D Mackney Land - Class

S O I L   S U I T A B I L I T Y   M A P P I N G   S T U D I E S
I N   I R E L A N D

J. Lee
An Foras Taluntais, Johnstown Castle, Wexford

M.A.F.F., A.D.A.S. Lands Arm Research Group Training Conference, Queens College, University of Cambridge, October 1, 1974

INTRODUCTION

The objectives of soil surveys are both fundamental and applied. The fundamental objective is basically to expand our knowledge of the environment. This may have no immediate practical benefit. The major applied objective is the improvement of agriculture. We make the assumption that experience with a particular kind of soil in one place can be applied to that particular kind of soil wherever it exists if consideration is taken of any climatic difference.

The natural soil classification provides the ground-work for any practical classification devised to meet some practical objective. The soil survey through the system of classification adopted seeks essentially to isolate the disordered aspects of land into ordered spatial frameworks. We map the soils of a region to enable us to make more precise statements about the mapped subdivisions than we can make about the region as a whole. The objective is to categorise the region into areas of approximately similar land-use potential. The landscape is resolved into a number of units each defined as accurately as the knowledge available allows and as precisely as the mapping scale allows. Sometimes it is not the defined units which are mapped but groups of them i.e. soil associations in general reconnaissance mapping. However, in our systematic approach to the mapping of the soils of the country on a county basis the defined units which are soil series are mapped. These are morphologically relatively uniform and as will be illustrated in this paper, they provide a valuable pathway for extension of knowledge on soil productivity.

Our basic programme of land resource appraisal has operated at three levels of organization:

(1) Detailed studies of experimental stations and also extension experimental sites (1:2,500).

(2) Detailed reconnaissance studies of counties (1:126,720)

(3) A combination of detailed reconnaissance and general reconnaissance to arrive at a national picture (General Soil Map of Ireland 1969) (1:575,000).

The major emphasis in our soil survey programme is directed to detailed reconnaissance mapping on a county basis. Soil mapping is carried out on maps of 1:10,560 scale which are reduced to 1:126,720 for publication.

The main purpose of this presentation is to summarize some of the research findings on soil suitability in Ireland. The findings are based mainly on the results of research carried out in the soil survey department as part of the national programme of land evaluation.

QUALITATIVE APPROACH TO SOIL SUITABILITY ASSESSMENT

Tillage and grassland

This is essentially a classification of soils according to the potential use or uses to which they are most adaptable. It is based principally on the significance of the more permanent characteristics of the soil and is largely qualitative in nature. Although the permanent characteristics of the soil provide the basis for the classification, environmental factors such as elevation aspect and local climate are also considered.

The approach adopted can be best illustrated by giving an example from a recent soil survey publication (1).

Table 1: Suitability classification of soils of County Clare

Suitability Class		Sub Class		Percent of total area
Tillage*	Grassland**		Type of Limitation	
1	A	a	No serious limitations	2.44
		b	Occasional steep slopes	10.91
		c	Light texture	1.33
2	A	d	Shallow soil over calcareous till	3.63
		e	Somewhat shallow soil over bedrock	0.08
		f	Weak structure	6.09

Table 1 contd.

Suitability Class		Sub Class		Percent of total area
Tillage*	Grassland**		Type of Limitation	
3	A	g	Weak structure, moderate drainage	0.52
3	B	h	Shallow soil over bedrock, liable to drought	0.17
		j	Some steep slopes, weak structure, low base status	0.57
		k	Moderate drainage, weak structure, severe wind exposure	0.94
3	C	m	Poor drainage, weak structure, heavy texture	5.47
4	C	n	Weak structure, liable to floods	0.07
		o	Weak structure, heavy texture, poor drainage	1.89
4	D	p	Poor drainage, weak structure	23.70
		q	Very light texture	0.09
5	B	r	Many boulders	1.82
5	E	s	Heavy texture, weak structure, liable to floods	0.25
		t	Many boulders, weak structure, some steep slopes, low base status	0.17
		u	Weak structure, high altitudes, some steep slopes	0.23
		w	Very shallow soil over bedrock, liable to drought	9.66
		x	Alkalinity, trace element problems, light texture	0.16
6666		y	Weak structure, some steep slopes, low base status, peaty surface	0.36
[1]Variable		v		9.37
Unclassified (Mostly peat)		z		20.06

* Tillage 1 = Very Good 2 = Good 3 = Moderate 4 = Poor 5 = Very Poor

** Grassland A = Very Good B = Good C = Moderate D = Poor E = Very Poor

[1]Areas described as variable are soil complexes. They are generally of poor suitability for tillage or grassland in County Clare.

A number of soil series is included in each suitability class. Although there may be diversity in the type of limitation applicable to soils within any suitability class, nevertheless, the soils in any one class have sufficient important characteristics in common in their use potential to warrant their inclusion in the same class. The type of limitation is specified at sub-class level and the geographic distribution of the sub-classes is shown on the soil suitability map.

In drawing up the classification only the normal or dominant phase of the soil series is considered. For instance, some of the series may contain small inclusions of soils that are too shallow or too rocky or that occur on slopes too steep for successful cultivation or management. Consideration is not given to these exceptions. In any system of classification involving multiple variables, it is not possible to fully accommodate all exceptions without impairing the purpose of the classification. Implicit in the classification is that the degree of limitation becomes more pronounced as one progresses down the scale of suitability classes. In addition, there is an implied quantitative hierarchial order in the grassland suitability classes intuitively derived from productivity information from benchmark experimental sites.

QUANTITATIVE APPROACH TO SOIL SUITABILITY ASSESSMENT

Wheat yield - soil series relationships

A study was carried out in Wexford (2) into the potential use of the series taxonomic unit of the soil classification scheme as an aid to the understanding of wheat yield distribution and quality differences.

Four contrasting soil series, Clonroche, Screen, Rathangan and Macamore were selected for study during 1964-'68. Brief details of these soils are given in Table 2.

Table 2: Details of soils selected for study

Series	Texture	Drainage	Classification
Clonroche	Loam	Well	Brown Earth (Entic Dystrochrept)
Screen	Coarse sand	Excessively well	Brown Podzolic (Entic Normorthod)
Rathangan	Loam	Poor	Gley (Orthic Fragaqualf)
Macamore	Sandy clay loam	Poor	Gley (Orthic Albaqualf)

Clonroche Series was subdivided into a southern area (Clonroche A) and a northern area (Clonroche B). The surface horizon is about 20 cms deeper in Clonroche A than in Clonroche B and whereas Clonroche B soils are stony below 25 cms, the deeper Clonroche A soils do not become stony until below 50 cms. These subdivisions would be separate taxonomic units in detailed mapping but such differences were not defined in the detailed reconnaissance survey (3).

Ten farms under a good level of management were selected on each soil series. Yields from the variety Atle were studied from 1964 to 1966. In 1967 the variety Quern was introduced on a large scale and it was necessary to study yields from this variety in 1967 and 1968. Harvestings were made at 10 random points in each field and yields calculated. The yield results are summarized in Table 3.

Table 3: Grain yields over all years from each soil series (tonne/ha)

Soil series	1964	1965	1966	1967	1968	Mean	CV (%)
Clonroche A	3.35	3.57	3.85	4.61	5.32	4.16	20.2
Clonroche B	2.99	2.78	4.16	4.94	5.81	4.13	30.4
Screen	2.68	2.80	3.62	4.66	5.48	3.84	31.3
Rathangan	2.36	2.79	3.28	4.22	4.86	3.50	33.0
Macamore	2.23	2.90	3.10	5.16	5.68	3.81	39.7

Over the 5-year period the mean yields from Clonroche A and B were similar. In 1964, 1965 and 1966 Clonroche A soils gave higher ($p < 0.01$) yields than did Rathangan and Macamore soils. In 1967, however, with the introduction of the variety Quern the yield pattern changed and Macamore soils had the highest yields. The yields on Rathangan soils were consistently low.

The substantially higher yields from Quern on all soils in 1967-68 contrast markedly with the 1964-66 yields from Atle. In 1967, there were no significant differences in yields between series and in 1968, Clonroche B and Macamore soils gave higher yields ($p < 0.01$) than did Rathangan.

Weather, rotation effects and wheat variety were complicating variables in assessing the soil factor. The coefficient of yield variation was lower for Clonroche A than for the other soils, indicating that yields from these soils were least sensitive to annual weather fluctuations. Under similar weather conditions the study showed that Clonroche and Screen soils were cultivated and sown earlier than the impeded Rathangan and Macamore soils and the former soils required less cultivation for seed bed preparation.

Wheat quality analyses showed that falling numbers and flour colour figures were better on the free-draining soils. The study indicated that the soil map permitted a more precise prediction of productivity than was previously possible.

Malting barley - soil factor relationships

Investigations are under way in the soil survey department into the possible effects of soil type on yield and quality of malting barley. The purpose of these investigations is to ascertain factors which might help to improve the quality and yields of the crop. Preliminary studies based on questionnaires which were carried out by An Foras Taluntais in co-operation with the Malsters and Advisory Officers, showed conclusively that the most important factor affecting quality, principally grain nitrogen, was the number of years that barley was grown after grass (minimum 3/4 years).

Not a suitable factor to show on maps

As the questionnaire survey progressed, an examination of the soil factors (soil type, solum depth, texture etc.) was also carried out to assess their possible effects on yield and quality. This study is continuing (4) and some preliminary findings are discussed here.

The following three soils were selected for study:

R = Moderately shallow; well to moderately well drained, medium to heavy loam increasing to clay loam in the B horizon; weak structure; free carbonates can be present throughout the profile; derived from Carboniferous Limestone glacial till (Ruptic Alfic Eutrochrept).

T_g = Shallow; well and excessively well drained, light to medium gravelly loams; slight textural increase in subsoil; free carbonates often present throughout the profile; derived from Carboniferous Limestone morainic sands and gravels (Rendollic Eutrochrept).

T_t = Shallow to moderately shallow, medium textured component of T_g

Some results of the study are shown in Table 4. Yields are based on sample harvestings from fields with standardized rotations (4/5 years after grass).

Table 4: Malting barley yields and quality in relation to soil type

Soil	Yield (kg/ha)		N (%)		1000 Corn Wt (g)		Headed Tillers/m^2	
	1972	1973	1972	1973	1972	1973	1972	1973
R	4013	3368	1.57	1.55	46.1	45.5	514	433
T_t	3467	3224	1.48	1.57	44.3	45.0	504	449
T_g	3711	3158	1.42	1.56	40.6	44.7	481	457

In 1972 there were significant differences for grain nitrogen and 1000 corn weight between T_g and R soils. No differences were significant in 1973. The interaction of soil and climate can partly explain the differing results between years.

T_g soils have lower Available Water Capacities (A.W.C.) than R soils. The deficit between rainfall and evapotranspiration gave an accumulated soil moisture deficit greater than A.W.C. for T_g soils from middle of July and from middle of August for R soils in 1972. The greater A.W.C.

8 missing

R. higher grain N
TG. lower grain N

Table 5: Number of sugar-beet loading areas in each soil association with average yields as indicated (average 1966-1968)

Soil association		yield category (t/ha)				
Soil assoc. No.	Principal soil in the association	<32.7	32.7-35.2	35.2-37.7	37.7-40.2	40.2-42.7
7	Acid Brown Earths (Dystrochrepts)	-	-	-	5	3
9	Brown Podzolics (Normorthods)	-	-	3	9	4
8	Acid Brown Earths (Dystrochrepts)	-	-	7	4	1
23	Shallow Brown Earths (Eutrochrepts)	-	2	4	2	-
24	Grey Brown Podzolics (Hapludalfs)	2	8	11	5	-
21	Grey Brown Podzolics (Hapludalf-Eutrochrept)	-	-	11	1	2
20,22	Grey Brown Podzolics (Eutrochrept-Glossudalf)	5	5	-	-	-
13	Gleys (Umbraquepts)	6	-	-	-	-

Fig. 1 shows the geographic distribution of yields in the country and Table 6 lists a number of climatic parameters which are considered representative of the yield zones.

The most outstanding feature of Fig. 1 is the decrease in yields which occur with latitude increase, also a tendancy for yields to decrease with decreasing maritime influence.

The three highest yielding areas (average 40.2-42.7 t/ha) occur on the southern coast. These areas have high sugar-beet densities and are characterised by well aerated, friable soils of adequate depth and of high suitability for tillage farming (Soils 7, 9 and 21)[1]. In general, the entire southern region of Ireland is high yielding (average 37.7-40.2 t/ha) and is characterised by soils (Soils 8 and 9) with similar properties to those outlined above.

The low yielding area on the western seaboard which averaged <32.7 t/ha grows few sugar-beet crops. In this area the crop is cultivated on

[1] Brief descriptive details of the soils of Ireland are given in the appendix together with a map showing their distribution.

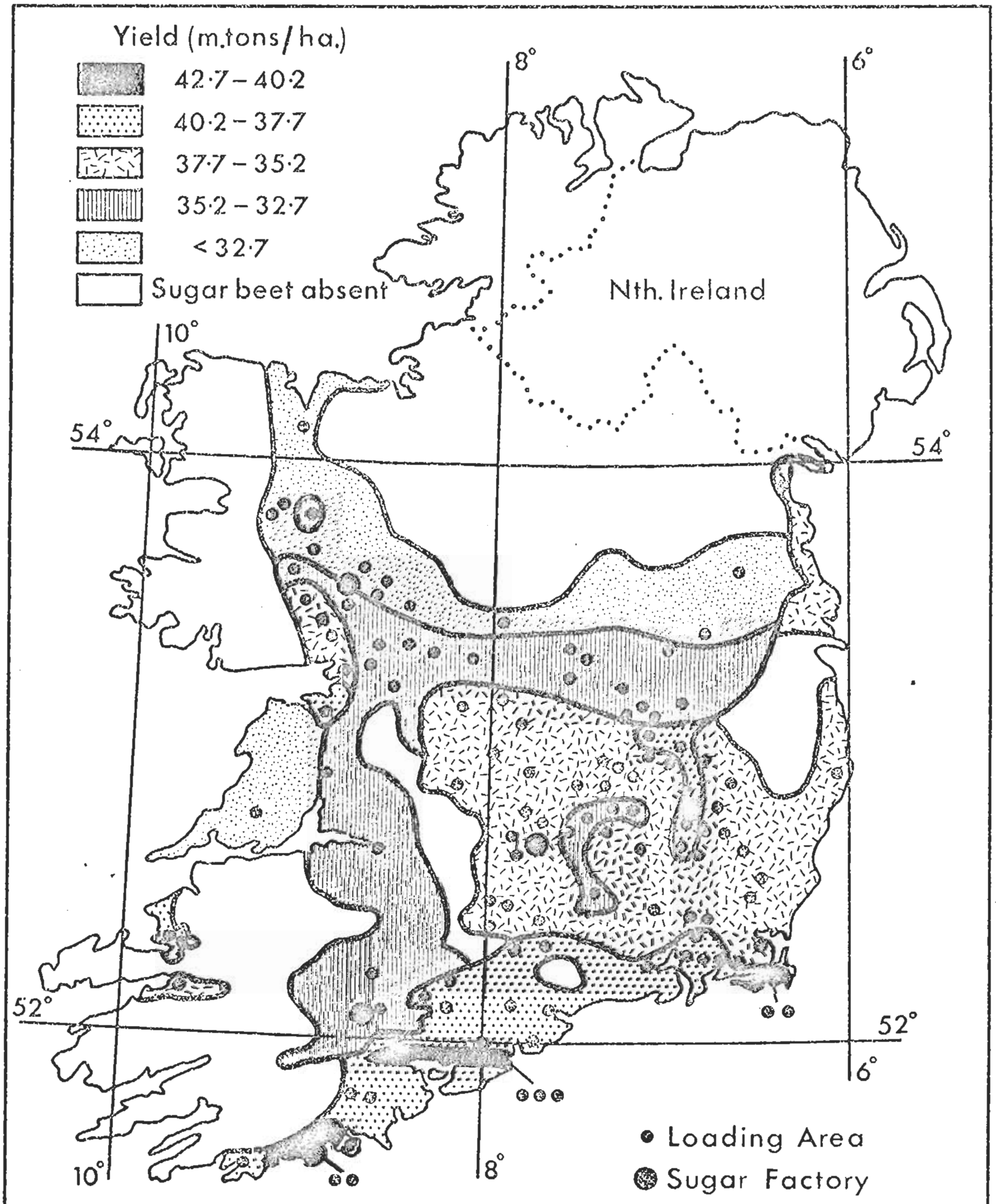


Fig.1: Geographic distribution of sugar beet yields in Ireland (average 1966–68)

Class 4 tillage soils (Table 1). The low yielding regions in the north midlands and to a lesser extent in the north-west also have few sugar-beet crops. The soils in these areas generally correspond with Suitability Class 3 (Table 1). Sugar-beet cultivated on Carboniferous Limestone derived soils 20, 21 and 24, in the Midland zone yield similarly. These soils are generally Classes 1 and 2 for tillage.

The average yield in the extensive south central and eastern area of the country was 35.2-37.7 t/ha. The soils in the south central area are generally similar to those in the Midlands. The soils in the eastern area have similar properties to those yielding 37.7-40.2 t/ha in the southern region but tend to be shallower.

The low-yielding zone (32.7-35.2 t/ha) in south central Ireland has impeded soils. The area is higher than 120 m O.D. The high yielding zone (37.7-40.2 t/ha) in the same general area is mainly on soil 20. These soils are well-drained, friable, gravelly, sandy loams of high base status. This area, which lies generally less than 65 m O.D. is one of the most intensively cultivated in the country (Class 1).

The relatively high yielding zone (35.2-40.2 t/ha) on the western seaboard is mainly Soil 23, which is well aerated and moderately structured with a high base status. The eastern extremity of this soil corresponds with the demarcation line with the Midland (32.7-35.2 t/ha) zone which comprises predominantly Grey Brown Podzolics. The high yielding area (37.7-40.2 t/ha) on the south western seaboard has a modified version of soil 24.

Southern coastal areas are about 1 month ahead of inland areas in accumulated growth potential by the end of April and over the March-September period (Table 6) have about a 10% advantage in growth potential over the lower yielding Midland areas. The friable, well aerated soils and higher spring temperatures undoubtedly favour early sowing and rapid growth.

More radiation in the southern areas means greater potential growth. Sugar-beet plants in southern areas reach a full leaf canopy quicker than

Table 6: Climatic parameters of major yield zones

Climatic parameter	yield zone (t/ha)				
	< 32.7	32.7-35.2	35.2-37.7	37.7-40.2	40.2-42.7
Accumulated degree days above 40°F (Feb.-Apr.)	430	480	-	-	520-570
Accumulated degree days above 40°F (Mar.-Sept.)	2625	2780	-	-	2900-2945
Mean daily global solar radiation (cals/cm²) (June)	430-440	440-460	450-500	450-500	490-520
Mean daily global solar radiation (cals/cm²) (June-Aug.)	370-390	380-400	400-420	410-430	420-450
Average growing season rainfall (mm) (Mar.-Sept.)	470-600	440-500	449-500	440-600	440-560
Mean date of last spring frost	May 15	May 1-May 15	Apr. 1-May 15	Mar. 15-May 1	Mar. 1-Mar. 15

in northern areas, and have a relatively larger leaf area index in June, when radiation is maximal. In the northern areas, plants reach maximum leaf area index later and therefore, the growth potential is less which limits dry matter production.

Sugar-beet yield - soil series relationship

A comparison was made of sugar-beet yields in County Wexford in 1964-1965 on Clonroche, Screen and Rathangan series (previously described) and Broadway series (well drained, Grey Brown Podzolic of sandy loam texture; Mollic Typudalf). As outlined earlier for the wheat study, Clonroche series was subdivided into A and B. Yields were studied on 10 well managed farms on each soil series. The results of this study have been published (6) and are summarized here. (Table 7)

There were significant root yield and sugar content differences between a number of series and the superior performance record of Broadway and Clonroche A soils was particularly notable. The yield differential between Clonroche A and B soils was also notable.

Climatic difference,

Table 7: Sugar yields (tonne/ha) by soil series 1964-1965

Soil Series		1964		1965		Mean sugar yield
		Sugar yield	Sugar percent	Sugar yield	Sugar percent	
Broadway		8.28	18.0	8.03	16.4	8.16
Clonroche	A	7.00	17.4	7.08	16.4	7.04
	B	5.15	16.2	5.30	15.9	5.23
Screen		5.60	16.2	5.62	16.0	5.61
Rathangan		4.84	16.9	5.55	15.8	5.20

is Rathangan suitable for sugar beet?

In 1964 most of the crops on Broadway series were sown before the second week in April. Sowing was on average 5 days later on Clonroche A soils, 10 days later on Clonroche B and Screen and 28 days later on Rathangan. Sowing dates were approximately the same in 1965 but because of more favourable weather conditions sowing was 20 days earlier on Rathangan soils.

While the proportion of the yield variance attributable to soil and climatic factors was not elucidated, it was recognised that Broadway and Clonroche A soils had a more favourable climatic environment than the remainder. The occurrence of Broadway series in the southeastern extremity of the country corresponds with one of the three highest yielding zones in Ireland (Fig. 1) which were shown on Table 6 to have a climatic advantage. It was concluded from the study that the soil series provided a valuable pathway for extension of knowledge on sugar-beet yields. The study also suggested that the climatic range of a soil series could be significant as evidenced by the superior performance record of Clonroche A compared to Clonroche B soils.

The work of partitioning the effects of soil and climate on yields was later developed (7,8) and some of the findings are included here. Yields were studied on Clonroche A and B soils over the 1965-'69 period. Mean sugar yields for the two soil regions were 7.35 and 5.97 t/ha respectively. The corresponding mean sugar percents were 16.5 and 16.1.

These results agreed substantially with the results obtained from the 1964-1965 study (Table 7). When the accumulated degree days above 42°F were compared for the two regions, it was shown that Clonroche A region had a 16% advantage over the April-December period and the advantage was approximately the same over the October-March period. Since neither area was shown to reach the varietal constant, i.e. the optimum number of degree days necessary in order that the crop would fully mature, it was concluded that Clonroche A had a 16% advantage in growth potential attributable to climate. By adjusting the measured yield for Clonroche B soils accordingly, it was shown that approximately 60% of the yield differential between the regions was attributable to climate and 40% attributable to soil factors. The results of this investigation illustrate the significance of climate when examining soil type -yield relationships particularly for crops with high varietal constants such as sugar-beet.

LAND EVALUATION FOR GRAZING LIVESTOCK

Production of grazing animals is the most important agricultural land-use enterprise in Ireland. As part of the soil survey programme, a comprehensive study was carried out to assess the potential of Irish land for livestock production (9). Some results of the study are presented here.

Approach adopted

Estimates of potential productivity were obtained from stocking rate experiments at the experimental stations of An Foras Taluntais and from dry matter output from cutting experiments on selected soils throughout the country.

The output data necessary for evaluation were extrapolated from these sites to analagous areas defined by soil and climate. The evaluation was based on the hypothesis that land or soil classes similar to those occurring on the experimental sites will respond similarly to management techniques for aminal production. The method, therefore, is based upon the concept of transfer by analogy.

The extrapolation of experimental data to the county at large was made possible by the publication of the Soil Map of Ireland (1:575,000) and as stated earlier the units on this map consisted of associations of Great Soil Groups. More precise predictions were possible for a number of counties (9) where the soil series was the categoric level of classification.

Pasture output - land quality relationships (lowland)

While it is outside the scope of this presentation to outline the findings obtained it is relevant to examine some of them.

Animal production experiments showed that stocking rates achieved without reducing the performance of individual animals ranged from 289 to 136 LU/100 ha. Stocking rate differences of this magnitude could not be attributed to differences in experimental techniques and, therefore, the explanation must be sought elsewhere.

A comparison was made of dairy production at Moorepark, Herbertstown and Mullinahone in relation to soil and climatic conditions. The experimental sites at Mullinahone and Herbertstown are located on Carboniferous limestone and consist of 65 and 40% wet land respectively which typify the wet component of Soil 24 (General Soil Map of Ireland). This land was artificially drained prior to the experiments. Moorepark provides data on the productive capacity of dry land.

Climatic data indicate that the growth potential of the south (i.e. Cork, Waterford, south Wexford areas) is greater than that of the midlands. This is supported by measurements of pasture dry matter production on many sites which indicate that 5 to 8% higher yields are obtainable in the south. On free-draining soils, pasture utilisation by animals should show similar differences.

The production levels achieved at these stations parallel the amount of wet land on the site; this relationship is illustrated in Fig. 2 and is based on applications of 48 kg and 230 kg N/ha with adequate phosphorus

(P) and potassium (K). Projections based on the above data show that one can expect to carry 212 LU on 100 ha of wet land with 230 kg N/ha and 173 LU with 48 kg N/ha (Fig. 2). This land is referred to as Class A wet land.

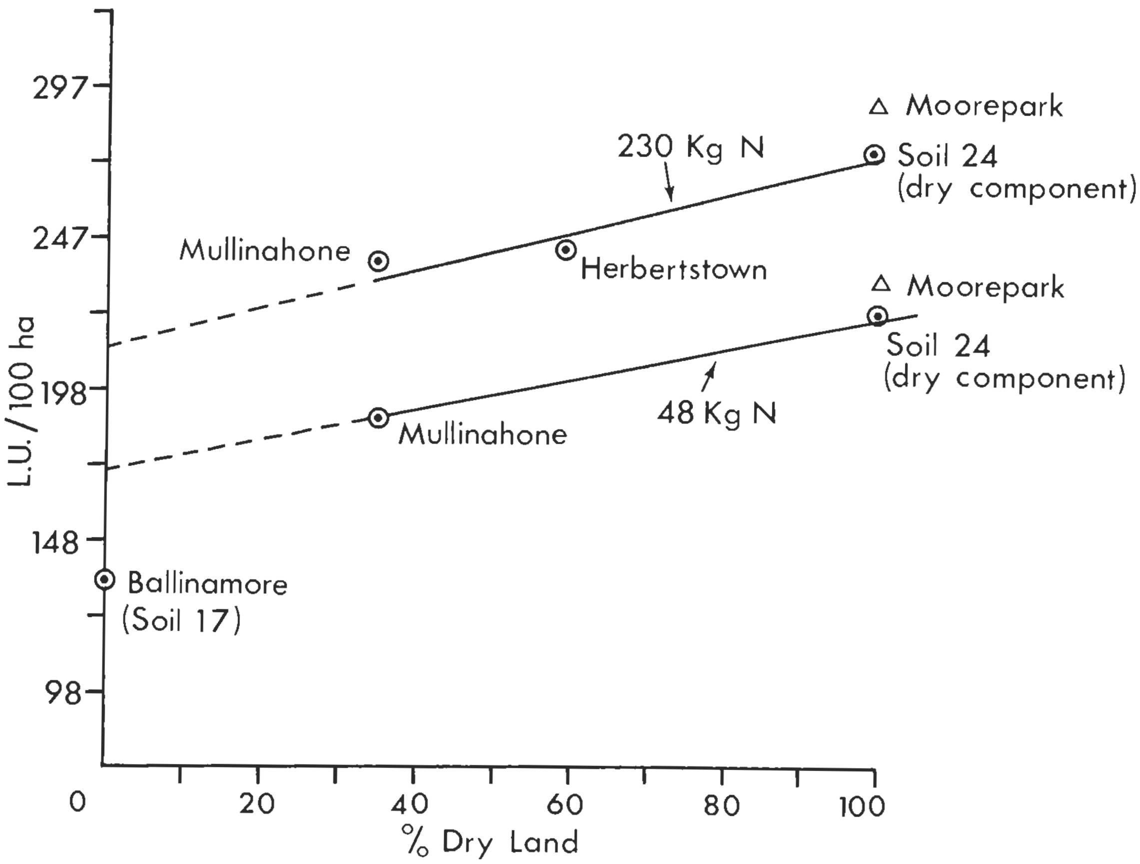
Research to date shows that the production capacity from the poorer (Class B) wet soils on carboniferous shales and drumlin areas (Soil 17, Fig. 2) is 136 LU/100 ha with low N application. There are no data available on animal responses to high N application on these soils but it is reasonable to speculate that the economics of high N use are doubtful in these areas.

The above data show that soil wetness is a major limitation in livestock intensification. At the other end of the scale, soil moisture stress is also a limitation but is of lesser magnitude. This is supported by level of pasture yields from light textured soils in the country. The light textured soils in the midlands gave 7% less pasture dry matter production than their heavier counterparts, while the Screen sandy soils in Wexford, which are the lightest in the country, produced 16% less than typical free-draining soils in the south of Ireland.

With such data it was possible to establish production targets for each of the 29 land units (excluding climatic and basin peat) shown on the Irish Soil Map and thus arrive also at a national target. These production targets were grouped into nine grazing capacity classes and their geographic distribution shown on a grazing capacity map.

The grazing capacity estimates derived were of necessity averages for the soil associations. Soil classification schemes are not structured to give information on the climatic environment. Grass or animal output/ha is determined by soil and climatic conditions and the treatment applied. The experimental treatments were defined and therefore the production from a soil is modified by the effect of climatic environment. A considerable part of climatic variation associated with altitude was excluded since the study was mainly confined to land below 150 m and therefore the climatic effects are mainly an expression of latitude and distance from sea.

Fig. 2: Stocking rate achieved under experimental conditions in relation to percentage dry land.



297
247
198
148
98
L.U./100 ha
0
20
40
60
80
100
% Dry Land
230 Kg N
48 Kg N
Moorepark
Soil 24
(dry component)
Mullinahone
Herbertstown
Moorepark
Soil 24
(dry component)
Mullinahone
Ballinamore
(Soil 17)

The grazing capacity estimates derived for the soil associations and series (Counties Wexford, Carlow, Limerick and Clare) were mainly a function of drainage regime with climate as an important determinant. There was scant information available on the effect of elevation and slope on carrying capacity and where these factors applied the grazing capacity estimates were reduced arbitrarily. However, few areas occurred above 225 m and the error due to elevation would be relatively small.

Grazing capacity of the lowland mineral soils

The grazing capacity estimates derived for each soil association are shown in Table 8.

Table 8: Areas (hectares) of mineral soil associations in Ireland and estimates of their grazing capacity

Soil No.	Area (000 ha)	48 kg N/ha Grazing capacity (L.U./100 ha)	230 kg N/ha Grazing capacity (L.U./100 ha)
4	187.2	173	212
6	64.2	207	257
6 (hill)	12.4	185	232
6 (Screen)	11.0	190	237
7	93.2	227	284
8 (South)	249.3	227	284
8 (North)	217.9	217	269
8 (hill)	108.4	185	232
10	11.9	210	264
9 (Kerry)	50.9	210	264
9	382.4	227	284
11	21.8	136	-
12	79.2	148	-
13	459.0	156	-
15	130.1	178	207
17	230.7	136	-

contd. over/

Table 8 contd.

Soil No.	Area (000 ha)	48 kg N/ha Grazing capacity (L.U./100 ha)	230 kg N/ha Grazing capacity (L.U./100 ha)
18	142.1	195	247
19	92.0	195	247
20	240.1	202	252
21	275.7	215	269
22	188.1	203	252
23	316.3	212	267
24	896.5	212	267
25 (Meath)	24.2	190	235
25	193.0	178	217
27	21.0	161	198
28 (Wexford)	3.2	183	227
28	26.8	173	212

Fig. 3 shows the grazing capacity map.

The average grazing capacity of the three major categories of lowland mineral soils is shown in Table 9.

Table 9: Average grazing capacity of major categories of lowland

Major land unit	Grazing capacity (L.U./100 ha)	
	48 kg N/ha	230 kg N/ha
Dry	217	272
Wet A[1]	173	212
Wet B[2]	143	-

[1] Wet A = Wet components of the Carboniferous Limestone, Sandstone and Ordovician Shale soils

[2] Wet B = Wet soils occurring on drumlins and Carboniferous Shales

DIFFICULT LAND AREAS

The extent of difficult farming land in the country is shown in Table 10.

Table 10: Extent of difficult farming land in Ireland

Land unit	Extent (million ha)	Percent of country
Wet mineral lowland (Wet B)	0.74	11.1
Mountain and hill	1.47	22.1
Lowlevel peat	0.78	11.7
Total	2.99	44.9

Wet mineral lowland (Wet B)

The soils are largely heavy impermeable surface water gleys associated with Carboniferous shale. The land-use options consist mainly of livestock production from grass or forestry. The problems associated with this land are represented in their more extreme form in County Leitrim. This is a county in north-central Ireland with a rapidly declining population. An interdisciplinary resource survey is underway in An Foras Taluntais with a view to making recommendations for the improvement of the welfare of the people in this county. The basic soil survey has been completed (10) and interpretive maps showing the productivity of defined areas for grazing (11) and forestry (12) have been prepared. These will play an integral role in the formulation of recommendations for the future land-use of the county.

The productivity study showed that intensive grazing of livestock $>$235 L.U./100 ha is possible on only 6% of the land. Moderate stocking intensities ranging between 125 and 200 L.U./100 ha are possible on 60% while the remainder of the land, consisting of climatic pest, is suited only to low intensity livestock production.

Measurements of forestry potential were made in order to compile basic data so that the economics of forestry versus agriculture could be assessed. This work was carried out by the soil survey department in conjunction with the Forestry Division, Department of Lands. In contrast to the poor suitability pattern for grassland, the forestry study showed that 43% of the county is capable of very high yields (24-26 m^3/ha), 28% of high yield (20-22 m^3/ha) and 16% of moderate yields (14-18 m^3/ha). Tables were published showing the grazing capacity of each mineral soil, and potential forest production Yield Class (m^3/ha/annum) for both mineral soils and peats.

Mountain and hill

Because of the complexity of the geology, ecology, climate and soils of these areas it follows that there is considerable variation in their productivity. These zones correspond with land above 150 m O.D. Their soils may be divided into five groups namely skeletal soils, blanket peats, podzols, peaty gleys and brown podzolics.

The transforming effects of drainage, fertilizing and seeding have been demonstrated for some of these areas. In the more favourable upland environments in the east and south, reclaimed rotavated podzols at 300 m O.D. have been shown to have 75% of the production potential of good lowland for pastures. While rotavation is adequate on the shallow relatively free draining podzols, under more extremely podzolized conditions with iron-pan development and with heavy impervious subsoils deep ploughing is required. This is illustrated in the reclamation of Calluna-dominant easy land (5°-12° slopes) areas at 120 m-200 m O.D. in the south of Ireland. These areas (e.g. Soil Assoc. 4) have also been shown to have 75% of the potential of lowland.

The work of the soil survey is a fundamental facet in our approach to assessing hill land resources. Our soil mapping criteria are developed against a background of reclamation possibilities and mapping is carried out within the constraints provided by mapping scale. Apart from soil type slope is a major criterion in improvement capability and three slope categories are recognised (i) $< 6^{\circ}$ (ii) 6°-12° and (iii) $\geq 12^{\circ}$. In many mountain and hill areas slopes represent a major limitation for agriculture. For instance it has been estimated (13) that only 11% of the West Mayo mountain and hill zone is readily accessible to machinery ($< 12^{o}$ slopes). Our objective is to develop a land improvement capability classification of these areas which would incorporate a quantification of the improvement potential of the land and also the measures necessary and costs involved in reclamation. For example the following classes could be distinguished.

1. Improvable land of suitable slope which (a) requires and (b) does not require ploughing in the reclamation process.
2. Land which could be improved by surface seeding only
3 Land suited to rough grazing
4. Land unsuited to agriculture

Lowlevel peat

Two main types of peat (i) blanket and (ii) basin or raised bog occur in the country. They are characterised by exceptionally high moisture contents, low hydraulic conductivity, low porosity, low shear strength and very few air-filled pores. Drainage is the main technical problem in peat development. Blanket peats occur mainly in western Ireland (mean annual rainfall 1250-1500 mm) while basin peats occur mainly in the midlands (850 mm rainfall).

The agricultural technical possibilities on these peats are being researched by an Foras Taluntais and considerable quantitative information is available on their reclamation possibilities for animal production (blanket peats) and for both tillage and animal production (basin peats). The mapping criteria for the peat areas are developed against the background of the use possibilities as determined at the research station. For instance in the basin peat areas, the following categories are recognised:

(i) Virgin bog

(ii) Cutover bog - reclaimed
- not reclaimed

(iii) Fen peat - reclaimed
- not reclaimed

Research shows that pasture yields on the reclaimed cutover basin peats compare favourably with those obtainable from good mineral soils.

CONCLUDING COMMENTS

It is hoped that this presentation will help to illustrate the methodology involved in the evaluation of land for rural purposes in Ireland. Our approach is multidisciplinary with the soil surveyor taking the initiative. A sequence of steps is involved: basic soil survey, qualitative soil suitability classification based on soil limitations and environmental factors and study of crop yields and quality with a view to a quantitative classification. The central emphasis in the research programme of An Foras Taluntais has been on livestock production from pastures and consequently from a land evaluation viewpoint more progress has been made in this direction than for arable crops.

Most current land classification systems are based upon the concept of transfer by analogy. The basic multiattribute soil classification system (i.e. the series taxonomic unit in Ireland) has been questioned by some workers from the viewpoint of utility for crop performance prediction. However, our experience has shown it to serve a useful function for both tillage and grassland assessment. For grassland this may be due to the significant relationship in Ireland between pasture production and utilization and soil drainage regime. In addition the Irish experience demonstrates that the higher categories of classification i.e. associations have an important potential use in evaluating regional soil resources which is particularly significant where detailed soil surveys and taxa of the lower soil categories have not been established. However, it is obvious that less precise predictions can be based on the more general categories.

Three esentially different approaches were adopted in assessing productivity (1) sample harvestings on well managed farms (wheat and barley) (ii) study of accurate yield records (sugar beet) and (iii) extrapolation of experimental data for experimental sites to analagous areas (grassland). The question of changing technology presents problems in these investigations and was illustrated in the wheat study when the variety Atle was largely replaced by a new variety Quern. Similarly any large scale introduction of new high yielding grass varieties would invalidate the results of the grazing capacity study although it is unlikely that the relativity between soils would alter. Nevertheless, the grazing capacity study provides targets for both national and regional livestock expansion if existing technology was applied. It also contributes to creating a positive attitude in the minds of financiers and planners in their approach to developing our agricultural economy in the sense that it removes uncertainty that the physical environment is limiting.

The Land Capability Classification developed by the Soil Conservation Service of the United States Department of Agriculture has been modified for use in Britain (14). This has been a valuable contribution from the viewpoint of interpretation of soil maps. The M.A.F.F. Agricultural Land Classification aims to predict production potential in relative terms and the question now is how to proceed to a quantitative classification for specific agricultural uses which would embrace input-output data. It is hoped that this presentation will stimulate discussion on the problem.

REFERENCES

1. Finch, T.F. Soils of County Clare. Soil Survey Bull. No. 23 An Foras Taluntais, Dublin 1971

2. Lee, J., Spillane, P. Ir. J. agric. Res. 9: 239-250 1970

3. Gardiner, M.J., Ryan, P. Soils of County Wexford. Soil Survey Bull. No. 1 An Foras Taluntais, Dublin 1964

4. Hammond, R.F. Personal communication 1974

5. Lee, J., Comerford, C.K. J. Int. Inst. Sugar-beet Res. 5 : 32-41 1970

6. Lee, J., Ryan, P. Ir. J. agric. Res. 5 : 237-248, 1966

7. Gardiner, M.J. Ir. J. agric. Res., II 211-217, 1972

8. Gardiner, M.J. Ir. J. agric. Res., II 219-232, 1972

9. Lee, J., Diamond, S. "The potential of Irish land for livestock production". Soil Survey Bull. No. 26. An Foras Taluntais, Dublin, 1972

10. Walsh, M. Soils section County Leitrim Resource Survey, Part 1. Soil Survey Bull. No. 29. An Foras Taluntais, Dublin, 1973

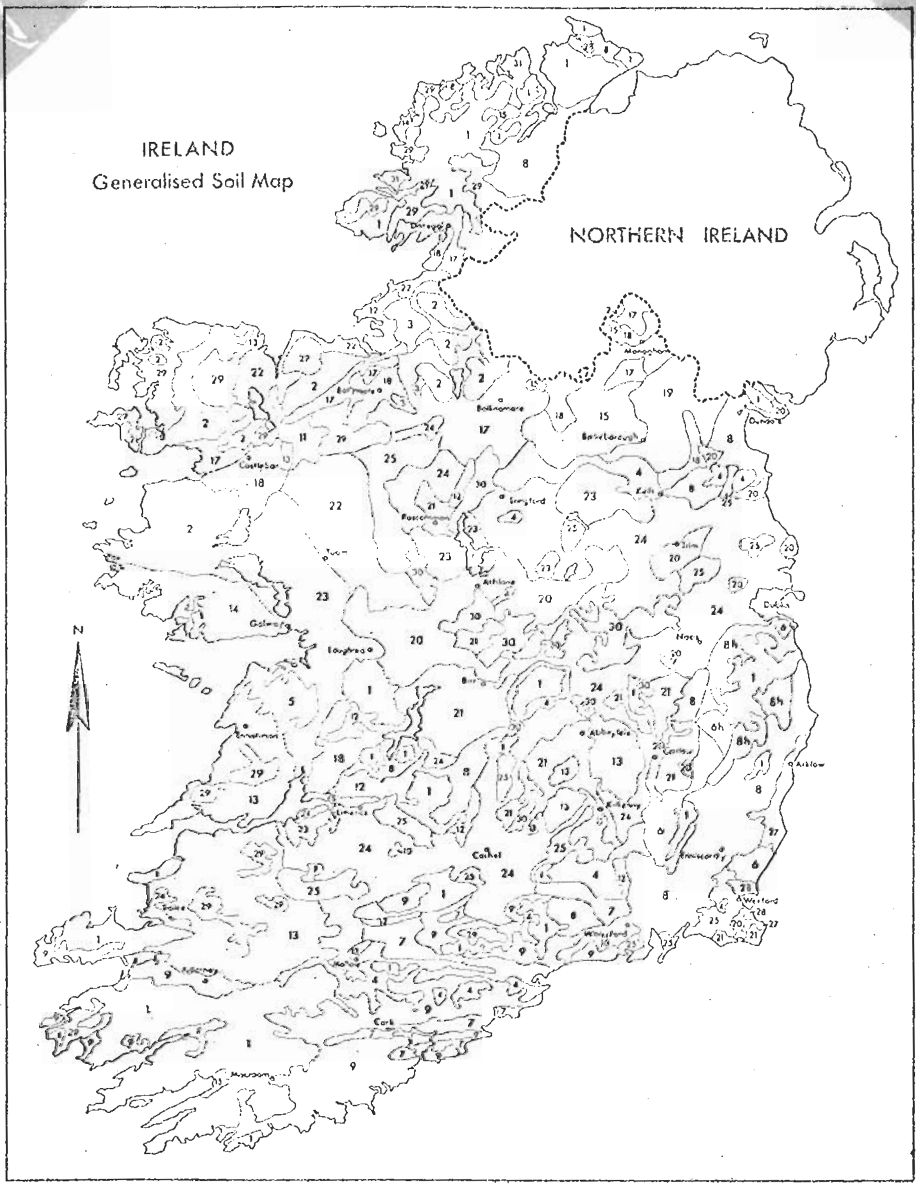
11. Lee, J., Walsh, M. Grazing capacity of Soils. Ibid

12. Bulfin, M., Gallagher, G. and Dillon, J. Forest production. Ibid

13. Kiely, J. Unpublished data.

14. Bibby, J.S., Mackney, D. Land use capability classification. Soil Survey of Great Britain, 1969.

- - - - - - - - - - - - - -


IRELAND
Generalised Soil Map
NORTHERN IRELAND
N

APPENDIX

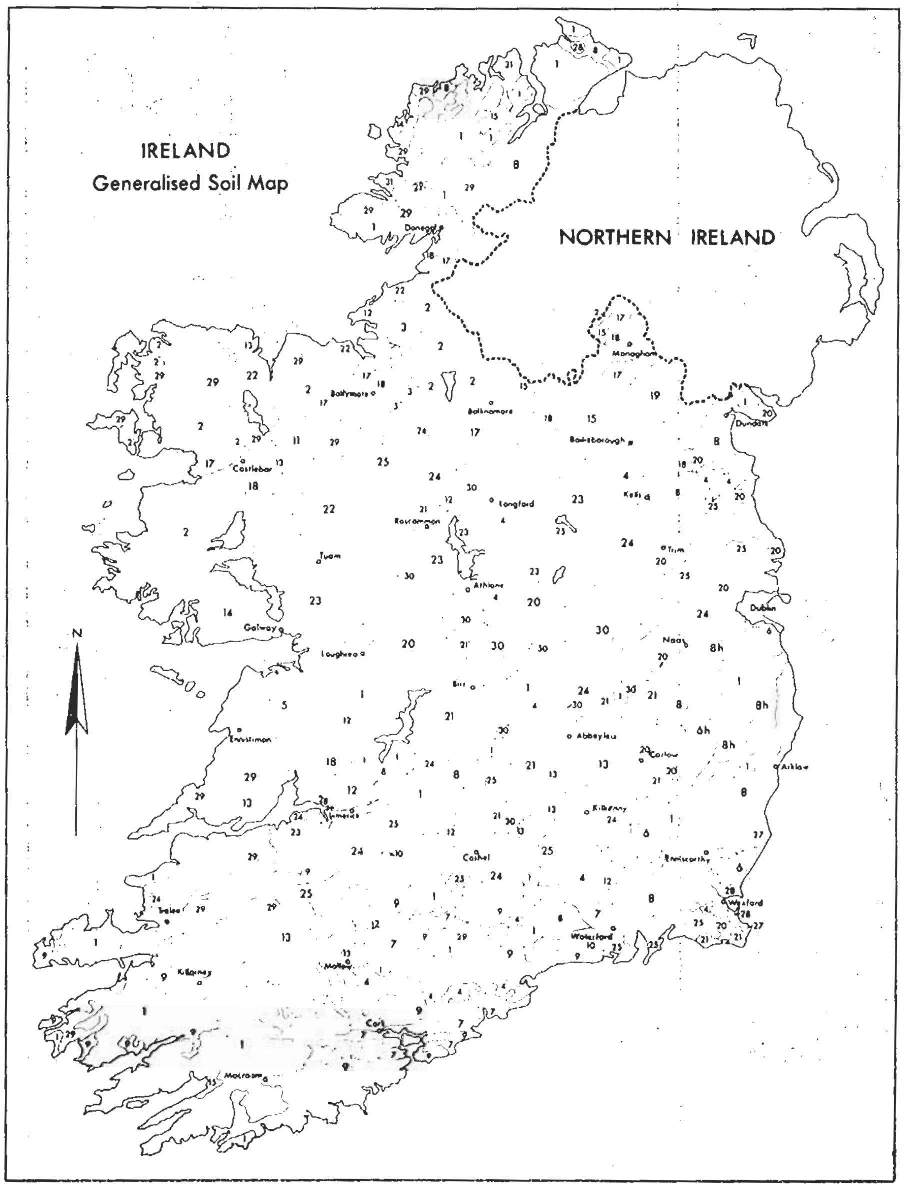


Fig 1: Reduced and simplified diagrammatic representation of the soil map of Ireland.

APPENDIX

Table 1: Major soil associations and their limitations for agriculture

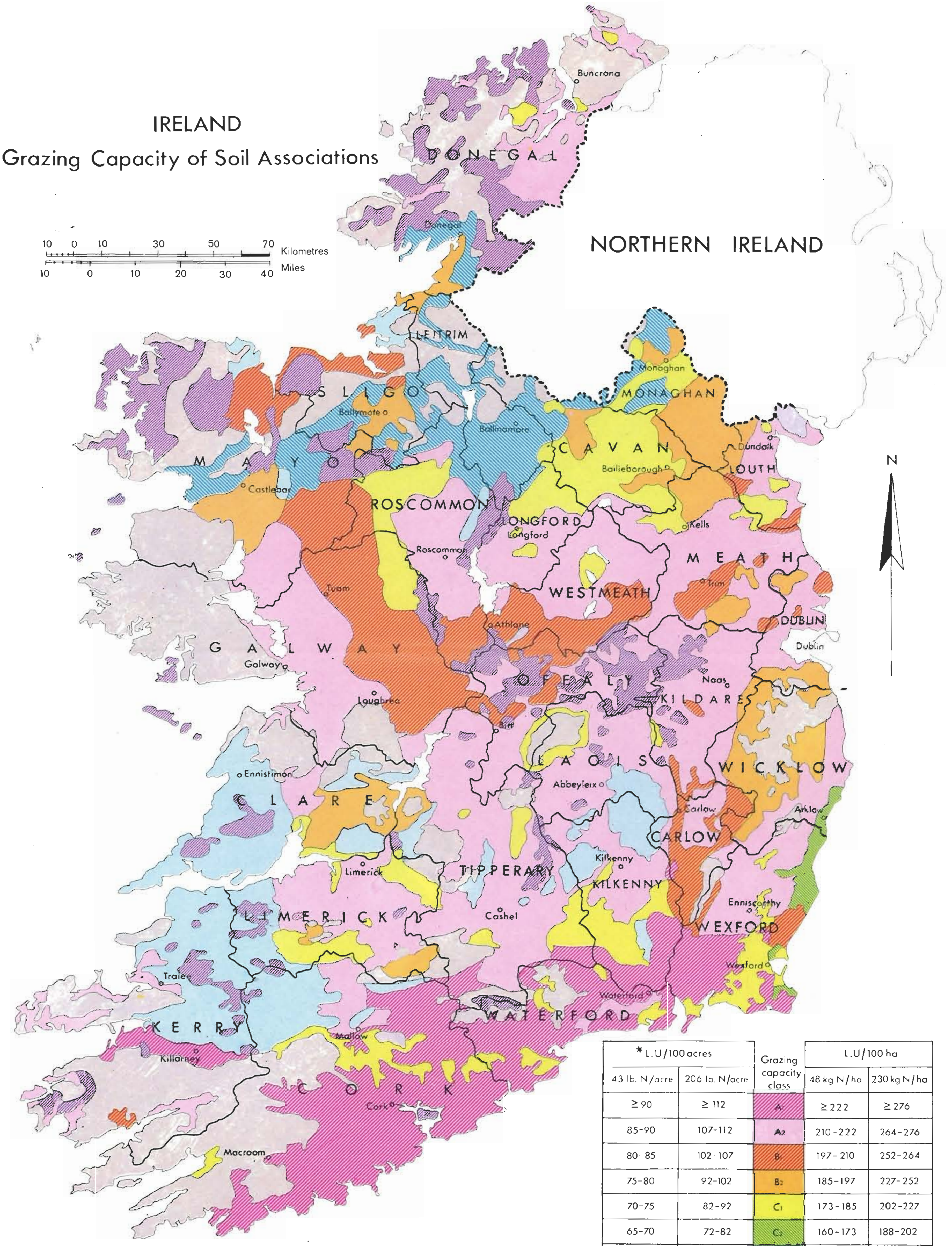
Physiography	Soil No.	Soil Association		Limitations		Percent total area
		Principal Soil	Associated Soils	Principal soil	Associated soils	
Mountain and hill	1, 2, 3	Peaty Podzols, Peaty Gleys, Climatic Peat	--	Steep slopes, high altitude, shallow depth		18.52
	4	Reclaimed Podzols (75%)	Gleys (25%)	Somewhat shallow, steep slopes and high altitude	Poor drainage	2.75
	5	Limestone Rock Outcrops (90%)	Lithosols and shallow Organic Soils (10%)	Rock outcrops, shallow depth		0.48
Rolling lowland	6	Acid Brown Earths, Brown Podzolics (80%)	Gleys, Regosols (20%)	Slight	Poor drainage	1.29
	7	Acid Brown Earths, Grey Brown Podzolics (92%)	Gleys (8%)	Slight	Poor drainage	1.37
	8, 9	Acid Brown Earths, Brown Podzolics (92%)	Gleys (8%)	Slight	Poor drainage	14.69
	10	Acid Brown Earths (92%)	Gleys (8%)	Rock outcrop	Poor drainage	0.01
	11	Podzols (60%)	Gleys, Climatic Peat Lithosols (40%)	Poor drainage, shallow depth		0.32
	12	Gleys (75%)	Peaty Gleys (25%)	Poor permeability, weak structure and heavy texture		1.01
	13	Gleys (80%)	Acid Brown Earths (20%)	Poor permeability, weak structure and heavy texture	Slight	6.68
	14	Rock Outcrops and Peat (90%)	Shallow Podzolized Soils (10%)	Rock outcrops, shallow depth		1.75

Table 1 (contd.)

Drumlin	15	Gleys (60%)	Acid Brown Earths (40%)	Poor permeability and somewhat heavy texture	Slight	1.96
	17	Gleys (90%)	Peaty Gleys, Acid Brown Earths and Peat (10%)	Very poor permeability weak structure and heavy texture		4.74
	18	Grey Brown Podzolics (70%)	Gleys, Peaty Gleys (30%)	Slight	Poor permeability and weak structure, heavy texture	2.31
	19	Acid Brown Earths (60%)	Gleys, Peaty Gleys (40%)	Slight	ditto	1.35
Flat to undulating lowland	20 (15%) peat	Grey Brown Podzolics (90%)	Gleys (10%)	Slight	Poor drainage	4.15
	21	Grey Brown Podzolics (90%)	Gleys (10%)	Slight	Poor drainage	4.05
	22 (20%) peat	Degraded Grey Brown Podzolics (90%)	Gleys (10%)	Slight	Poor drainage	3.25
	23	**Shallow Brown** Earths (97.5%)	**Rock outcrops** (2.5%)	Slight	**Rock outcrop**	4.38
	24	Grey Brown Podzolics (85%)	Gleys (15%)	Slight	Poor drainage	13.17
	25	Gleys (90%)	Grey Brown Podzolics (10%)	Poor permeability and weak structure, somewhat heavy texture	Slight	3.19
	27	Gleys (100%)	-	Very poor permeability and weak structure, heavy texture		0.45
	28	Regosols (60%)	Gleys (40%)	Poor permeability and weak structure		0.42
Organic soils	29, 30, 31	Climatic and Basin Peat (75-90%)	Organo-mineral soils, Reclaimed Podzols (10-25%)	Utilisation constitutes a special problem		5.71

Map III

IRELAND
Grazing Capacity of Soil Associations



Compiled by J. Lee and S. Diamond
Head of National Soil Survey M. J. Gardiner

*L.U/100 acres		Grazing capacity class	L.U/100 ha	
43 lb. N/acre	206 lb. N/acre		48 kg N/ha	230 kg N/ha
≥ 90	≥ 112	A_1	≥ 222	≥ 276
85-90	107-112	A_2	210-222	264-276
80-85	102-107	B_1	197-210	252-264
75-80	92-102	B_2	185-197	227-252
70-75	82-92	C_1	173-185	202-227
65-70	72-82	C_2	160-173	188-202
60-65	—	D_1	148-160	—
55-60	—	D_2	135-148	—
<55	—	E	<135	—
—	—	Unclassified	—	—

*One Livestock Unit equals one 10·5 cwt cow or equivalent.

Prepared and published by National Soil Survey, An Foras Talúntais.

Printed at Ordnance Survey Office, Dublin, 1972.