An Analysis of Land Potential for Grazing in Ireland with Particular Reference to Farm Size Relationships

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INTRODUCTION

Those fields of soil science which are related to the study of the genesis, morphology, classification and mapping of soils may be collectively termed "soil survey" 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 If we map the soils of a region we do so in order to be able to make more precise statements about the mapped subdivisions than we can make about the region as a whole, the objective being to resolve the region into

areas of approximately equal land-use potential The landscape is resolved into a number of subdivisions each defined as accurately as the available information allows and as precisely as the mapping procedure justifies Sometimes it is not the defined sub-divisions 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 subdivisions which are soil series are mapped These are morphologically relatively uniform and our research (1) has shown that 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
(2) Detailed reconnaissance studies of counties
(3) A combination of detailed reconnaissance and general reconnaissance to arrive at a national picture (General Soil Map of Ireland 1969)

The soil survey enables us to indicate the limits of the area to which the conclusions of a particular research station may be applied and in this regard it is logical that our research stations should be strategically sited to represent the major land systems within the country

While much research has been carried out on the role of soil survey in the application of agricultural technology to farming, its possible utility as a basis for systematizing statistics on farm size has not been investigated Against the above background, the objectives of the present study are to

(1) examine the extent of major land units in Ireland with particular reference to regional variation
(2) evaluate the productivity of the lowland soils for livestock production,
(3) examine the relationship (if any) between holding size and soil association,
(4) investigate the number of holdings on each soil association that have a capacity to support selected stocking targets,
(5) investigate the reduction in holdings which would be necessary on each soil association to create units capable of supporting the selected stocking target, assuming that holdings below the stocking target were restructured to bring them up to the selected target while those above it were assumed to remain unchanged

Only the technical capacity of land is considered in the study, while the willingness and ability of management to work the land which are acknowledged as important limiting factors are not considered

LAND RESOURCES IN IRELAND

There is a total of 6 64 million ha of land in the Republic of Ireland (exclusive of urban areas and roads) An Foras Taluntais has been making a soil survey of this land since its establishment in 1959 The work is

being systematically carried out on a county basis and it will be 12-15 years before the country is completed In the meantime, until the soil survey of Ireland is complete we must make the best estimates of our soil resources that we can The results of the first national inventory of our soils were published in 1969 (2) and this inventory provides the only basis for estimating Ireland's land potential

There are three major categories of land in the country (i) lowland mineral, (ii) mountain and hill, and (iii) low level peat and their extent is shown in Table 1

TABLE 1

Extent of major land units in Ireland

Land unit	*Acreage (million ha)*	*Per cent land area*
Lowland mineral	4 39	66 1
Mountain and hill	1 47	22 1
Low level peat (blanket and basin)	0 78	11 7

Two-thirds of the land of Ireland consists of lowland mineral soils, the remaining one-third consisting of mountain and hill and low level peat The mountain and hill unit corresponds generally with land above 152m O D

The lowland areas may be subdivided into dry and wet The wet land is subdivided into two classes, viz (A) wet components of the Carboniferous limestone, sandstone and Ordovician shale soils and (B) those soils occurring on drumlins and Carboniferous shales Their distribution is shown in Table 2

TABLE 2

Categorisation of lowland mineral soils

Category	*Acreage (million ha)*	*Per cent lowland area*	*Per cent total land area*
Dry	2 95	67 2	44 4
Wet A	0 70	16 0	10 6
Wet B	0 74	16 8	11 1

Table 2 shows that two-thirds of the lowland is dry and one-third consists of wet land

Land resources – regional variation

Table 3 shows the index of occurrence of each land unit according to province, the index 100 representing the average level of occurrence for the country

TABLE 3

Land unit index of occurrence by province

Province	Lowland mineral			Mountain and hill	Low level peat
	Dry	Wet A	Wet B		
Leinster	132	155	33	58	75
Munster	101	80	126	132	33
Connacht	75	66	116	78	203
Ulster (part of)	61	97	136	142	128
Ireland	100	100	100	100	100

Table 3 shows that the better soils (Dry and Wet A) are most common in Leinster, in fact the frequency of occurrence of dry land in Leinster is approximately twice that for Connacht and the Ulster counties The per cent occurrence of low level peat in Connacht is twice that for Ireland and compared with Munster the occurrence of this land unit in Connacht is six times greater While the per cent occurrence of mountain and hill in Leinster is approximately 60 per cent of the national average, it is considerably in excess of the national average in the Ulster counties and Munster

There is great variation in the composition of land resources between counties (Table 4) For example, the per cent dry lowland mineral unit varies from 70 per cent (Dublin) to 7 per cent (Leitrim)

Table 5, which is derived from Table 4, shows county groupings according to the occurrence of dry lowland

TABLE 5

Classification of counties according to estimated percent dry lowland

Group	Per cent dry lowland	Counties
I	>60	Dublin, Meath, Carlow, Westmeath, Waterford, Kildare, Louth, Wexford
II	50–60	Tipperary, Offaly, Laois, Kilkenny
III	40–50	Cork, Galway, Limerick, Wicklow, Roscommon, Longford, Monaghan
IV	30–40	Cavan
V	20–30	Clare, Kerry, Mayo, Sligo, Donegal
VI	<20	Leitrim

TABLE 4

Land resource acreages (000 ha) by county

County	*Dry*	*Percentage of County*	*Wet A*	*Percentage of County*	*Wet B*	*Percentage of County*	*Mountain and hill*	*Percentage of County*	*Low level peat*	*Percentage of County*
Dublin	61 2	70 0	18 2	20 8	—	—	7 1	8 0	1 0	1 2
Meath	155 5	68 7	49 0	21 6	—	—	11 8	5 2	10 4	4 6
Carlow	57 8	67 0	14 7	17 0	8 6	10 0	4 3	5 0	0 9	1 0
Westmeath	114 8	66 4	18 1	10 5	—	—	1 5	0 9	39 3	22 7
Waterford	116 8	65 2	10 5	5 9	—	—	52 0	29 1	—	—
Kildare	106 4	65 0	32 7	20 0	—	—	0 4	0 25	24 0	14 2
Louth	51 0	65 0	17 5	22 3	—	—	7 7	9 8	2 2	2 8
Wexford	140 7	62 0	68 1	30 0	6 8	3 0	10 7	4 7	1 2	0 5
Tipperary	247 7	59 9	53 5	12 9	23 8	5 7	59 7	14 4	28 8	7 0
Offaly	115 9	59 2	16 7	8 5	—	—	11 8	6 0	51 0	26 1
Kilkenny	107 6	53 5	21 7	10 8	37 4	18 6	33 2	16 5	1 1	0 5
Laois	86 8	52 7	13 3	8 0	15 7	9 5	25 7	15 6	23 1	14 0
Cork	348 3	48 3	36 4	5 1	62 2	8 6	263 3	36 5	10 5	1 5
Galway	271 7	47 8	43 1	7 6	11 8	2 1	76 7	13 5	165 5	29 1
Limerick	124 7	47 8	53 6	20 0	56 8	21 7	25 5	9 5	2 1	0 8
Wicklow	82 8	42 5	18 8	9 7	—	—	92 7	47 6	0 4	0 2
Roscommon	98 6	41 8	32 2	13 7	20 0	8 5	5 3	2 2	76 4	32 4
Longford	41 0	41 0	24 0	24 0	2 7	2 7	1 9	1 9	30 3	30 4
Monaghan	50 1	41 1	32 0	26 3	37 2	30 5	2 5	2 1	1 2	1 0
Cavan	53 0	29 8	31 7	17 8	47 0	26 5	36 8	20 7	8 9	5 0
Clare	88 3	29 0	33 5	11 0	79 1	26 0	84 8	27 9	18 7	6 1
Kerry	127 6	28 0	11 4	2 5	107 5	23 6	172 1	37 7	37 4	8 2
Mayo	139 6	27 0	22 6	4 4	58 7	11 4	148 7	28 8	147 3	28 5
Sligo	41 1	23 5	10 6	6 1	48 5	27 7	48 1	27 5	26 8	15 3
Donegal	108 6	23 4	16 0	3 4	33 7	7 2	262 3	56 4	40 0	8 6
Leitrim	10 0	7 0	2 9	2 0	79 2	55 0	21 2	14 7	30 6	21 3
Total	2947 4	44 4	702 8	10 6	736 7	11 1	1467 84	22 1	779 1	11 7

Occurrence of "marginal" land

Economists frequently speak of some land areas as being "marginal" or "submarginal" for particular types of use The usual inference with these statements is that the areas fall either at or below the no-rent or extensive margins for the particular uses considered However, in the context of this paper the term "marginal" land is simply taken to be synonymous with difficult farming areas

There are three associated land unit categories, (i) mountain and hill, (ii) low level peat, and (iii) wet mineral lowland (Wet B) Their extent is shown in Table 6

TABLE 6

Extent of marginal land units in Ireland

Land unit	*Extent (million ha)*	*Per cent of country*
Mountain and hill	1 47	22 1
Low level peat	0 78	11 7
Wet mineral lowland (Wet B)	0 74	11 1
Total	2 99	44 9

Approximately 45 per cent of the land area of the country is in the "marginal" category The mountain and hill unit occurs mainly in the west and south-west, the peat in the west and midlands and the wet mineral lowland in the north-west and west

Table 7, which is derived from Table 4, shows a grouping of counties according to the extent of "marginal" land There is wide variation in the occurrence of this land which ranges from 90 per cent (Leitrim) to 8 per cent (Wexford) It is estimated that 70 per cent of the "marginal" land occurs in the eight western sea-board counties

TABLE 7

Classification of counties according to estimated percent marginal land

Group	*Per cent marginal land*	*Counties*
I	>80	Leitrim
II	60–80	Kerry, Sligo, Donegal, Clare, Mayo
III	40–60	Cavan, Cork, Galway, Wicklow, Roscommon
IV	20–40	Offaly, Longford, Kilkenny, Limerick, Laois, Monaghan, Waterford, Westmeath, Tipperary
V	<20	Carlow, Kildare, Louth, Dublin, Meath, Wexford

ESTABLISHING LIVESTOCK PRODUCTION TARGETS FOR DIFFERENT SOILS

Experimentation is the key to agricultural innovation and we make the assumption that research experience with a particular kind of soil in one place can be applied to that soil wherever it exists if allowance is made for any climatic difference Obviously experimentation must be confined to particular points and the soil survey acts as a bridge that allows us to transfer the knowledge gained by research and farming experience from one point to areas of similar environment An Foras Taluntais has devoted considerable effort to assessing the capabilities of our grasslands and have established production targets to match the variety of land and environmental situations which exist in the country In addition, pasture dry matter production data are available from extension cutting experiments on selected soils throughout the country By extrapolating both the animal and grassland output data to analagous land and climatic areas it is possible to arrive at a grazing capacity estimate for each soil association in the country The approach adopted was comprehensively outlined in an earlier study by the author (3)

Both the pasture and animal output data indicate that soil drainage is a major determinant in level of production achieved Consequently the grazing capacity estimates derived for the soil associations are mainly a function of drainage regime with climate as an important determinant

The relationship between percentage dry land on the experimental site and stocking rate achieved is shown in Figure 1 The relationship is shown under a low (48 kg/ha) and high (230 kg/ha) level of nitrogen (N) application The production levels achieved parallel the amount of wet land on the site From Figure 1 it can be seen that one can expect to carry 173 and 212 livestock units[1] (LU)/100 ha of wet land (Class A) with low and high N application Research at Ballinamore shows that the production capacity from the poorer (Class B) wet soils is 136 LU/100 ha In contrast, a considerably higher target of 290 LU/100 ha is achievable on free draining land in the south of Ireland

Grazing capacity of lowland mineral soils

The grazing capacity of each lowland mineral soil association in the country is shown in Table 8 Brief descriptive details of the soils of the country are to be found in Appendix (Table 1) together with a simplified map showing their geographic distribution

The grazing capacity figures represent the average for each soil association For instance, Soil Association 24 which comprises 85 per cent dry and 15 per cent wet land has a grazing capacity of 212 L U /100 ha This is based on the grazing capacity of the components as follows, 85 per cent at 200 L U /100 ha and 15 per cent at 173 L U /100 ha It is clear from

[1] A livestock unit equals a 533 kg lactating cow or equivalent

FIGURE 1

Stocking rate achieved under experimental conditions in relation to percentage dry land

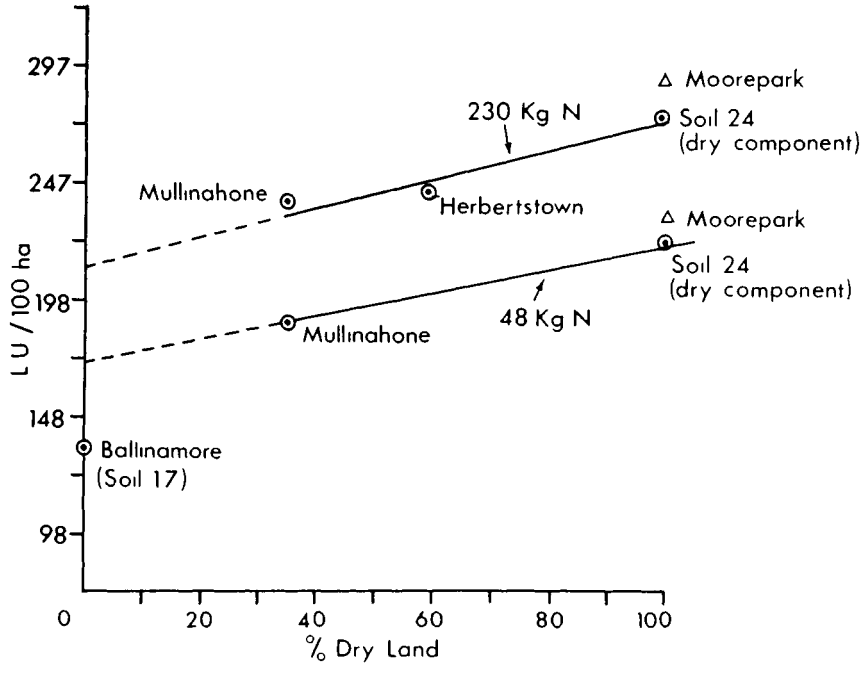


TABLE 8

Areas of mineral soil associations in Irish Republic and estimates of their grazing capacity

Soil Association 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	175	212
6	64 2	207	257
6 (hill)	12 4	185	232
6 (Wexford)	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
9 (Kerry)	50 9	210	264
9	382 4	227	284
10	11 9	210	264
11	21 8	136	—
12	79 2	148	—
13	459 0	156	—
15	130 1	178	207
17	230 7	136	—
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

Table 8 that there is pronounced variation in the capacity of different land areas for livestock production

It is provisionally estimated that the average grazing capacity of the mountain and hill units is 50 L U /100 ha Soil Association 4 is included in Table 8 because of its relatively high grazing capacity After allowing for land under urban and road use (3 per cent) and under fences, ditches etc (5 per cent) and also allowing for land under tillage crops not devoted to livestock, the total grazing capacity of our land is estimated to be 10 3 million L U at the high N level There were 6 1 million L U in the country in 1973 so livestock numbers could be increased by a factor of 1 7 This refers to the technical capacity of the land only and assumes the present structure of land-use in the country

The average size of holding[2] (>2ha) in Ireland in 1970 was 14 8 ha (36 5 acres) and the average size of farm[3] in 1966 was 16 2 (40 acres) There were 256,350 holdings above 2 ha and 188,460 farms above 2 ha

Figure 2 shows the distribution of farm size in Ireland together with the total acreage in each size category Although farms above 40 ha only comprise 11 per cent of the total, they occupy 37 per cent of the area under farms whereas farms less than 12 ha which comprise 37 per cent of the total only occupy 12 per cent of the total area

There are striking differences in average size of unit between counties (Table 9) An examination of the acreage of land in the different size categories shows, for instance, that 65 per cent of the farmland in Kildare is occupied by farms above 40 ha in size, while the corresponding figure for Leitrim, which is on the lower end of the scale, is only 8 per cent In contrast, while farms below 20 ha comprise 63 per cent of the farmland in Leitrim the corresponding figure for Kildare is 14 per cent These figures illustrate the magnitude of regional farm size variation

There is a significant relationship between percentage dry land and average size of farm in each county The relationship is expressed as follows

$$Y = 7\ 73 + 0\ 227X \qquad R^2 = 46\%\ (P \leq 0\ 001)$$

where X = percentage dry land
Y = average farm size (ha)

While farm size is considerably in excess of holding size in the better counties, the acreage of both these units are approximately equal in the poorer countries

[2] An agricultural holding is defined as all land used wholly or partly for agricultural or livestock production, that is, operated, directed or managed by one person alone or with the assistance of others, without regard to ownership, title, size or location and may be in one or more places if in the same neighbourhood and are known and operated as a single holding or property *(Statistical Abstract of Ireland* 1969)

[3] A farm is the land area held by a rated occupier who stated in the Census of Population that farming was his principal occupation *(Census of Population of Ireland* Vol IV, 1966)

FIGURE 2

Distribution of farm size in Ireland and acreage in each size category (1966)

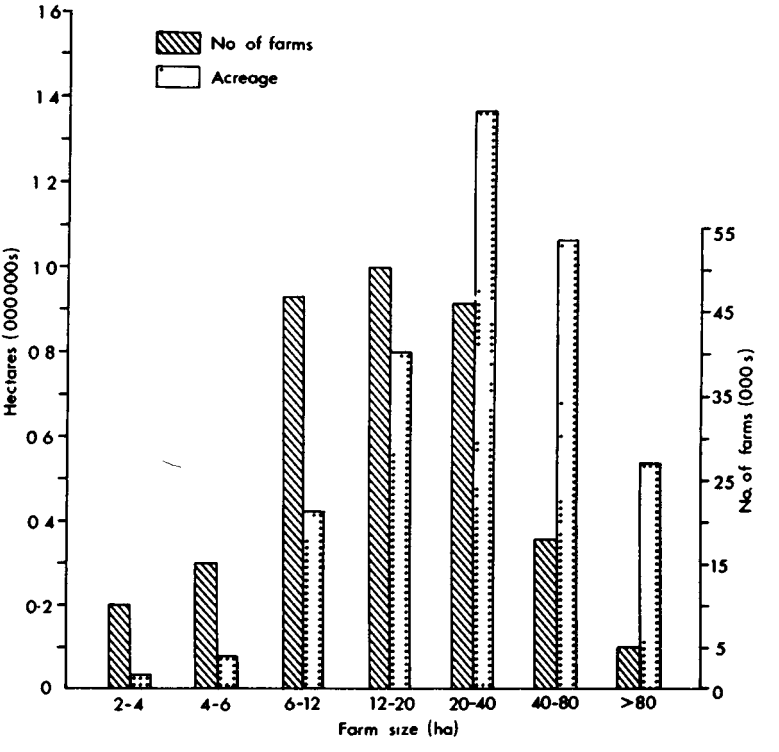


TABLE 9

Average holding and farm size (>2 ha) by county

County	Farm size (1966)		Holding size (1970)	
	ha	*acres*	*ha*	*acres*
Waterford	27 9	69	22 7	56
Kilkenny	26 3	65	22 3	55
Wicklow	26 3	65	20 2	50
Kildare	25 5	63	18 2	45
Wexford	25 1	62	19 8	49
Carlow	24 7	61	19 8	49
Tipperary	23 9	59	20 6	51
Cork	25 5	58	20 2	50
Laois	21 9	54	18 6	46
Offaly	21 1	52	17 8	44
Limerick	21 1	52	17 8	44
Dublin	20 6	51	13 4	33
Meath	19 4	48	15 8	39
Westmeath	19 0	47	17 0	42
Clare	18 2	45	17 4	43
Kerry	17 4	43	15 8	39
Louth	15 4	38	11 7	29
Longford	13 8	34	13 0	32
Roscommon	12 6	31	12 6	31
Galway	12 6	31	12 6	31
Cavan	12 1	30	12 1	30
Leitrim	11 7	29	11 7	29
Monaghan	11 7	29	10 9	27
Sligo	11 7	29	11 7	29
Donegal	10 1	25	11 3	28
Mayo	10 1	25	10 1	25

Over the 1951-66 period, the numbers of farms (>0 4 ha) in the country declined from 235,331 to 199,107 which is a reduction of 15 4 per cent There is a highly significant relationship between the rate of decline in a county and the occurrence of dry land The relationship is expressed as follows

$$Y = 26\ 19 - 0\ 257X \qquad R^2 = 66\ 6\%\ (P \leq 0\ 001)$$

where Y = percentage reduction in farms (1951-66)

X = percentage dry land in county

The decline in numbers is occurring in the lower size categories while the number of holdings is increasing, particularly in the 20-40 ha size category This is evidenced by the fact that there was an increase of 4 per cent in the number of holdings in this size category over the 1960-70 period It is relevant to point out that the rate of adjustment in the number of farms is considerably lower than in other countries of the EEC

THE RELATIONSHIP BETWEEN SIZE OF HOLDING AND SOIL ASSOCIATION

Methodology

The soil map of Ireland (1 575,000) was enlarged to the scale of the map (1 250,000) showing the boundaries of District Electoral Divisions (D E D 's) It was then possible to list D E D 's against soil association Six D E D 's were randomly selected on a county basis to represent each soil association Details of holding size distribution (1970) for the selected

TABLE 10

*Mean size of holding (>2 ha) by soil association**

Soil Association No	*Major occurrence*	*Mean size*
7	Cork, Waterford	23 0
8	Wexford, Wicklow, Waterford, Kilkenny, Tipperary, Louth, Donegal	22 8
9	Cork, Waterford	22 5
21	Carlow, Laois, Kildare, Offaly, Tipperary, Kilkenny	20 6
27	Wexford	20 9
13	Kerry, Clare, Limerick, Cork, Laois, Kilkenny	18 9
24	Meath, Dublin, Kildare, Westmeath, Offaly, Longford, Laois, Tipperary, Limerick	18 6
20	Offaly, Westmeath, Meath, Galway, Roscommon	16 2
4	Waterford, Kilkenny, Cork, Longford	14 8
23	Galway, Mayo, Roscommon	14 6
25	Roscommon, Galway, Wexford, Tipperary	13 6
18	Mayo, Sligo	12 0
17	Leitrim, Cavan, Monaghan, Sligo, Roscommon, Mayo	11 9
22	Galway, Mayo, Sligo	11 4
15	Cavan	10 7
19	Monaghan	10 0

*Any two means not sidescored by the same vertical line are significantly different ($P \leq 0\ 01$)

D E D 's were obtained from the records of the Central Statistical Office By grossing the holding size distribution data for a particular soil across counties, it was possible to estimate the national pattern of size distribution for this soil This enabled the mean size of holding for each soil to be calculated Duncan's (4) new multiple range test was applied to determine if there were significant differences between all combinations of means

Comparisons established

Table 10 shows the mean holding size for the major lowland mineral soil associations

Largest size holdings are associated with the well drained arable soils (Soils 7, 8 and 9) of high grazing capacity (Table 8) occurring dominantly in the south of Ireland The well drained limestone soils (Soils 21, 24, 20) in central Ireland are associated with intermediate size holdings whereas smallest sizes are associated with the dominantly poorly drained soils of low grazing capacity (Soils 15, 17, 18, 19, 25) Holding size is significantly higher on Soil 13 than on the remaining poorly drained soils Very small sizes are associated with Soil 22 in east Galway, Mayo and Sligo While the mineral component of Soil 22 is of good quality, a high proportion of peat (20 per cent) occurs in this mapping unit Similarly, holding size is surprisingly low on the well drained arable Soil 23 which has a high grazing capacity in Galway, Mayo and Roscommon Figure 3 shows a cumulative frequency distribution of holding size on four major lowland soil associations in the country

To be of value in farm structure studies, the soil map must be a tool for making more precise statements about the parts of the landscape covered by each soil unit mapped than could previously have been made about the landscape at large without it This may be assessed by comparing the extent to which farm size variance pooled over all the mapped soil units is less than that of the landscape at large This is conveniently done in terms of ρ, the intra-class correlation given by

$$\rho = \frac{\sigma_\tau^2}{\sigma_\tau^2 + \sigma^2}$$

where σ_τ^2 is the between class variance and σ^2 is the within class variance If the pooled variance (σ^2) of the farm size is no less than that of the landscape at large then $\rho = 0$, if the mapped soils are each homogeneous then $\rho = 1$, a large intra class correlation indicating relatively small variation within soil units When this test is applied to the more extensive soils in Table 10 (Soils 24, 21, 8, 17, 13, 20 and 25) $\rho = 0\ 824^{***}$ ($p \leq 0\ 001$)

Distribution of holdings according to soil association

Knowing the average size of holding and the total area of each soil it is possible to calculate the number of holdings on each soil association The results are shown in Table 11

FIGURE 3

Cumulative frequency distribution of holding size on four major lowland soil associations (1970)

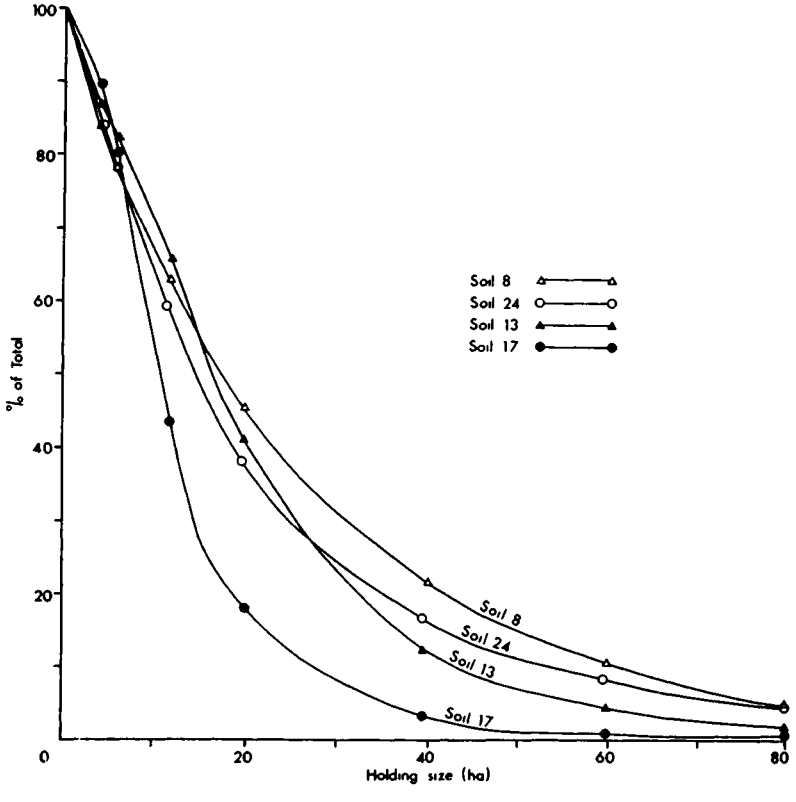


TABLE 11

Number of holdings on each Soil Association

Soil Association No		*Number of holdings (000) >2ha*
	Lowland mineral	
4		8 5
6		2 8
7		2 6
8		17 6
9		13 2
11		1 4
12		4 4
13		17 5
15		9 6
17		20 2
18		10 2
19		6 6
20		11 9
21		9 3
22		15 1
23		15 4
24		31 4
25		11 0
27		0 9
	Mountain and hill	
1, 2, 3, 5, 14, 29, 31		37 7
Total		247 3

The number of holdings on the mountain and hill zone were estimated from data obtained from (5) and may include some holdings occurring on low level peat in the western areas

In 1970, there were 256,300 holdings above 2 ha in the country The total number of holdings derived from Table 11 shows a close approximation to the actual number In Table 11 no estimate is provided for Soils 10 and 28 which together occupy only 0 4 per cent of the country and for Soil 30 (mainly basin peat) The number of holdings on Soil 4 is overestimated because of the relatively high concentration of forestry on this unit

From Table 11 it is possible to estimate the proportion of holdings on each of the major land units in the country The results are shown in Table 12

TABLE 12

Distribution of holdings by major land unit

Land unit	*Percentage total holdings*	*Percentage land area*
Dry	53	44 4
Wet A	12	10 6
Wet B	20	11 1
Mountain, hill	15	33 9

Table 12 shows that an estimated 35 per cent of holdings are located on the "marginal" land units (Table 6) It can be seen that only 53 per cent of holdings in the country are located in areas which are not beset with the physical problems of soil and topography limitations

Comparison of holding size on similarly mapped soils by county

Size of holdings on similarly mapped soils is compared between counties in Tables 13-15 It is evident from these tables that there is a wide range in size on most soils This is particularly notable on the more productive and dominantly well-drained Soils 21, 24 and 8 Although the average size of holding on these soils is relatively high (Table 10) size is surprisingly low on Soil 21 in Roscommon, Soil 24 in Longford and Soil 8 in Louth The low size on Soil 24 in Longford is associated with the occurrence of a relatively high proportion of peat within this mapping unit in the county Size is relatively low and particularly uniform throughout Soil 20 which is dominantly well-drained, size is also particularly uniform throughout Soil 17 (poorly drained) Soils 13 and 22 are also associated with relatively uniform size holdings between counties

From an examination of Tables 13-15 it is also clear that there is substantial variation in size of holding between soils within most counties For instance size of holding in Cork ranges from 26 1 ha on Soil 7, which is an excellent tillage and grassland soil with a grazing capacity of 284 L U /100 ha, to 20 6 ha on Soil 13 which has a restricted use range and with a grazing capacity of 156 L U /100 ha In Wexford, size varies from 25 2 ha on Soil 8, which is excellent tillage and grassland soil with a similar grazing capacity to Soil 7, to 13 6 ha on Soil 25, which has a restricted use range compared to Soil 8, and with a grazing capacity of 235 L U /100 ha There is less variation in holding size between soils of varying productivity in the western counties For instance, in Mayo size ranges only from 12 2 ha on Soil 23 which has a high grazing capacity of 267 L U /100 ha to 11 1 ha on the poorly drained Soil 17 which has a grazing capacity of 136 L U /100 ha

TABLE 13

*Intercounty holding size (>2 ha) comparison on flat to undulating lowland dry soils (1970)**

Soil No 24		*Soil No 21*		*Soil No 22*		*Soil No 20*		*Soil No 23*	
County	*Farm size*	*County*	*Farm size*	*County*	*Farm size*	*County*	*Farm size*	*County*	*Farm size*
Kilkenny	25 4	Kildare	25 3	Galway	13 4	Offaly	17 1	Galway	18 7
Tipperary	20 6	Tipperary	23 6	Mayo	12 2	Westmeath	16 6	Roscommon	16 6
Limerick	19 3	Kilkenny	21 5	Sligo	9 0	Meath	16 1	Mayo	12 2
Westmeath	18 6	Carlow	19 1			Roscommon	16 0		
Offaly	17 6	Laois	20 8			Galway	15 5		
Kildare	17 5	Offaly	17 9						
Meath	17 2	Roscommon	13 0						
Laois	16 6								
Dublin	16 0								
Longford	14 8								

*In Tables 13–15 any two means not sidescored by the same vertical line are significantly different ($p \leq 0\ 01$)

TABLE 14

Intercounty holding size 2> ha comparison on rolling lowland dry soils (1970)

Soil No 7		*Soil No 8*		*Soil No 9*	
County	*Farm size*	*County*	*Farm size*	*County*	*Farm size*
Cork	26 1	Waterford	26 9	Cork	23 7
Waterford	20 0	Wexford	25 2	Waterford	21 1
		Tipperary	24 3		
		Kilkenny	22 8		
		Wicklow	22 6		
		Carlow	22 6		
		Donegal	18 8		
		Louth	11 5		

TABLE 15

Intercounty holding size >2 ha comparison on wet mineral lowland soils (1970)

Soil No 13		*Soil No 17*		*Soil No 25*	
County	*Farm size*	*County*	*Farm size*	*County*	*Farm size*
Kilkenny	22 8	Cavan	12 8	Tipperary	20 8
Laois	20 6	Sligo	12 7	Galway	13 7
Cork	20 6	Roscommon	12 4	Wexford	13 6
Clare	19 5	Monaghan	12 2	Roscommon	10 8
Limerick	16 6	Donegal	12 0		
Kerry	16 6	Leitrim	11 2		
		Mayo	11 1		

HOLDINGS CAPABLE OF ACHIEVING SPECIFIED STOCKING TARGETS

Approach adopted

Target stocking levels of 20, 60 and 100 L U are arbitrarily chosen However, it is relevant to point out that the lower level should be about the minimum required to generate an income comparable to average industrial earnings under a dairy cow farming system The intermediate

level corresponds on average to that which has been suggested (6) to keep one labour unit efficiently employed using moderate technology The number of hectares required on average on each soil association to support the above stocking targets is shown in Table 16 These are referred to later as "critical" acreages and are calculated from the data in Table 8

TABLE 16

Number of hectares needed to support 20, 60 and 100 L U s by soil association

Soil Association No	*Stocking target*		
	20 L U	*60 L U*	*100 L U*
7	7 0	21 1	35 2
9	7 0	21 1	35 2
8	7 2	21 7	36 2
21	7 4	22 2	37 1
23	7 5	22 5	37 5
24	7 5	22 5	37 5
6	7 8	23 3	38 9
20	7 9	23 8	39 7
22	7 9	23 8	39 7
18	8 1	24 3	40 5
19	8 1	24 3	40 5
25	9 2	27 6	46 0
4	9 4	28 3	47 1
15	9 6	28 9	48 2
27	10 1	30 4	50 6
13	12 8	38 5	64 3
17	14 7	44 2	73 6

The percentage of holdings on the study soils above the selected "critical" values were estimated by interpolation from cumulative frequency distributions of holding sizes in the sample D E D 's on the selected soils and grossed across counties to arrive at the national position for the relevant soil The frequency distributions were based on holdings above 0 4 ha size

Variation between soil associations

The results are shown in Table 17 It is calculated from this table that the number of holdings in the lowland areas of the country capable of sustaining 20, 60 and 100 L U s are 157,700, 55,500 and 26,500 respectively It is clear from the table that the proportion of holdings capable of achieving these targets shows pronounced variation between wet and dry

TABLE 17

Holdings (per cent) above 'critical capacity of 20, 60 and 100 L U s according to lowland soil association

Soil Association No	*No of holdings (000) (>0 4ha)*	*Holdings (per cent) above critical" size to sustain*		
		20 L U	*60 L U*	*100 L U*
23	16 9	83 0	21 5	7 0
9	15 7	79 5	51 5	28 5
6	3 4	77 5	45 0	20 5
7	3 3	77 5	52 5	29 0
8	20 5	75 5	43 0	25 5
21	11 2	76 5	35 5	20 0
20	13 3	76 5	26 0	11 0
24	36 8	74 0	34 5	19 0
27	1 1	74 5	35 0	14 5
22	16 4	68 0	10 0	2 0
18	11 0	68 0	12 0	2 5
4	10 0	64 5	18 0	6 0
25	12 1	64 5	15 0	5 5
13	20 1	64 0	14 0	4 0
15	10 3	54 0	5 5	1 0
19	7 3	60 0	10 0	2 0
17	21 9	31 0	2 0	0 5
Total	231 3	67 6	24 0	11 4

soil associations particularly For instance only 31 per cent of holdings are of adequate size to support 20 L U on the poorly drained Soil 17 compared to approximately 80 per cent in the well drained Soils 6, 7, 8, 9, 20, 21 and 23 The proportion is also comparatively small on Soils 13, 15, 18 and 19 which all include high amounts of wet land

At the 60 L U target less than 15 per cent of holdings are of adequate size on the wet soils and Soil 17 has a particularly poor position Soil 27 is a notable exception in the wet soils On the extensive area of limestone derived soils (Soils 20, 21 and 24 particularly) 20-35 per cent are of sufficient size with the exception of Soil 22 where the proportion is considerably lower at 10 per cent The favourable position of Soil 23 at the 20 L U target and the relatively poor position of this arable soil association at the 60 L U target is a reflection of the low average holding size (14 6 ha) On Soils 7, 8 and 9 in the south of the country, approximately 50 per cent of holdings are of sufficient size to sustain 60 L U s The most favourable farm structure position is associated with the latter soils

A target of 100 L U is practically unattainable on the wet soils, the limestone soils occupy an intermediate position and the well drained arable soils in the south show the best position in this regard, with approximately 30 per cent of holdings of sufficient size to sustain 100 L U s

Variation within soil associations

Although it is clear that soil association exerts a considerable influence on the proportion of holdings capable of achieving a specified stocking target, there is also a wide intercounty range within a soil association This is shown for a number of major soils in Table 18

TABLE 18

Intercounty range in percentage holdings above "critical" capacity on particular soil associations

Soil Association No	*Stocking target*		
	20 L U	*60 L U*	*100 L U*
24	89–56	53–12	22– 5
8	88–58	54–20	36–11
21	82–70	53–17	35– 6
20	83–72	31–20	14– 5
13	71–53	24– 9	8– 1
25	75–53	34– 6	17– 2
17	38–24	3– 1	2– 1

The wide range is especially evident on the more extensive soil associations i e Soils 8 and 24, where the range is greatest at the 20 L U target and narrows considerably at the 100 L U target

By applying the intra-class correlation test to the original data from which Table 18 is derived the following correlations were established with respect to the soils in the table

$$\rho_1 = 0\ 732^{***} \quad (p \leq 0\ 001)$$
$$\rho_2 = 0\ 538^{***} \quad (p \leq 0\ 001)$$
$$\rho_3 = 0\ 690^{***} \quad (p \leq 0\ 001)$$

where ρ_1, ρ_2 and ρ_3 refer to the 20, 60 and 100 L U targets respectively, the test of significance of the intra-class correlation being very highly significant in each case

REDUCTION IN HOLDINGS NECESSARY TO CREATE UNITS CAPABLE OF SUPPORTING THE SELECTED STOCKING TARGETS

By calculating the total acreage in holdings below the "critical" size for each soil association and the number of units based on 20, 60 and 100 L U which this acreage could support, it is possible to show the reduction which would be necessary to create units capable of supporting at least the above number of L U s Existing units above the "critical" size are assumed to remain so

The results are shown in Table 19

TABLE 19

Reduction (percentage) in holdings required

Soil Association	No of holdings (000) (>0 4ha)	Stocking target		
		20 L U	60 L U	100 L U
23	16 9	7 4	38 4	57 0
18	11 0	11 2	48 8	66 0
20	13 3	11 3	37 7	54 7
9	15 7	11 7	38 2	46 8
22	16 4	11 7	49 7	66 8
27	1 1	12 9	36 0	51 6
21	11 2	13 0	35 3	50 2
8	20 5	13 3	32 2	45 5
7	3 3	13 9	27 0	38 8
24	36 8	14 0	36 7	51 2
6	3 4	14 7	32 5	47 8
4	10 0	15 3	48 3	63 8
25	12 1	15 7	49 2	65 0
19	7 3	17 3	54 0	69 7
13	20 1	18 7	36 1	66 3
15	10 3	18 7	58 5	73 5
17	21 9	29 8	67 9	80 0
Total	231 3	15 2	43 4	59 4

There is a wide variation between soils in the reduction in holdings required It can be seen that if all holdings were large enough to sustain 100 L U s the reduction in holdings would range from 80 per cent on the poorly drained Soil 17 to approximately 40 per cent on the well drained Soil 7 At the 20 L U target, the smallest reduction would be 7 per cent on the well drained Soil 23 and the greatest reduction would be approximately 30 per cent on Soil 17 It is estimated that the total reduction in holdings required in the lowland area of the country is 35,100, 100,500 and 137,700 at the 20, 60 and 100 L U targets respectively The reductions are shown graphically for Soils 24 and 17 (Fig 4)

The reduction in holdings required on contrasting soils within counties is illustrated for two counties in Table 20

TABLE 20

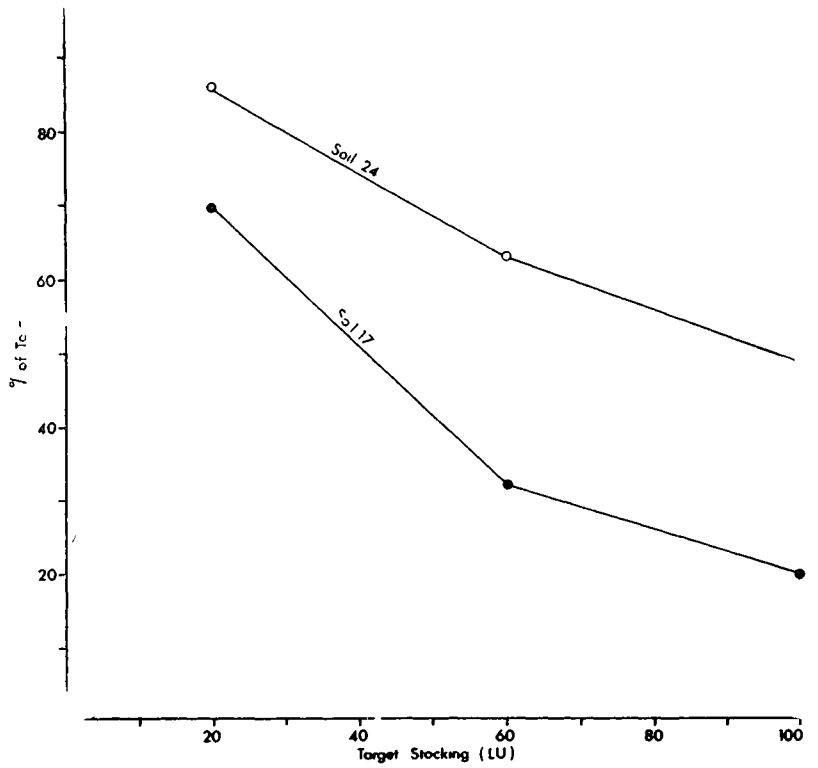
Reduction in holdings on contrasting soils within counties

County	*Soil Association No*	*No of holdings (000) (>0 4ha)*	*Stocking target*		
			20 L U	*60 L U*	*100 L U*
Wexford	8	3 76	6 9	20 4	34 3
	25	1 50	29 8	52 0	64 5
Limerick	24	4 24	11 2	30 5	45 3
	13	2 10	21 5	54 0	70 4

The results can vary considerably between soils within counties as exemplified by East Limerick (Soil 24) and West Limerick (Soil 13) and also by the position in Wexford

FIGURE 4

Reduction in holdings necessary on two contrasting soil associations (Soil 24 (dry) and Soil 17 (wet))



DISCUSSION

Our land resources and their potential productivity

Intensive production of livestock is possible on 44 4 per cent of the total land area of the country or 67 per cent of the lowland area This area has an average production potential of 272 L U /100 ha (based on high N use) Another 45 per cent of the country is beset with physical

limitations of soil, topography or climate and corresponds with our difficult farming areas On the wet mineral component of this "marginal" land, stocking potential is limited to 143 L U /100 ha on average, whereas on the heterogeneous mountain and hill units stocking is limited to an average of 50 L U /100 ha, this being a provisional estimate On the remaining 10 per cent, which is the better type of wet mineral lowland, the average production potential is 212 L U /100 ha (based on high N use)

It is estimated that the average livestock density in the lowland mineral soil areas in 1973 was 141 L U /100 ha However, this shows considerable variation and can range from 250 L U /100 ha on better farms on dry land in the intensive dairying areas to 62 L U /100 ha in the more difficult wet areas It was shown (7) that only 2 3 per cent of farms from An Foras Taluntais Farm Management Survey were stocked at the rate of 198 L U /100 ha or better in 1968 However, it is likely that this position has improved to some degree considering the 16 per cent increase in the number of livestock units in the country since 1968 Nevertheless the average stocking rate in 1973 indicates that there is a considerable gap between the technical capacity of land and existing levels of production While the potential stock carrying capacity of the country is estimated at 10 3 million L U s, it is important to point out that this is based on the existing land-use structure and existing technology

Present levels of animal production are relatively low at farm level because of inadequate primary energy production from grass and the inefficient utilization of this energy by inefficient animals and it would appear that the potential increase in output of milk or meat/ha seems much greater than any foreseeable increases in arable crop production For instance, the introduction of higher yielding new grass varieties to the dry land areas which research (8) has shown to have a biological potential above 20,000 kg harvestable dry matter/ha could theoretically uplift the stocking capacity of the country by 40 per cent The average dry matter production from Irish pastures is 6,000 to 7,000 kg/ha but values of around 15,000 kg/ha are already being attained by the small number of intensive grassland farmers

In assessing the productive capacity of land this study was limited to an illustration of soil type-grassland production relationships An examination of the relative efficiency of different land-utilization systems from an energy production viewpoint is outside the scope of the study However, it is important to point out that there are a number of alternative methods of exploiting the productivity of good land which is not open to poor land areas

(a) the production of crops for direct human consumption,
(b) the production of arable crops for animal feed,
(c) the production of grass for animal feed

In the poor land areas agricultural production is limited substantially to grass exploitation

The data provided on the disparity in land resources between counties

should help in providing a useful framework for spatial studies of agricultural economies

Size of holding – land potential relationships

While the study demonstrates that it is possible to systematise farm size data against soil association, it is also clear that there is a considerable range in size within many soil associations as illustrated by the inter-county comparisons Despite this, the study succeeded in quantifying the generally paradoxical relationships between holding size and productive capacity of land in the lowland area of the country The results showed that there can be substantial land potential linked inter- and intra-county variation in holding size

The "critical" acreages needed to support the specified stocking targets assume a high level of management and high levels of pasture production and utilization This involves essentially the application of the existing technology developed at An Foras Taluntais Research Centres The results indicate that 67 per cent of holdings in the country are limited to a technical carrying capacity of 20 L U , and only 24 per cent are capable of achieving the modest target of 60 L U In the wet land areas (Soils 15, 17 and 19 particularly) the structure position is very inadequate However, it is important to note that the results are based on feed energy production from within the farming system and that the position would alter depending on level of feed energy importation into the system

Land appraisal implications

A detailed analysis of tax assessment based on land valuation is outside the scope of this paper and will provide the basis for further studies However, it is relevant to briefly point out the implications of the study from the viewpoint of land appraisal for taxation purposes This is particularly relevant in view of the Government's decision to base the income tax assessment of larger farms on their Griffith Valuation

Earlier studies by the author (9) in Co Wexford showed that the Griffith Valuation did not provide an equitable basis for assessment in that it failed to establish a proper value relationship between land tracts of varying productivity More recently (3) an objective evaluation of Wexford land for grazing purposes was completed which could provide the basis for an equitable system of land assessment Table 21 shows the inequity which may exist between the Griffith Valuation and land potential for grazing livestock Soils 8 and 27 which occupy 50 per cent and 9 per cent of Wexford respectively are selected for illustrative purposes

TABLE 21

Comparison of Griffith Valuation and land potential for livestock

Soil No	*Griffith Valuation Index*	*Productivity Index*
8	100	100
27	130	72

To overcome inequities of this nature, a schedule of land valuations could be based on grazing capacity ratings by fixing a maximum valuation rate for land of the highest grazing capacity and standardizing the valuation of each land unit shown on the detailed reconnaissance county soil maps (where available) against this

Economic implications

Recent studies (10) show that only 20 per cent of farms in the Republic attained comparable incomes to those received outside agriculture in 1973, the comparable income being £1,723 If we assume a family farm income of £90 per cow, 20 dairy cows should generate an income comparable to that received outside agriculture The assumed income of £90 per cow makes no allowance for capital employed This study indicates, therefore, that even with the existing farm size pattern and when the technical capacity of the land only is considered, approximately 67 per cent of holdings are capable of achieving incomes comparable to those outside agriculture under a dairy cow system of farming If we assume an upper figure of 40 cows to achieve comparable income, it is estimated that only 40 per ceut of holdings are of sufficient size to suppot this level of stocking Under a beef system the proportion would be considerably less The managerial or social factors obtaining at farm level or capital availability are not considered In practice, these are of fundamental importance in assessing possible levels of economic performance

SUMMARY

Two-thirds of the land of the Republic of Ireland consists of lowland mineral soils, the remaining one-third consisting of mountain and hill and low level peat Two-thirds of the lowland area is dry and one-third consists of wet land There are considerable intercounty differences in the composition of land resources with the dry land unit varying in extent from 70 per cent to 7 per cent An estimated 70 per cent of the difficult farming land in the country occurs in the eight western seaboard counties

The stock carrying capacity of the lowland areas varies from 284 livestock units (L U)/100 ha to 136 L U /100 ha, the difference being largely attributable to soil drainage

An estimated 53 per cent of agricultural holdings in the country occur on dry land, 32 per cent on wet land and 15 per cent in the mountain, hill and low level peat zones While significant relationships were established between size of holding and soil association in the lowland areas, there can be a considerable range in size on similar type land across countries The most unfavourable structural position in the lowland areas is associated with the poorer wet mineral soils or areas with relatively high proportions of peat

An estimated 67 per cent of holdings are limited to a carrying capacity of 20 L U however this could range from as little as 30 per cent in the poorer areas to over 80 per cent in some

of the better areas At a 60 L U target, only 24 per cent are of adequate size with a range from 1 per cent in the poorer areas to 42 per cent in the better areas At a target of 100 L U , 11 per cent are of sufficient size with a range from 0 5 per cent in the poorer areas to 29 per cent in the better areas In arriving at these estimates, the technical capacity of the land only is considered

The implications of the study for land appraisal for taxation purposes are also briefly described and it is suggested that a schedule of land valuations could be based on grazing capacity ratings

ACKNOWLEDGEMENTS

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APPENDIX

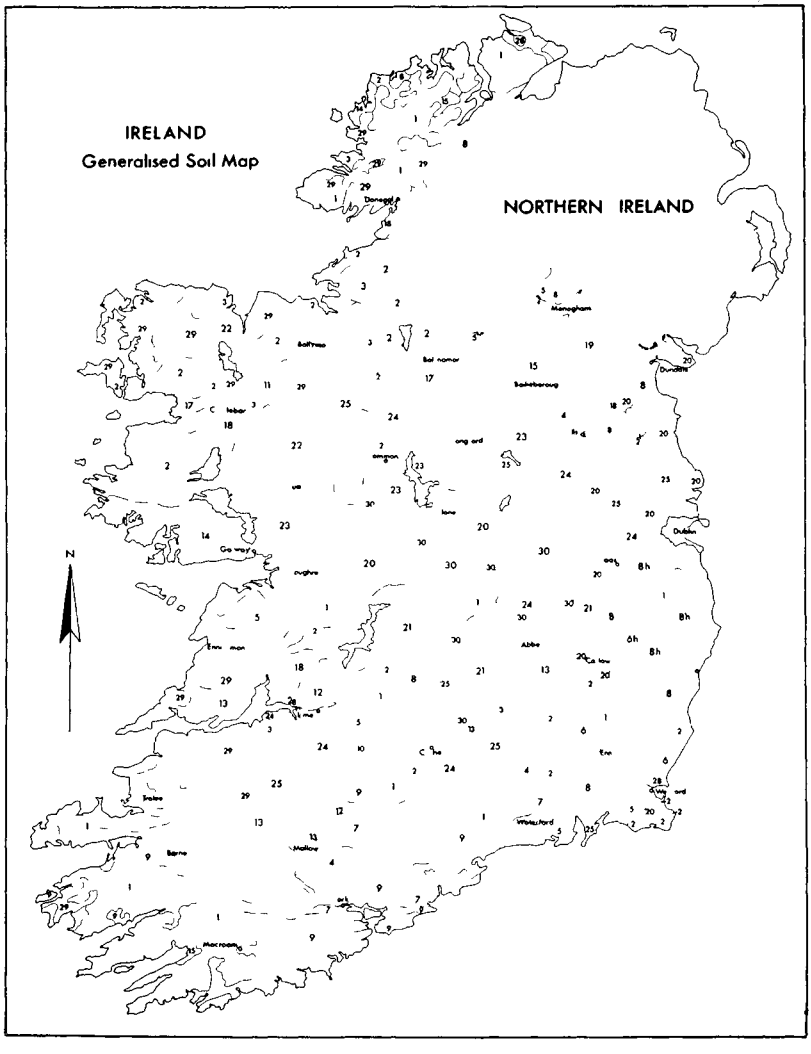

Figure 1 Reduced and simplified diagramatic representation of the soil map of Ireland

TABLE 1

Major soil associations and their limitations for agriculture

Physiography	*Soil No*	*Soil Association*		*Limitations*		*Per cent 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
	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
Rolling lowland	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

	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
Drumlin	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
	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
Flat to undulating lowland	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 88
	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

DISCUSSION

Dr M Ross It is with great pleasure that I propose the vote of thanks to John Lee I have long been a fan of John's in his efforts to link the findings of the National Soil Survey to the economic aspects of farming His work a decade ago on the stochastic factors in beet growing in Wexford and their relationship to the probability of farmers on different soils being induced to grow beet have provided indispensable insights into the physical aspects of the farm decision process for this crop

His general work on the potential of Irish land for livestock production is an essential ingredient in any effort at a thorough-going analysis and planning of Irish agriculture Given the data he provides it should be possible to overcome some of the difficulties facing the Farm Management Survey when it attempts to arrive at a meaningful concept of adjusted acres to describe farm size When I was myself engaged in writing my thesis a decade ago on the use of operations research techniques for regional agricultural planning, I did not then have the benefit of John's work I sought to expand from the tri-regional classification of Professor O'Connor's National Farm Survey A paper by Dr Attwood to the Society had illustrated the divergences in income between Rural Districts within the designated areas If the most empoverished districts in these areas were omitted, then the North and West region fell naturally into two regions – a seaboard area of low income distinct from the dairying areas associated with a band of country running from Monaghan to Killala but including parts of South and East Donegal Using the income data provided by Drs Attwood and Geary, the East and Midland region readily resolved itself into three parts – a western livestock area with an emphasis on sheep, a midland area emphasing fat cattle, and an east and south east area with greater prominence given to tillage The southern area can also be decomposed into dairying with and without tillage All this work was based on economic data Nevertheless when these regions are compared with the generalised soil map for the country which Dr Lee has shown, it immediately becomes apparent that the economic practice is closely related to the basic soil realities and that the work of Drs O'Connor and Attwood as well as my own work, accords well with the physical resources of an area as outlined by Dr Lee

Dr Lee in his paper refers to the discrepancy between land potential and the Griffith Valuations I submit that the changes in agricultural technology in the last century helped explain some of these divergences The Macamore soil of Wexford was a good soil when worked with a spade but became a difficult soil when heavy machinery had to be used Light sandy soils a century ago did not benefit from artificial fertilizers and therefore yielded poorly Today they are often ideal and in addition do not result in heavy implements being bogged down in wet weather

In conclusion might I ask for an explanation to the statement on page 158 which equates 256,350 holdings averaging 14 8 ha with 188,460 farms averaging 16 2 ha

Once again might I enthusiastically propose that Dr Lee deserves the thanks of the society for a really excellent paper

Mr T P Linehan I welcome Mr Lee's valuable work relating to a very important characteristic in any classification of our land and in any study of the relative performance and relative capacity of various parts of that land It would be extremely interesting if in the course of any sample surveys etc of agricultural holdings, one could readily record the appropriate soil association or soil series in addition to the other characteristics normally collected

Perhaps it would be useful to say a few words on the section "farm size in Ireland" relating to the differences that exist between "holding" and "farm" In the regular June agricultural enumeration, the unit of enumeration is the agricultural holding which is as defined in the footnote on page 158 of the paper Every holding is covered irrespective of whether there is a residence on the holding or not or whether there is any specific person to whom the holding can be related or not In the periodical Census of Population on the other hand, however, the basic unit of enumeration is the individual person Where that person indicates on the census form that his principal occupation is "farmer", information on the size of farm (i e holding) is also requested Almost all of these farmers own the land which they work but there are a small number who are farmers but not land holders There are, however, a considerable number of land holders who are not farmers and in the Census of Population these are classified to their principal occupation In the 1966 and 1961 Censuses of Population, information on land holders by size of holding was obtained as additional information Some additional land is indeed held by persons who would not be covered in the Census of Population at all if they were not present in the country at the time of the Census and further land which belongs to institutions, companies etc would not appear as belonging to any land holder distinguished as such in the Census of Population

The examination of the relationship between size of holding and soil association is interesting indeed In this context the showing of Table 12 could be improved if the percentages of land area shown in the final column were adjusted to take account of two factors Since the holdings on low level peat are negligible, the acreage has naturally been omitted from the table, consequently only 88 2 per cent of the land area is covered If the figures are adjusted proportionately to bring the total to 100 this will increase all the entries The second adjustment stems from the fact that a considerable area of land is not on agricultural holdings The total is approximately 2 8 million acres This of course includes the area under low level peat but most of the remainder must relate to mountain and hill land This would all fall to be deducted from the corresponding entry on Table 12 and after a further adjustment to again bring the total to 100, I suspect that the figure for the percentage of land area corresponding to dry land on holdings will at least be equal to the percentage of holdings

In this analysis using the sample of District Electoral Divisions I would

like to suggest what I consider to be an important extension In the basic records there is available for each such D E D the various numbers of livestock in different categories and crops grown etc These could be readily converted to one figure for standard man days or some appropriate measure in each case and it would be of great interest to examine the relationship between the actual usage and the potential as described in the paper

Other speakers have commented on the implications of the figures shown in Tables 16 and 17 in the context of viable farms etc The author has indeed mentioned in several places that in arriving at these estimates the technical capacity only of the land was considered This is indeed a qualification and the other "managerial or social factors obtaining at farm level or capital availability" must be taken into consideration in any realistic interpretation There is however another qualification which I think should be stressed more The technical capacity is based on the results achieved in experimental conditions in a Research Institute using the higher levels of N mentioned in the paper How realistic is it to assume that these conditions could in fact be reproduced on all holdings throughout the country?