING TO AMERICAN SYSTEM (7th APPROXIMATION)

In presenting the information collected in the course of the soil survey, it is desirable that the characteristics of the different soils and their relationships to one another be set forth in a systematic manner. In devising a system of soil classification, the requirements of those who apply the information in a practica[1] manner in various land use practices and of those interested in the scientific study of soils must be kept in mind.

In an attempt to meet the requirements of practical users, the main criterion followed in this Bulletin has been that of choosing a system of soil classification and nomenclature with which practical users are most familiar. For this reason, the system used is that which has been evolved principally in Europe and which has been commonly used in this country.

Scientific interests require more exact principles. The criteria used to distinguish classes of soils and the names used to identify these must be rigidly defined. While the older systems of classification satisfy these requirements in many cases, nevertheless, difficulties arise since the definitions and names of classes are often incomplete and can vary from country to country. In addition, the nomenclature used can be rather ambiguous; due to lack of precise definition and correlation, similar soils may be named differently or different soils may be included under the same class name.

In recent years a system of soil classification has been developed in the United States* in which it was attempted to correlate soils as a broad spectrum, to select and define the criteria to be used in distinguishing soil classes, to definte the limits of any property in a particular class and to establish a new terminology based on classical Greek and Latin roots. On account of the explicit definitions of soil classes, the new system provides a useful framework for correlating the soils with those of other countries and also for correlating the soils of County Carlow with those of other counties in the future.

The classification of the soils of County Carlow according to the new American system (7th Approximation) is shown in Table 1. The soils are confined to five Orders: Entisol, Inceptisol, Alfisol, Mollisol and Spodosol. These are further divided into Sub-Orders, Great Groups and, in most cases, Sub-Groups. Definitions of the various classes are available elsewhere* and are not given here.

At the Order level, soils of recent origin have been classified as Entisols. Included are the alluvial soils (except Clohamon Series) and the Carrigvahanagh lithosolic soil. The alluvial soils fall into the Sub-Order Aquent and Great Group Haplaquent;

no separation is made at the Sub-group level. The Carrigvahanagh Lithosol is separated from the alluvial soils at the Great Group level.

The Order Inceptisol includes soils which previously in this Bulletin have been called peaty Gleys and Gleys. It also includes all of the Brown Earths and the Clohamon Series of the allu\ial soils; the other alluvial soils are in the Order Entisols. The gley soils included are separated from the Brown Earths and Clohamon Series at the Sub-Order level, the former falling into the Aquepts and the latter into the Ochrepts. The peaty Gleys are separated from the other Gleys at the Sub-Group level. The Ochrepts are sub-divided into Eutrochrept and Dystrochrept Great Groups with the more base-rich Brown Earths falling into the former and the medium and low base-status Brown Earths into the latter. Further division is made in each of these Great Groups at the Sub-Group level.

TABLE 1: Classification of Soils according to American System: 7th Approximation

Order	Sub-Order	Great Group	Sub-Group	Series
Entisol	Aquent	Haplaquent		Millquarter, Kilmannock, River Burren.
		Cryaquent		Carrigvahanagh.
Inceptisol	Aquept	Umbraquept	Histic Umbraquept	Ballinrush, Belmount, Clowater, Raheenleigh.
			Orthic Umbraquept	Castlecomer.
			(Mollic) Umbraquept	Athy (Poorly drained).
		Ochraquept	Orthic Ochraquept	Coolnakisha, Moanduff.
	Ochrept	Eutrochrept	Aquic Eutrochrept	Athy (Imperfectly drained).
			Rendollic Eutrochrept	Athy (Shallow), Clohamon.
		Dystrochrept	Eutric Dystrochrept	Acaun, Ballytarsna, Keeloge, Broughillstown (Mod. deep).
			Orthic Dystrochrept	Ballindaggan, Borris.
Alfisol	Aqualf	Albaqualf	Orthic Albaqualf	Parknakyle, Toberbride.
			Mollic Albaqualf	Seskinrea
		Ochraqualf	Mollic Ochraqualf	Greenane.
			Orthic Ochraqualf	Ballywilliam, Newtown
	Udalf	Typudalf	Aquic Typudalf	Ballinabranagh.
			Orthic Typudalf	Kellistown, Mortarstown, Paulstown, Rathvinden.
		Glossudalf	Orthic Glossudalf	Athy (Mod. deep).
Mollisol				Broughillstown (Shallow).
Spodosol	Aquod	Ferraquod	Orthic Ferraquod	Tomard.
		Placaquod	———	Blackstairs, Black Rock Mountain.
	Orthod	Typorthod	Orthic Typorthod	Clonegall, Knocksquire, Ridge (Flaggy Variant) Ballinagilky.
			Entic Typorthod	Kiltealy, Ridge.

The Order Alfisol includes those soils previously called Grey-Brown Podzolic and some which were called Gley. In this Order natural drainage differences are distinguished at the Sub-Order level, the Gley falling into the Aqualfs and the well-drained Grey Brown Podzolics into the Udalfs. There is further sub-division of the Aqualfs at the Great Group and Sub-Group levels. At the Great Group level within the Udalfs the Athy Grey-Brown Podzolic is separated from the others, and the latter are further divided at the Sub-Group level to cater for more minor differences obtaining.

The Order Mollisol includes soils that have a mollic epipedon. Only the shallow component of the Broughillstown Complex falls into this Order.

The Order Spodosol includes all the soils which have been previously classed Podzol and Brown Podzolic. The brown podzolic soils are all in one Sub-Order (Orthod) and in one Great Group (Typorthod) but are split at the Sub-Group level into Orthic and Entic Typorthods. The Podzols, with the exception of the Ballinagilky Series, are in the Sub-Order Aquod but thereafter are divided into Ferraquods and Placaquods at the Great Group level; Ballinagilky Series falls into the Sub-Order Orthods with the Brown Podzolics and continues with them into the Great Group, Typorthod.

/

APPENDIX V

FOREST—PRODUCTIVITY INVESTIGATION ON SOME COUNTY CARLOW SOIL SERIES*

Site Classification

Site productivity is classified by Yield Classes. These are determined by a top-height for age relationship for each species. Yield-class tables have been produced by the British Forestry Commission for most species and weie used in compiling the results of the investigation. In the case of *Pinus contorta,* however, the yield tables prepared by the Forestry Division were used; these cover the coastal variety of *contorta* pine and are more applicable to Irish conditions than the British Forestry Commission tables, which cover the inland variety. The tables of the Forestry Division are based only on crops up to 35 years of age so that the derived yield-classes are provisional.

On any one soil series a number of yield-classes may normally be found. This is due to factors other than soil which affect site productivity; these would include elevation, exposure, aspect and drainage. When interpreting the results it must be understood that not only are the *contorta* tables provisional but the British Forestry Commission tables have not been fully tested for this country; howexer, since no other tables are available these provide the only basis for classifying site productivity.

Explanatory note on the Yield-Class Tables

When a crop is rated as having a yield-class 220, it means that the actual or potential maximum mean annual increment is 220 Hoppus feet† per acre. In Figure 19 the relationship of mean annual increment (total crop yield to date divided by the number of years to date) and current annual increment (increase in yield between the beginning and end of the growing season) to age and growth is shown.

The point at which the two graphs cross (Fig. 19) indicates where the mean annual increment is at a maximum. Here this occurs at X years of age. Consequently when a crop is rated as yield-class 220, it means that at X years of age it will have reached its maximum mean annual growth increment of 220 Hoppus feet per acre. For crops less than X years of age the potential maximum mean annual increment will be 220 Hoppus feet per acre. The yield-classes are divided by intervals of 20 Hoppus feet

*This contribution was prepared by Research Officers of the Forestry Division (Research Branch), Department of Lands, whose co-operation is gratefully acknowledged.

†The Hoppus foot is the unit normally used in measuring the cubic content of round timber in this country. One Hoppus foot = 1.273 cubic feet (true measure).

so that yield-class 220 is superior to yield-class 200. The advantage of yield-class as a measure of site producthity is that ratings for all species are comparable.

It should be noted that the Forestry Division's *contorta* tables show larger productivity gaps between the yield-classes since they are converted from quality-class tables.

For those not familial with forest productivity norms, the optimum yield-classes of the conifers discussed are as follows: Scots Pine, 160; *Contorta* Pine, 160; Sitka Spruce, 280; Norway Spruce. 240: European Larch, 140; Japanese Larch, 160.

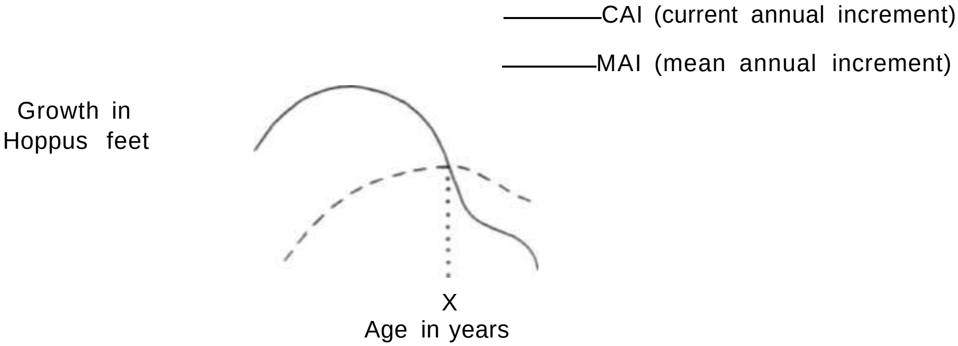


Fig. 19—*MAI (mean annual increment) and CAI (current annual increment) graphed against age and growth.*

Yield-Class Assessment for Standing Crops*

Ballindaggan Series

These soils are Acid Brown Earths derived from shale with some mica-schist influence: they occur on moderate to steep slopes and at elevations above 700 feet O.D.
Scots Pine: Yield-class 120 (Average).
Japanese Larch: Yield-class 120 (Average).

Borris Series

These soils are Acid Brown Earths derived from glacial till mainly of granitic origin. They occur on moderate slopes and at elevations about 400 feet O.D.
Norway Spruce: Yield-class 220 (Average).
Scots Pine: Yield-class 160 (Average).
European Larch: Yield-class 80 (Average).
Sitka Spruce: Yield-class 200 (Average).

Kee/oge Series

These soils are Brown Earths of low to medium base status derived from Carboniferous shales. They occur on steep slopes and at elevations about 750 feet O.D.
Norway Spruce: The principal species planted on the Keeloge series is Norway

The forests examined and the soil series represented in each are listed at the end of this section.

Spruce. Yield-class 200 is a good average rating of site productivity. Since the terrain is unusually steep, variation occurs in top-height trees.

Japanese Larch: The differences in top-heights between trees at the top and those at the bottom of the slope are much more significant in the Japanese Larch than in the Norway Spruce. The larch at the top of the slope has a yield-class rating of 80 compared with 140 at the bottom. The area carries a heavy competing vegetation and the larch on the more fertile bottom slopes seems to be more competitive.

Clonegall Series

These soils are Brown Podzolics derived from glacial till composed of shale, granite and some mica-schist. They occur on moderate slopes and at elevations about 300 feet O.D.

Japanese Larch: Yield-class 80 (Average).

Scots Pine: Yield-class 120 (Average).

Sitka Spruce: Yield-class 200 (Average).

Blackrock Mountain Series

These soils are peaty ironpan Podzols derived from shattered mica-schist bedrock. They occup on steep slopes and at elevations about 1,000 feet O.D.

5/7*ka Spruce:* Average yield-class rating is 140. Sitka spruce shows considerable variation on this series with a minimum rating of 80 and a maximum of 200.

Japanese Larch: Yield-class 80 (Average).

Scots Pine: Yield-class 120 (Average).

Pinus Contorta: Yield-class 110.

Blackstairs Series

These soils are peaty ironpan Podzols derived from shattered granite bedrock. They occur on steep slopes and at elevations about 900 feet O.D.

The area investigated was Coonogue Wood, Borris Forest, which occur ies approximately 20 acres. Because of steep slopes and rock outcrops, the general development of all species is patchy with crops on the lower slopes significantly better than those on the upper slopes.

On the upper slopes *Pinus contorta* has a yield-class iating of 110, Douglas Fir has an average of 140 but Japanese Larch has not been successful at all. On the lower slopes Norway Spruce has an average rating of 140 and Sitka Spruce of 180.

Tomard Series

These soils are gleyed Podzols derived from shattered Carboniferous flagstone bedrock. They occur on gentle slopes and at elevations about 950 feet O.D.

Sitka Spruce: The area investigated here was only 5 to 6 acres. Sitka Spruce is the main species planted. The top-height trees indicate an average yield-class for the area of 240. There is some variation in yield-class ranging from a minimum of 200 to a maximum of 280.

Pinus Contorta: Yield-class 110.

Belmount Series

These are very poorly drained, peaty gley soils derived from glacial till mainly of granitic composition. They occur on gentle slopes and at elevations about 450 feet O.D.

Norway Spruce: Yield-class 180 (Average).
Scots Pine: Yield-class 100 (Average).

Castlecomer Series

These are poorly drained gley soils derived from Carboniferous (Coal Measure) shale and sandstone drift materials. They occur on gentle slopes and at elevations about 800 feet O.D.

Sitka Spruce: This is the only species growing on the Castlecomer Series: it has an average yield-class of 140. However, there is some variation in site productivity over the area investigated (8 to 9 acres), which is hardly suflfcient to provide a true measure of the site productivity of the entire series.

Seskinrea Series

These are very poorly drained gley soils derived from Carboniferous (Coal Measure) shale and sandstone drift materials. They occur on gentle slopes and at elevations about 850 feet O.D.

Sitka Spruce: This species is most common on the Seskinrea Series. Yield-class throughout the series is uniform. Top-height trees indicate that 91 per cent of the Sitka Spruce crops have yield-class ratings of 180 to 200.

Norway Spruce: A yield-class calculated for Norway Spruce stands on this series averaged 160.

Pinus Contorta: Crops of the coastal variety on this series have a yield-class rating of 160 which is considered a top site productivity for the species.

Cutaway Bog

This is the transitional type peat. Sitka Spruce is the principal species planted. As indicated by 70 per cent of the top-height trees, most of the spruce crop is in the yield-class 160 to 180, and there is little variation throughout the area investigated. *Pinus Contorta* (Coastal Var.) has a rating of 160.

Forests Examined and the Soil Series Represented in Each

Rossmore Forest (Rossmore Property)

Keeloge Series:	Compts. 26-29, 57.
Cutaway Bog:	Compts. 46-50.
Seskinrea Series:	Compts. 17-21, 23-24, 32, 40-43.
Castlecomer Series:	Compt. 21 (partly).
Tomard Series:	South-east projection of Coirnt. 32.

Bunclody Forest (Kilbranish Property)

Black Rock Mountain Series:	Compts. 24-42, 44-49, 59, 65-66, 69-70.
Clonegall Series:	Compts. 57, 62-64.
Ballindaggan Series:	Compts. 4, 9-10, 12, 51-54.

Tinahely Forest

Borris Series:	Compt. 1.
Blackstairs Series:	Compts. 2, 18-19.

Borris Forest (Raheenkyle Property)

Clonegall Series:	Compts. 6-10.
Black Mountain Series:	Compts. 1-4, 11.

Coonogue Wood Property

Blackstairs Mountain Series:	Compts. 13-15.

Clonegall Forest {Ballintemple Property)

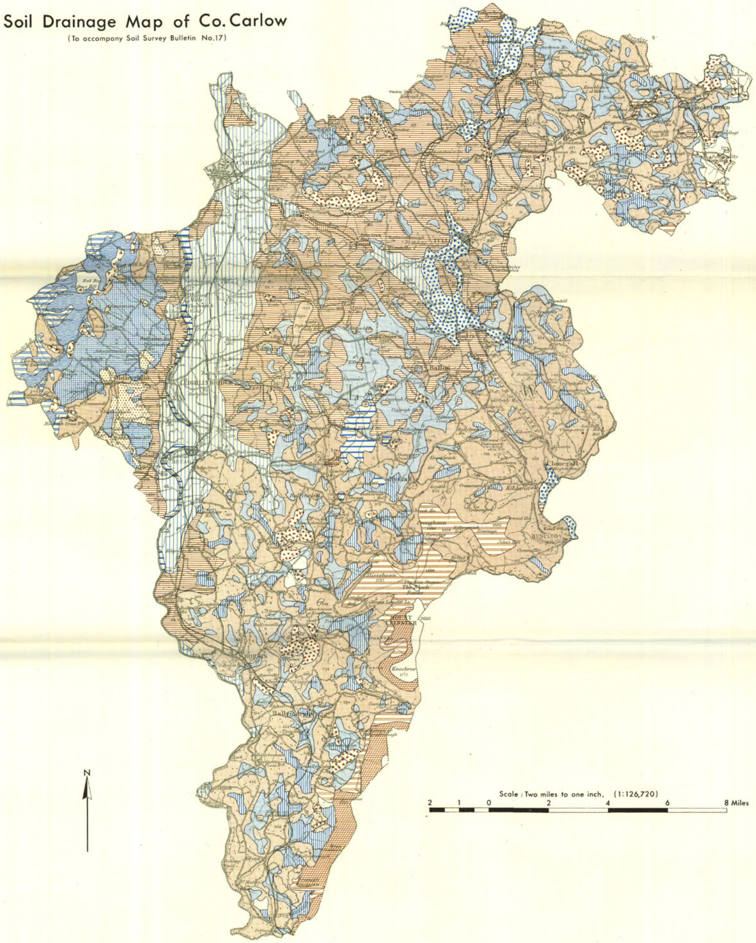
Borris Series:	Compts. 1-15.
Belmount Series:	Compts. 1-5.

Soil Series Index

NATIONAL SOIL SURVEY OF IRELAND

Soil Drainage Map of Co. Carlow

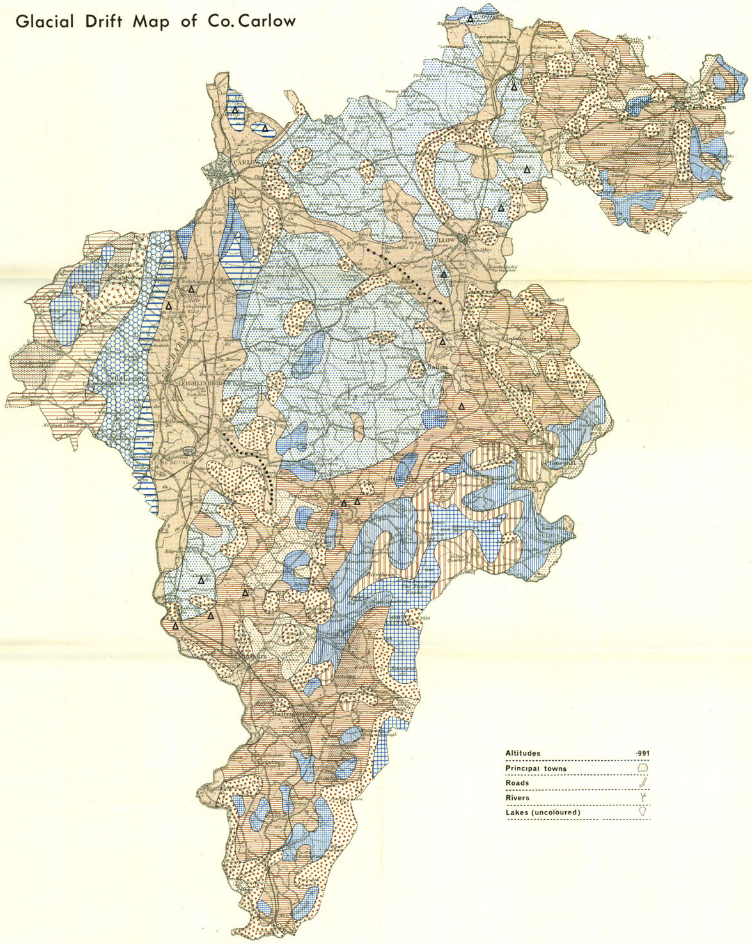
(To accompany Soil Survey Bulletin No.17)



MAP SYMBOL	NATURAL DRAINAGE CLASS	CONDITIONING FACTORS	PER CENT OF TOTAL AREA
	Excessively drained	Rapid run-off.	1·54
	Well drained	Moderate to rapid permeability, deep water-table.	33·98
		Moderate permeability, deep water-table.	21·56
		Moderate to rapid permeability, periodic very high water-table.	0·27
	Imperfectly drained	Moderate to slow permeability, water seepage, deep water-table.	0·70
		Moderate permeability, springs and water seepage, seasonal high water-table.	2·42
		Moderate to slow permeability, periodic very high water-table.	0·26
		Moderate permeability, deep water-table.	0·70
		Slow permeability (ironpan), deep water-table.	2·78

MAP SYMBOL	NATURAL DRAINAGE CLASS	CONDITIONING FACTORS	PER CENT OF TOTAL AREA
	Poorly drained	Very slow permeability, water seepage, deep water-table.	2·80
		Very slow permeability, deep water-table.	0·96
		Slow to very slow permeability, seasonal very high water-table.	0·91
		Moderate permeability, springs and water seepage, seasonal high water-table	11·95
	Very poorly drained	Moderate permeability, springs and water seepage, seasonal high water-table.	4·93
		Very slow permeability, seasonal high water-table.	1·09
	Variable drainage	Moderate to rapid permeability, seasonal high water-table in places.	9·82
		Moderate to rapid permeability, deep water table.	2·16
	Unclassified.	————	1·17

Glacial Drift Map of Co. Carlow



BEDROCK RUBBLE

- Shale and Sandstone
- Schist / Slate
- Granite

GLACIAL TILL, mainly

- Shale and Sandstone
- Shale and Sandstone with Limestone
- Limestone
- Limestone with Granite
- Granite
- Schist / Slate with Granite

FLUVIO—GLACIAL GRAVEL, mainly

- Limestone
- Granite / Schist

POST—GLACIAL

- River Alluvium
- Blanket Peat
- Transitional and Fen Peat

- Δ Moraine drift
- Soliflucted drift
- Esker

Based on Drift Maps of Geological Survey.

Surveyed by C.R. Aldwell and M. O'Meara.

Soil surveyed by M. J. Conry. Head of National Soil Survey, Dr. P. Ryan.
Cartography by J. Lynch and V. Staples.

Copies of this map and bulletin available from Publications Section, An Foras Talúntais, 33 Merrion Road, Dublin, 4. Price: Thirty shillings.

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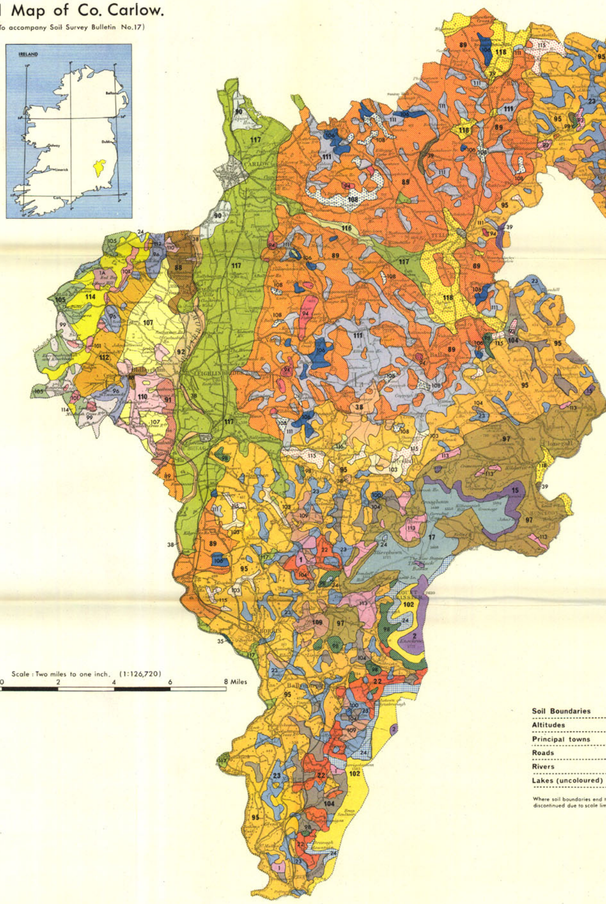
Printed at the Ordnance Survey Office, Dublin. August 1967.

NATIONAL SOIL SURVEY OF IRELAND

Soil Map of Co. Carlow.

(To accompany Soil Survey Bulletin No.17)



Scale: Two miles to one inch. (1:126,720)

2 1 0 2 4 6 8 Miles

Soil Boundaries	
Altitudes	·991
Principal towns	
Roads	
Rivers	
Lakes (uncoloured)	

Where soil boundaries end thus> delineation is discontinued due to scale limitations

GREAT SOIL GROUPS	Grey—Brown Podzolics					Brown Earths					Brown Podzolics				Podzols				Lithosol
SERIES	88 Ballinabranagh	89 Kellistown	90 Mortarstown	91 Paulstown	92 Rathvinden	93 Acaun	15* Ballindaggan	94 Ballytarsna	95 Borris	96 Keelogs	97 Clonegall	22 Kiltealy	98 Knockquire	99 Ridge	100 Ballinagilky	17 Black Rock Mountain	24 Blackstairs	101 Tomard	102 Carrigvahanagh
PER CENT OF TOTAL AREA	0·63	19·69	0·40	0·41	0·43	0·23	0·42	0·42	22·73	0·60	6·10	2·01	0·77	0·70	0·34	1·88	0·90	0·36	1·54

GREAT SOIL GROUPS	Gleys														Regosols			
SERIES	103 Ballinrush	23 Ballywilliam	104 Belmount	105 Castlecomer	106 Clowater	107 Coolnakisha	108 Greenane	109 Knockmullgurry	110 Moanduff	111 Newtown	112 Parknakyle	113 Raheenleigh	114 Seskinrea	115 Tobarbride	38 Millquarter	39 Clohamon	35 Kilmannock	116 River Burren
PER CENT OF TOTAL AREA	0·40	5·69	2·94	0·96	0·81	1·59	0·76	1·66	0·70	5·45	1·21	0·78	1·09	0·81	0·90	0·27	0·01	0·26

*Numbers out of sequence represent soil series already mapped in Co. Wexford.

117 Athy Complex	118 Baughillstown Complex	1 Basin Peat	1A Transitional Peat	2 Hill Peat
9·82	2·16	0·22	0·54	0·41

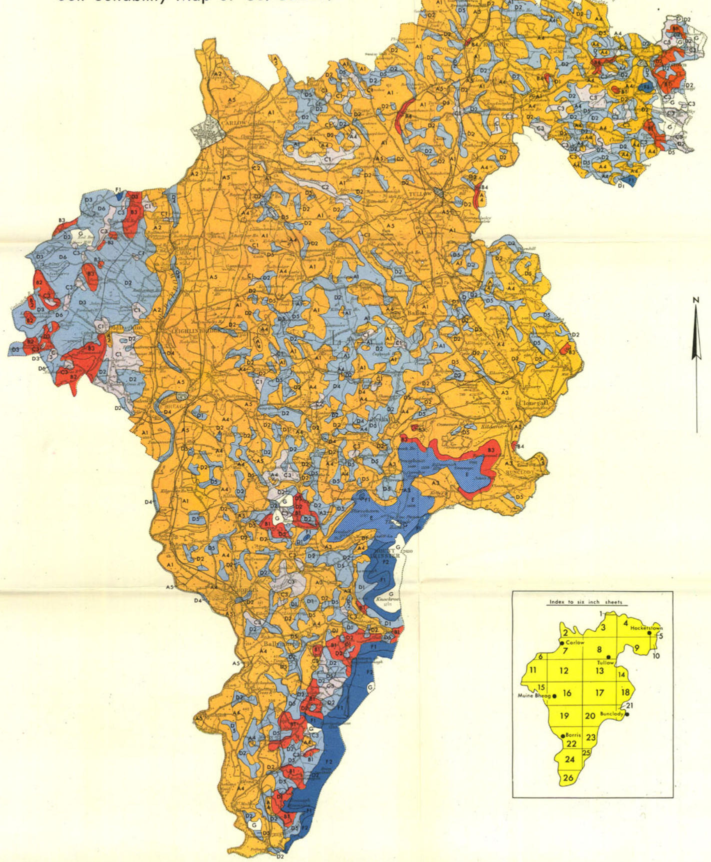
MAP SYMBOL	SUITABILITY CLASS *	Use-Range	Type of Limitations**	Per cent of total Area
A1	SUITABLE FOR TILLAGE, PASTURE, MEADOW AND FORESTRY.	Wide use-range	Local anomalies in soil molybdenum levels.	19·69
A2			Pastures somewhat liable to poaching.	1·87
A3			Moisture deficit in very dry periods.	6·10
A4			Moisture deficit in very dry periods, cobalt deficiency.	23·38
A5			Moisture deficit in places in dry periods, crops mature unevenly.	11·98
B1	MODERATELY SUITABLE FOR TILLAGE, PASTURE AND MEADOW; SUITABLE FOR FORESTRY.	Moderately wide use-range	Particularly low nutrient status; cobalt deficiency; moisture deficit in very dry periods.	2·01
B2			High elevations; moisture deficit in very dry periods.	0·70
B3			Somewhat high elevations and steep slopes; moisture deficit in very dry periods.	1·02
B4			Periodic flooding.	0·27
C1	MODERATELY TO POORLY SUITABLE FOR TILLAGE; MODERATELY SUITABLE FOR PASTURE, MEADOW AND FORESTRY.	Somewhat limited use-range	Impeded drainage; adverse physical conditions; liable to poaching.	1·46
C2			Periodic flooding; adverse physical conditions; liable to poaching.	0·26
C3			Particularly low nutrient status; impeded drainage; cobalt deficiency; somewhat high elevations.	2·36

MAP SYMBOL	SUITABILITY CLASS	Use-Range	Type of Limitations	Per cent of total Area
D1	POORLY SUITABLE FOR TILLAGE; MODERATELY TO POORLY SUITABLE FOR PASTURE AND MEADOW; MODERATELY SUITABLE FOR FORESTRY.	Limited use-range	Particularly low nutrient status; rockiness; somewhat high elevations; cobalt deficiency.	0·77
D2			Serious drainage problem; adverse physical conditions; liable to severe poaching.	13·54
D3			Serious drainage problem; adverse physical conditions liable to severe poaching; high elevations.	2·17
D4			Serious drainage problem; adverse physical conditions; liable to severe poaching; periodic flooding.	0·91
D5			Very serious drainage problem; adverse physical conditions; liable to severe poaching.	4·93
D6			Very serious drainage problem; adverse physical conditions; liable to severe poaching; high elevations.	1·09
E	UNSUITABLE FOR CULTIVATION, MEADOW, OR INTENSIVE GRAZING; MODERATELY SUITABLE FOR FORESTRY AND EXTENSIVE GRAZING.	Very limited use-range	Particularly low nutrient status; iron-pan formation; impeded drainage; high elevations and moderately steep slopes; cobalt deficiency.	1·88
F1	UNSUITABLE FOR CULTIVATION, MEADOW, OR INTENSIVE GRAZING; MAINLY UNSUITABLE FOR FORESTRY; MODERATELY TO POORLY SUITABLE FOR EXTENSIVE GRAZING.	Extremely limited use-range	Particularly low nutrient status; iron-pan formation; impeded drainage; high elevations and moderately steep slopes; rockiness; cobalt deficiency.	0·90
F2			Particularly low nutrient status; high elevations and steep slopes; extreme rockiness.	1·54
G	UNCLASSIFIED.	———	———	1·17

* In making this classification a high standard of management practices (including lime and fertiliser amendments, as required) is assumed. Limited areas of certain series within a class may more exactly fit into one of the other suitability classes.

**Limitations noted here refer mainly to physical soil problems under existing conditions. Inadequate natural nutrient status is a major limitation in most of the soils and many need liming.

Soil Suitability Map of Co. Carlow.



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