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The Spatial Structure of Agricultural Output in the Republic of Ireland

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I INTRODUCTION

MIXED livestock production with some arable cropping is the description often taken as applying to the form of agriculture practised throughout Ireland, with little or no reference to the major regional variations in the emphases placed on different farming enterprises which are such a striking feature of the agricultural scene. The complete agricultural enumeration, taken at intervals of five years, provides comprehensive statistics for detailed study of the spatial patterns of crop areas and livestock numbers. In contrast, data relating to the value of farm output are deficient, so that areal analyses of the type available in many other countries have not been done. It is the purpose of this paper to contribute to such analysis by using the agricultural statistics on a rural district basis in conjunction with county output values estimated by Dr M. Ross and converted to gross margin values. These data are employed to outline concisely spatial characteristics of agricultural output.

Farm enterprise patterns are mapped and discussed, with the unit of measurement being the percentage contribution to total gross margin made by each of seven product categories: arable crops, milk, cattle, sheep, horses, pigs and poultry. Type-of-farming areas are delimited by least squares analysis and by cluster analysis, the latter technique yielding six groups of rural districts whose output orientation characteristics are discussed. Finally, an attempt is made to describe and explain areal patterns in the productivity of agricultural land and labour.[1]

II THE DATA

Monetary values of output were used in the study as the common measure of crop areas and livestock numbers. This enables farming enterprises to be compared in terms of their economic significance, the most vital consideration

1. Some of these topics are treated at length in Gillmor, D.A., *Agriculture in the Republic of Ireland*, Budapest: Académiai Kiadó, in press.

for Irish farmers. Estimated output data on a county basis have been published (Ross, 1972, pp. 27–30) and access to additional unpublished figures, relating in particular to individual crops, was granted by Ross. These data refer to the year 1969, being the most recent available, but the relative importance of different enterprises and their spatial patterns, with which this paper is concerned, change much more slowly than the absolute values of output. It was possible to obtain for each crop and livestock category county values of gross agricultural output, being sales from the county plus consumption by farm households within it. The agricultural enumeration was the source of statistics on crop areas and livestock numbers, the different categories of animal being equated in terms of livestock units through use of a set of coefficients adapted to Irish circumstances (Gillmor, 1970, pp. 587 and 588). It was then possible to compute standard gross output values per hectare and per livestock unit in each of the 26 counties for the individual crops and livestock.

Gross margin, being gross output less direct costs such as fertilisers, seed and feedstuffs incurred in the production of a particular enterprise, may be regarded as a more meaningful measure of the importance of an enterprise than is gross output. Gross margin indicates the contribution an enterprise makes to the agricultural economy by representing the value added by farming, so that it is nearer to the ideal concept of net income or profit, which cannot be computed because of the difficulty of allocating common costs amongst enterprises. It was thus decided to use gross margins, although data are less readily available and the methodology is necessarily more complex. Data in the Farm Management Survey (Heavey and Hickey, 1973) were used to compute, for each of the major crops and livestock, the percentage of gross output of the enterprise accounted for by its gross margin. In the absence of appropriate Farm Management Survey data, the percentage for horses was taken to be the mean of the values for the other grazing livestock, that for poultry was adopted as the mean of broiler and egg production derived from Nix (1972) and those for horticultural crops were obtained from Hickey.[2] Use of gross margin rather than gross output standards did not greatly affect the relative positions of most enterprises, the percentage for all crops and livestock other than the farmyard enterprises being within the range 63–83. The percentage for pigs was 35·7 and for poultry 13·3, as direct costs are high, so that gross output values would have given an exaggerated impression of the importance of these enterprises as profit generators. The gross margin percentages were applied to the county standard gross outputs previously computed, to give county standard gross margins.

The county standard gross margins were used with the 1970 agricultural statistics on a rural district basis in order to apportion gross margin values amongst the rural districts and to investigate the structure of agricultural production at this level. The adoption of county standards is least satisfactory in counties such as Cork, Galway and Donegal where there are pronounced intra-county

2. Hickey, B. C., An Foras Talúntais, Dublin, personal communication.

variations in the nature and efficiency of farming. For each rural district, the numbers of crop hectares and livestock units were multiplied by the appropriate county standard gross margins to derive gross margin values for individual enterprises. These values were summed to give the total gross margin value for the rural district and the percentage distribution amongst seven farming enterprises was calculated. The aggregate and percentage gross margin values for the 158 rural districts comprised the data on which the study was based.

III FARM ENTERPRISE PATTERNS

The various crop and livestock products were grouped into seven categories: arable crops, milk, cattle, sheep, horses, pigs and poultry. Serious problems of definition arose only in relation to dairying and beef production (Gillmor, 1970, p. 589), the available statistics not clearly distinguishing dairy and beef livestock or the proportions of beef output derived from each. The value of milk output was taken to represent dairying and other products were allocated to the cattle production enterprise.

The role of each enterprise in the agricultural economy is shown by mapping its percentage contribution to total gross margin value on a rural district basis (Figs. 1—6 and 8). The system of class intervals used on the maps is based on variations from the means of all rural districts, measured in standard deviation units. In each shading series, the mean is the value separating the sloping and vertical parallel lines. The class interval on each map is one-half of the standard deviation for that enterprise; the classes below and above the mean represent values that are successively 0–0·5σ, 0·5–1·0σ, 1·0–1·5σ and 1·5–2·0σ from the mean. The majority of the frequency curves are positively skew, so that only three low-emphasis classes below the mean, and four high-emphasis classes above the mean are included. If there are rural districts with values more than 1·5σ below the mean or more than 2·0σ above it, the lowest or highest class is left open-ended. Classes which are not represented by any rural district are omitted and the lower ends of keys are not extended below zero. The system of classification based on standard deviations was selected to give some uniformity and comparability between maps, while at the same time adequately illustrating the spatial variations in the importance of each enterprise. One disadvantage of the scheme is that where variability is high, with a large standard deviation and class interval, the map may convey an impression of uniformity on superficial observation. The standard deviation expressed as a percentage of the mean for each product is: poultry 128, sheep 103, horses 91, arable crops 86, pigs 61, milk 44 and cattle 29.

The spatial role of arable cropping is a product of many influences, including the physical factors of relief, drainage, soil and climate, and human factors such as farm size, availability of capital and machinery, labour, access to markets, historical influences, social conditions, local practices and government measures. The distribution of arable cropping is the sum of the distributions of its

component parts, the effects of the many influences on farmers' decisions varying between the individual crops (Gillmor, 1969). However, the balance of advantage in favour of the east and parts of the south are such as to result in a distinct spatial pattern (Fig. 1). Leinster accounts for 59 per cent of the national gross margin value of arable cropping, with Counties Cork, Tipperary, Donegal and Waterford contributing an additional 29 per cent. Elsewhere the role of tillage is of generally minor significance, being lowest where land conditions are very unfavourable around the Shannon estuary and in the drumlin belt of the north.

There is a distinct spatial pattern in the role of milk production, based largely on the dairying regions of the southwest and, to a lesser extent, of the drumlin belt (Fig. 2). Dairying in these areas consists mainly of summer milk supply to creameries off heavy grassland which is wet and soft in winter, where farmers would have difficulties in developing alternative land uses. The southwest has the advantage of a milder climate and a longer growing season, with the historical assets of the successes of the Cork Butter Market, the southern provisions trade and the co-operative creamery movement. Munster and Kilkenny contribute 64 per cent of the national gross margin value of milk production, with a further 10 per cent coming from Counties Cavan, Monaghan, Sligo and Leitrim. The liquid milk trade is of greatest significance in the Dublin supply area but the contribution of dairying to farm income is less than average. Despite an extension of creamery milk production, the role of dairying is least in the southeast and across the central lowland, where, as along the west coast, milk in excess of farm household requirements is largely fed to livestock.

In contrast with the distribution of dairying, cattle production is of greatest importance across the central lowland, especially in its northern part but with a southerly extension in Clare (Fig. 3). The emphasis is on the rearing of young stock to the west of the Shannon but more mature animals are produced on the better quality land and larger farms of the east. The distribution of cattle is closely related to the large scale movements of cattle which occur within the country, mainly to better land, to districts where cattle are more easily wintered, to larger farms, to non-dairying areas and towards the places of slaughter and export. The role of cattle production in the farming economy is least in the arable cropping districts of the east and the dairying districts of the southwest, where its comparative disadvantage is greatest with respect to these more profitable enterprises.

Sheep play a major role in the farm economy of upland areas, where they have a comparative advantage over other enterprises which are more adversely affected by the environmental conditions. This is most evident in the Leinster Chain, west Donegal and west Connacht, and to a lesser extent in the southwest and on other mountain ranges (Fig. 4). Lowland sheep farming is significant in parts of east Leinster but its role is greatest in the traditional producing area on the dry limestone land of south Connacht. In contrast, sheep are of least

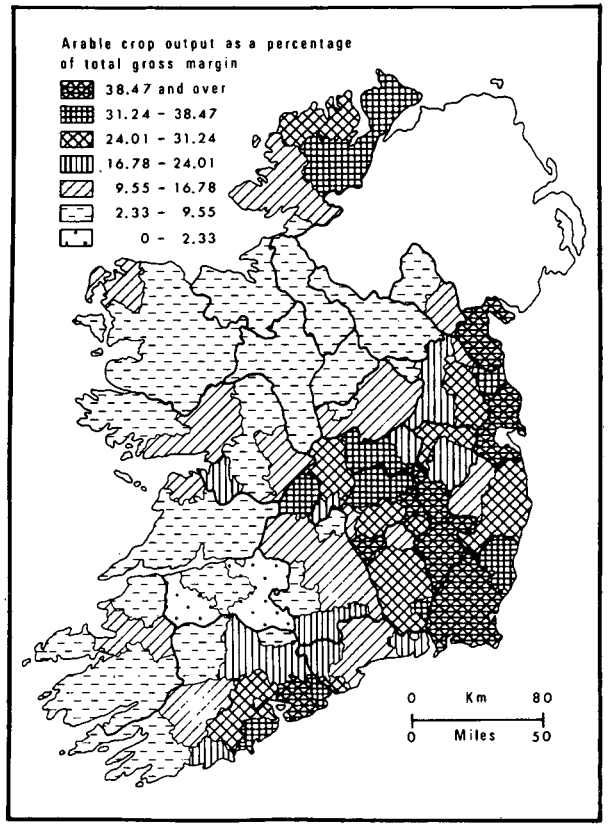

Figure 1: *the role of arable crop production*

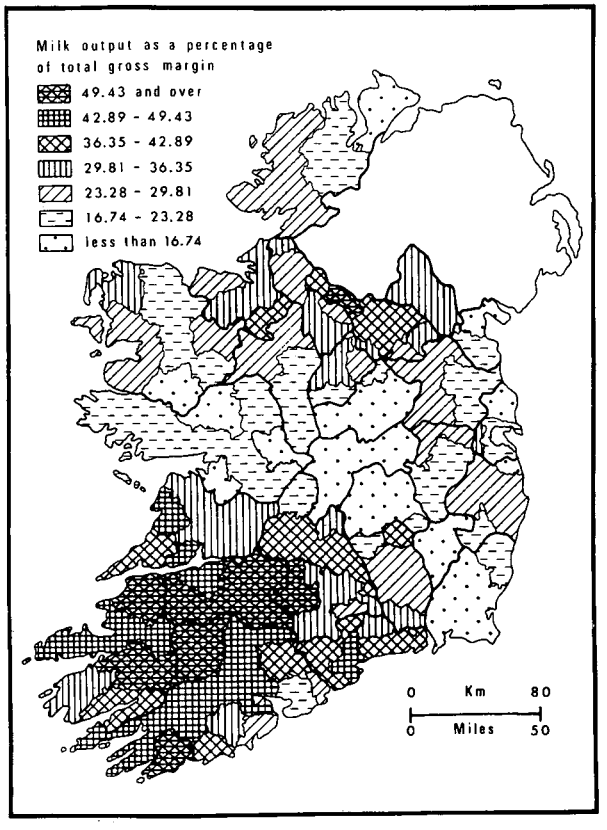

Figure 2: *The role of dairying*

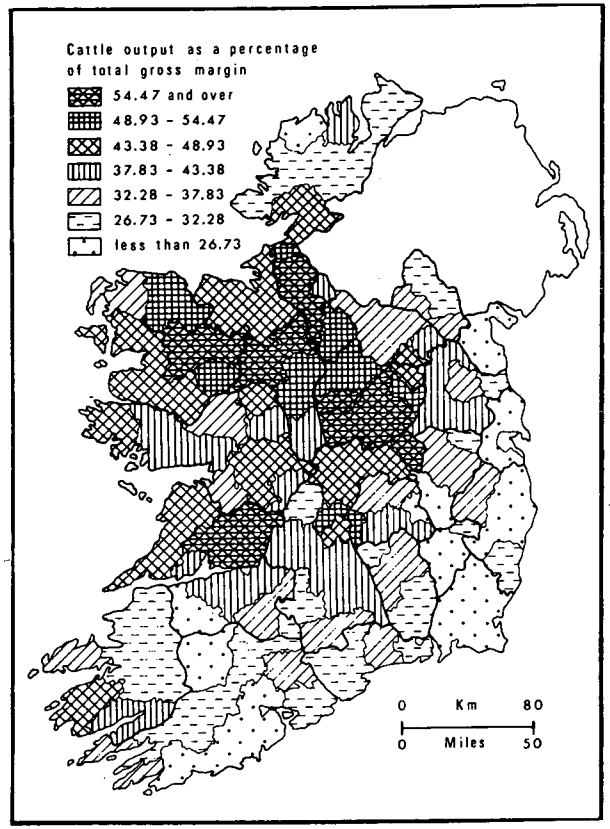

Figure 3: *The role of cattle production*

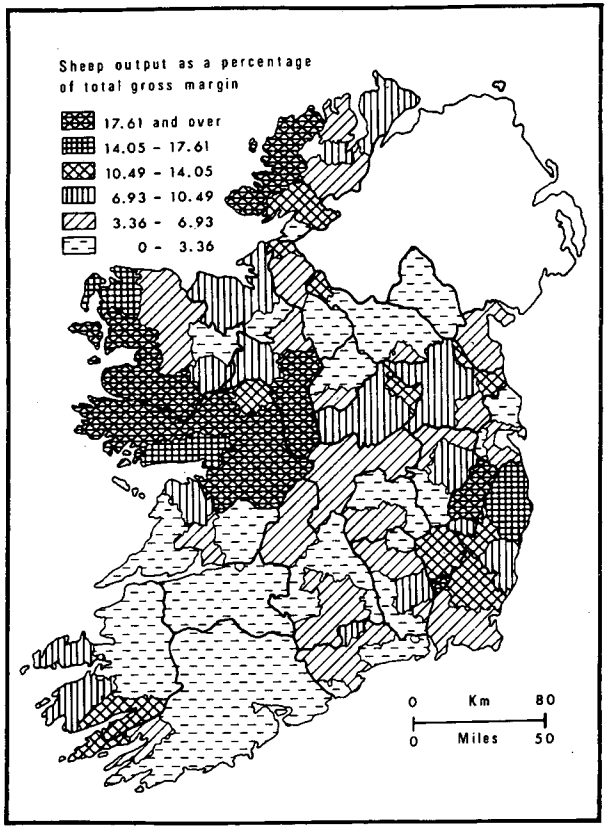

Figure 4: *The role of sheep production*

significance on wet soils, where disease susceptibility is high, they do not thrive well and they are in competition with dairy cows, as in central Munster and lowland parts of the drumlin belt.

The role of horse production is greatest in the Dublin region (Fig. 5). Many horses and ponies are kept for recreational purposes in the vicinity of the city and 44 per cent of the state's thoroughbreds are in Counties Kildare, Meath and Dublin. Location factors for stud farms seem to be land and pasture type, farm size, access to Dublin, and traditional, military and social influences, with the major centre being the Curragh in central Kildare. Horse breeding is also significant across the south from Wexford to Clare. Output in the western half of the country, where farming is less mechanised, is largely of working horses and it is lowest in areas bordering Northern Ireland, where tractor ownership is high.

Although pig feeding practices have changed, there is a traditional association between dairying and pig keeping, accounting in part for the spatial pattern of production (Fig. 6). The role of pigs is greatest in the creamery supply areas of small farms in west Cork and Monaghan-south Leitrim, the latter district being a southward extension of the major producing area in Northern Ireland. Dispersed districts of high value reflect the establishment of large fattening units, as in the vicinity of the towns of Tullow, Roscrea, Tipperary, Mitchelstown and Waterford. Pig production has a minor role in much of the west and midlands where there is little interest amongst farmers, handicaps in western areas including the cost of feedstuffs, capital scarcity, the age structure of the population and a lack of familiarity with pigs.

Poultry production formerly played an important role in the economy of small farm areas in the north, west and southwest but this association has largely ceased (Fig. 8). The organisational restructuring of the industry has resulted in locational shifts, with large production units being established in the east and parts of the south, where there is closer proximity to markets, cheaper feedstuffs and more capital and enterprise. Individual units may be large enough to affect rural district values, as in east Wicklow and Carlow, but organisation in west Limerick is on a co-operative basis. County Monaghan is the only area of traditional farmyard production which has developed the modern industry on a large scale, to the extent that it now has one-fifth of the national flock, and poultry contribute 9 per cent of the county's total gross margin value.

IV TYPE-OF-FARMING AREAS

Geographers and agricultural economists have shown much interest in the regionalisation of agriculture and different sets of agricultural regions for the Republic of Ireland have been delimited by Stamp (1931), Freeman (1945), Scully and Swanson (1964), Gillmor (1967) and Ross (1969). The schemes indicate the major areal characteristics of Irish agriculture but the criteria used

and the sets of regions differ, and there was a varying but strong subjective element involved in delimitation. Sufficient data and an adequate methodology for a comprehensive quantitative regionalisation based on the totality of Irish agriculture do not exist. The present study is limited to investigation of the spatial patterns in the type of farming, which is the orientation of agricultural production as indicated by the relative importance of the component enterprises. The two quantitative techniques adopted are least squares analysis and cluster analysis. The study was undertaken in order to use a common measurement base and more objective procedures than those previously employed. No method can be regarded as completely objective, as many subjective decisions concerning the data, techniques and procedures used are involved.

1. Least Squares Analysis

Least squares analysis was devised by Weaver (1954) and modified by Thomas (1963) as a statistical method of representing crop associations and identifying the most important crops in areas. Symbolic letters are used to indicate the appropriate ranking and number of products in the theoretical enterprise combination to which the actual output structure in a rural district most closely approximates, as measured by the least sum of squared deviations (Fig. 7). Rural districts with the same combination are grouped together on the map.

Combinations with three or two enterprises are typical, the principal enterprise always being either cattle production, dairying or arable crop growing, with cattle ranking first in more than one-half of the rural districts. There are two large uniform tracts having two-enterprise combinations, cattle-milk in the north-west and milk-cattle in the south-west. The importance of arable crops in much of the eastern half of the country, north Donegal and south and east Cork, and the inclusion of sheep in south and west Connacht, west Donegal and parts of Leinster, result in a more mixed and complex pattern elsewhere, with three- and four-enterprise combinations predominating. Pig production is part of the enterprise combinations in west Cork and Cavan-Monaghan, with poultry in Monaghan and the only inclusion of horses occurring in central Kildare.

2. Cluster Analysis

Cluster analysis is a numerical classification technique which seeks to separate data into constituent groups so that similarity is maximised within, but minimised between, groups. The technique has been reviewed by Everitt (1974) and was used effectively in agricultural regionalisation studies by Aitchison (1970, 1974) and Winsberg (1970). An agglomerative hierarchial clustering procedure[3] was used to group rural districts together on the basis of similarities in the structure of their gross margin data taking the seven enterprises into account.

3. The computer program used was STU3CLUST, provided by S. Daultrey, University College, Dublin. It is an adaptation of the cluster program package developed by D. Wishart.

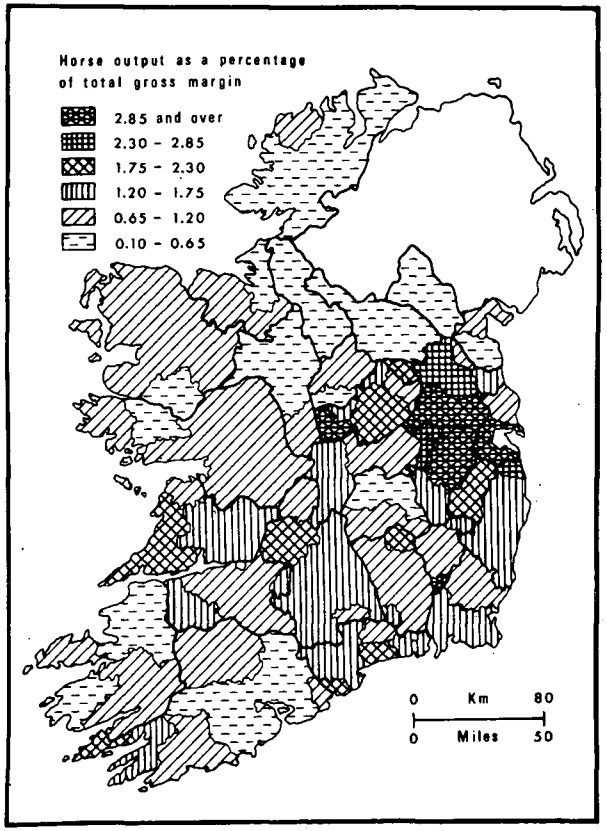

Figure 5: *The role of horse production*

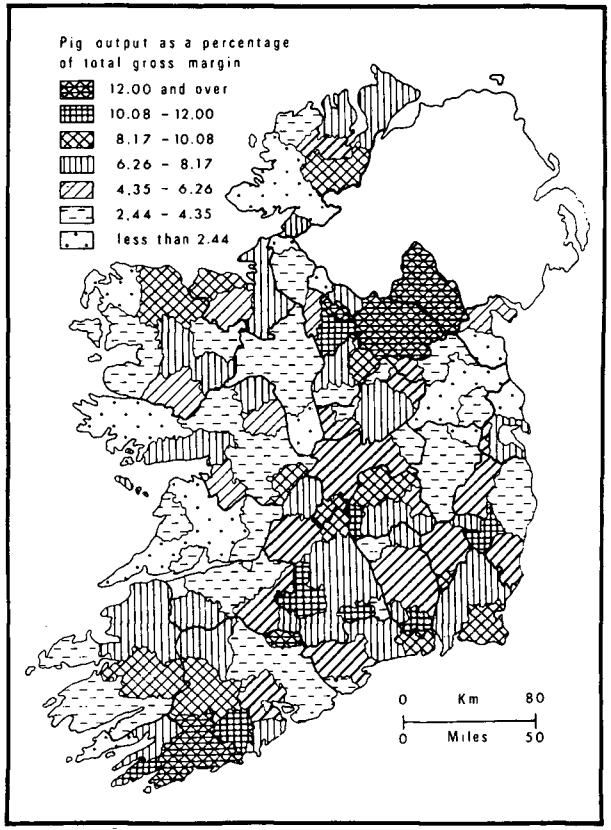

Figure 6: *The role of pig production*

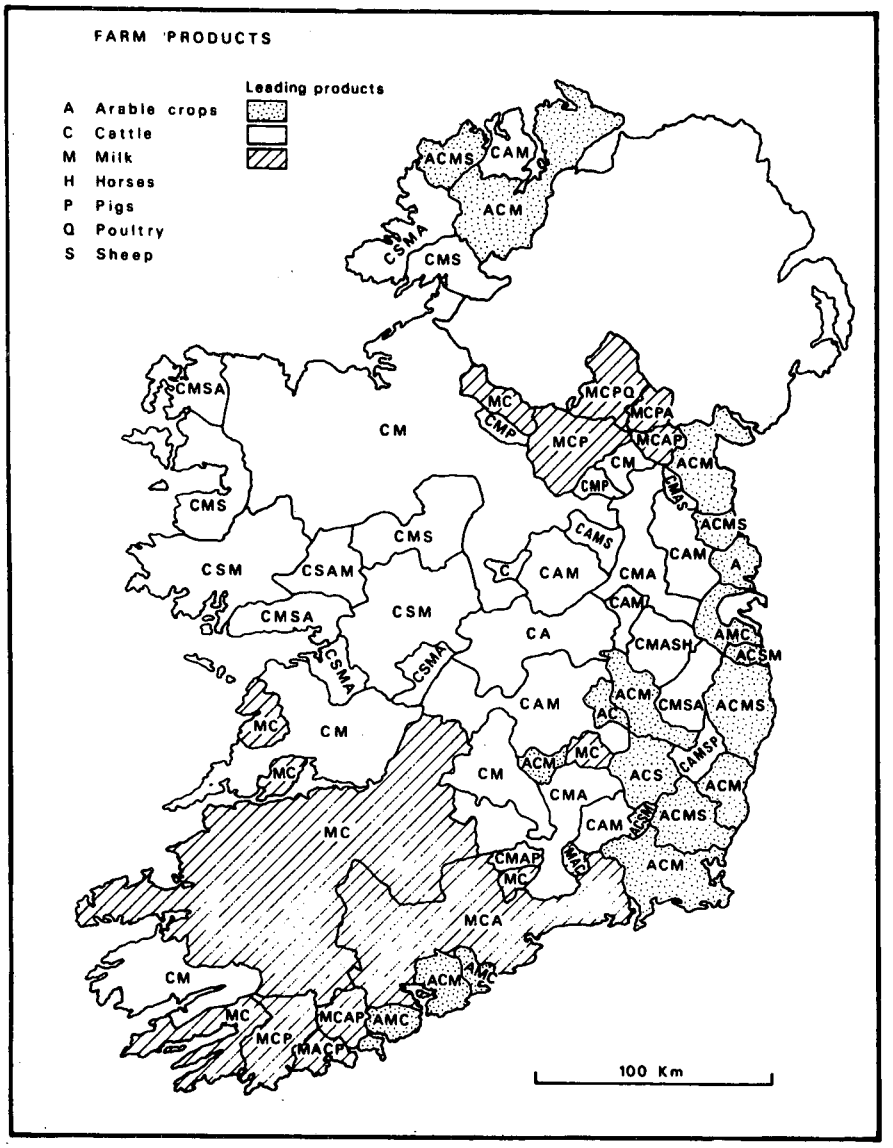

Figure 7: *Farming enterprise combinations*

The level of classification at the six-group fusion stage was taken as yielding meaningful groups for delimitation and mapping (Fig. 9). The gross margin structure of the six groups is given in Table 1 and their enterprise combinations classified by the least squares method are included in Table 2. The principal characteristics of the type-of-farming areas are as follows:

Group A: This cluster of rural districts is strongly oriented towards arable cropping, with cattle production and subsidiary dairying. It is the only group in which cropping is the leading enterprise, its value being twice that of the second enterprise, cattle production. The group is fragmented spatially but it remains quite homogeneous through the clustering procedure and it is the type-of-farming area most unlike the remainder of the state. At a later stage of fusion, it is joined by the previously unclassified districts in south Carlow and north Dublin. This ultimate group occupies 10 per cent of the state's crops and pasture but contributes 38 per cent of the gross margin value of arable crops.

Table 1: *Gross margin structure by type-of-farming group*

	Percentage of total gross margin						
Group	*Arable crops (A)*	*Milk (M)*	*Cattle (C)*	*Sheep (S)*	*Horses (H)*	*Pigs (P)*	*Poultry (Q)*
A	47·27	15·05	23·50	6·33	1·31	5·61	0·92
B	21·79	30·40	32·78	4·90	1·44	7·18	1·50
C	6·82	26·24	52·08	6·97	0·88	6·00	1·00
D	10·62	16·72	40·80	25·32	0·88	4·55	1·12
E	29·77	9·82	46·96	5·54	1·07	5·39	1·45
F	5·65	51·81	31·50	1·53	1·07	7·45	0·99
State	19·50	30·59	34·83	6·21	1·19	6·52	1·16

Group B: There is a combination of cattle production and dairying with arable cropping but this is the largest and most diverse of the groups, occupying 36 per cent of the state's agricultural land. The role of the leading enterprise is less dominant than in any of the other clusters. The group tends to be transitional in character, being interposed between areas where arable cropping is dominant and those where cattle production or dairying are very important. There is greater relative emphasis on arable cropping in Leinster districts contiguous with Group A areas and in Donegal, on dairying in southern parts, and on cattle, sheep and horses in mid-Leinster. In Cavan-Monaghan the mixed character of Group B is partly attributable to the importance of pig and poultry production.

Group C: Cattle production dominates to a greater extent than does the leading enterprise in any other cluster, with dairying as the next ranking enterprise. It is the second biggest of the groupings, representing the extension over a large area

of a farming type which has considerable uniformity and simplicity, with almost four-fifths of gross margin value accounted for by cattle and milk.

Group D: Cattle and sheep production are the main enterprises, contributing two-thirds of gross margin value, with subsidiary dairying and arable cropping. The characteristic which most distinguishes the group is the significance of sheep production, its role being three and a half times greater than in any other cluster. Lowland sheep farming predominates in the east of the area and mountain sheep farming in the west.

Group E: This is the smallest of all the farming-type areas but it is a grouping which is clearly defined in the clustering procedure. It has a unique cattle production and arable cropping two-enterprise association, being the only group in which dairying is not included in the enterprise combination and the one in which the dairying contribution to gross margin value is least.

Group F: Dairying is strongly dominant with cattle production in this farming-type area. The group is pre-eminent in milk production, contributing 35 per cent of the national gross margin value in dairying from 18 per cent of the state's agricultural land. Milk and cattle account for 83 per cent of its total gross margin, an even greater dominance by the two main enterprises than in the other two-enterprise combination groups, C and E. Although the third-ranking pig production lags far behind, it contributes a greater share of gross margin value than in the other five groups. The roles of arable cropping and sheep production are less than in the other type-of-farming areas. Group F is distinct from other clusters, being the second last group to fuse with the rest of the state.

V AREAL PRODUCTIVITY

Land and labour productivity was measured on a rural district basis by relating total gross margin values to the areas of crops and pasture (Fig. 10) and to the numbers of males engaged in agriculture (Fig. 11). The data necessary to compare output with capital investment are not available. The most striking feature of the spatial productivity patterns is the contrast between the high values in the east and south and the low levels in the west and northwest, the range and diversity being greater in labour productivity than in land productivity.

The areal productivity patterns are the outcome of a great complex of variables, the principal influences probably being land quality, farm size, farm enterprise, livestock and crop productivity, capital investment, accessibility to inputs and markets, labour supply, and varied social and personal factors. The importance of inherent land quality differences is indicated by the fact that the livestock carrying capacities of the best soils are estimated to be twice those of the least productive soils (Lee and Diamond, 1972); actual land productivity variations are substantially greater but physical differences must account in part

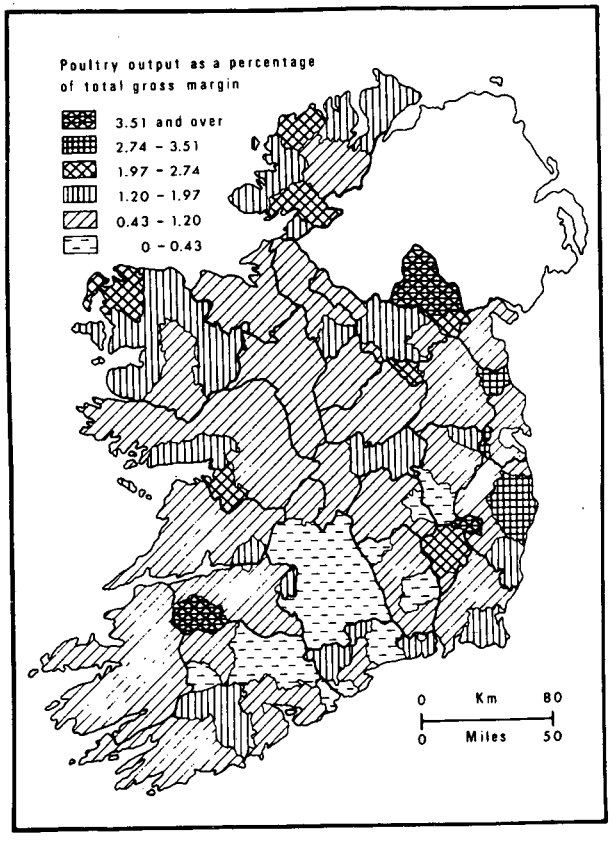

Figure 8: *The role of poultry production*

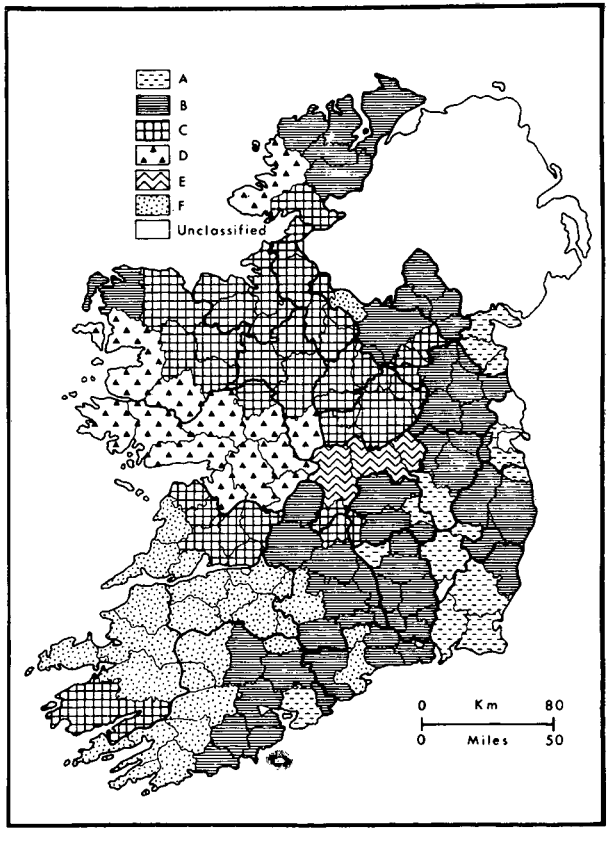

Figure 9: *Type-of-farming groups*

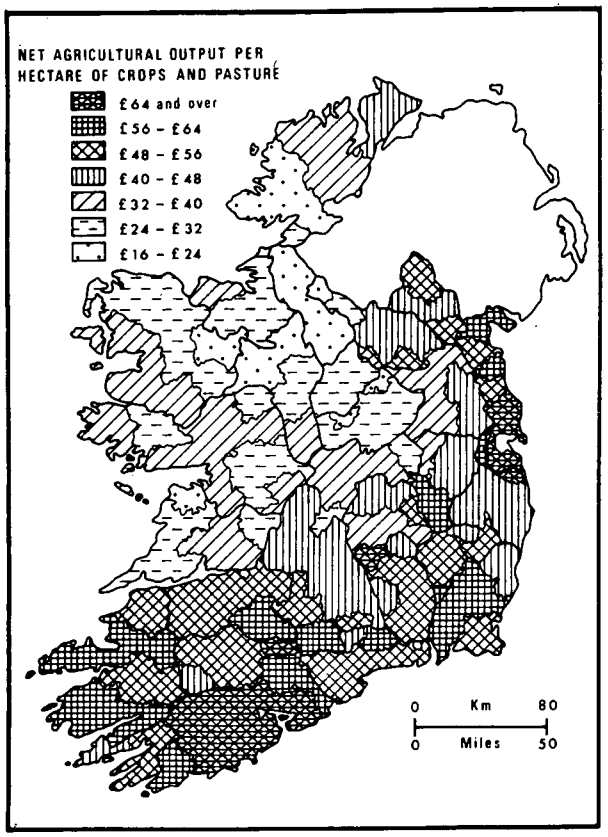

Figure 10: *Productivity of agricultural land*

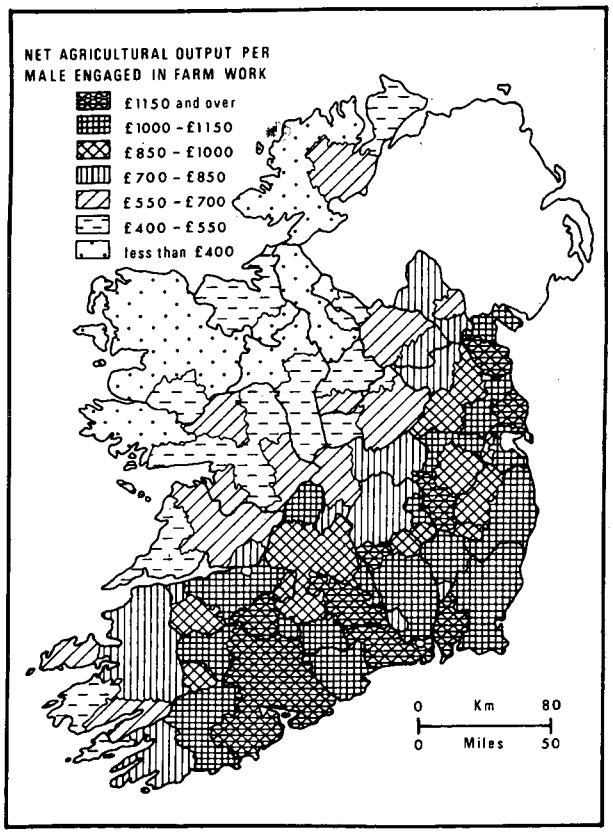

Figure 11: *Productivity of agricultural labour*

for the low output levels prevailing in the west and north. The inter-related factors of farm size and farm labour density have an important bearing on labour productivity. Output per person is very low in the small farm areas where there is still a large and under-employed labour force. Output per hectare is also low, reflecting in part the agricultural orientation, with a strong emphasis on cattle and sheep production. The predominance of drystock accounts in large part for the low land productivity in much of north Leinster but labour productivity is higher than on the small farms of the west. In contrast, high land productivity is associated with dairying and arable crop enterprises, especially where these are combined, as in south Cork. Intensive enterprises contribute to the high productivity levels of County Dublin, where horticulture is of major importance, and of County Monaghan and east Cavan, where pig and poultry production are significant. Heavey and Hickey (1973) have demonstrated the extent to which productivity is related to farm system and farm size. High land and labour productivity in the east and south are in part a result of greater capital investment, easier access to input supplies and markets, and more favourable social circumstances than in the west and north.

The marked differences in productivity between the type-of-farming groups (Table 2) indicate the influence of farm system, though other variables such as land quality and farm size are also reflected in the values because of the distinct spatial pattern of the groupings. Both land and labour productivity are highest in A, the group most oriented towards arable cropping. Land productivity is quite high in Groups B and F but, with a higher labour density, gross margin per person is less in the dairying area. Land productivity is very low in Groups C, E and D, where cattle are dominant or very important and succeeded by milk, arable crops and sheep respectively. With a lower density of labour, gross margin per person in E is comparatively high. In the drystock areas, not only are incomes low but also they are unstable.

Table 2: *Enterprise combinations and productivity values by type-of-farming group*

Group	*Enterprise combination*	*Gross margin per hectare crops and pasture (£)*	*Gross margin per male engaged in farm work (£)*
A	ACM	60	1,172
B	CMA	48	932
C	CM	29	473
D	CSM	34	459
E	CA	32	707
F	MC	50	860
State	CMA	43	760

It is evident that spatial variations in the structure of agricultural output play a major role in areal productivity patterns, which are also a response to many other variables that should receive further investigation. However, sufficient information on the physical resource base and on the spatial characteristics of Irish farming now exists for comprehensive regional agricultural planning to be initiated. The marked areal differences in farming productivity alone indicate the urgent need for land use planning and greater regional agricultural development promotion. The considerable spatial variations in Irish agriculture render the imposition of many uniform national policies inappropriate.

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