Livestock

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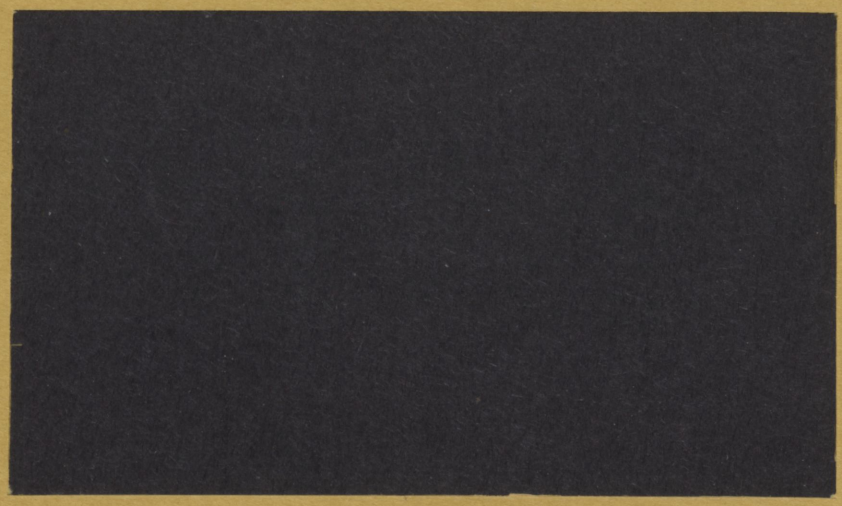

TRENDS IN REGIONAL LIVESTOCK MIX IN ONTARIO AND PROJECTIONS FOR 1980 - AN APPLICATION OF HIERARCHICAL ANALYSIS

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and J. B. Stackhouse.

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FOREWORD

This paper represents a report on one part of a research project to examine the pressures for change in the structure of the Ontario feed milling complex. The project is a joint undertaking of the School of Agricultural Economics and Extension Education, the Ontario Ministry of Agriculture and Food, and the Canadian Livestock Feed Board.

The authors wish to acknowledge the assistance and advice of a number of people in making this report possible. Special thanks are due to Mr. T. G. MacAulay and Mr. G. C. Robertson for their assistance in locating a methodology and computer routine for the regionalization scheme developed herein, Professors R. G. Marshall, M. A. MacGregor and T. F. Funk provided helpful suggestions on an earlier draft of the paper as did Dr. Garth Coffin of the Canadian Livestock Feed Board. Finally, we are indebted to Dr. Roger Eyvindson and Mr. Charles Croddock of the Economics Branch, Agriculture Canada for providing livestock ration information.

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1.0 INTRODUCTION

The Ontario feed milling complex has undergone substantial structural change in the past decade. Previous research [21] has shown that: the number of milling establishments has decreased since 1961; the industry has become increasingly concentrated in Western Ontario; distribution patterns have been altered towards increased sales of concentrates relative to complete feeds; large plants have become larger and are shipping feeds direct to farmers, thus, bypassing small local mills and dealers; and an attendant excess capacity has developed - particularly in the local milling sector. One reason for these structural changes lies in the trend toward regional specialization of livestock production in the province. A second reason is a trend toward on-farm feed mixing which has changed the nature of demand for products produced by the feed milling complex.

In view of these observations, a research project was initiated in 1972 which has a general objective of determining the impact of these and other trends on the long run structure of the Ontario feed milling complex. One segment of this research project included a detailed analysis of trends toward regional specialization

of livestock production in the province. This paper reports on the results of this analysis and provides projections for regional livestock inventories and feed consumption in 1980.

Specifically, the paper has the following objectives. First, a regionalization pattern is developed for the provinces that aggregates groups of counties which have had similar levels and trends in livestock production. Second, trends over the period from 1961 through 1971 are analyzed for each region. Third, livestock numbers by region and species are projected to 1980. Finally, feed consumption by region, livestock species and type of feed - i.e. premix, supplement and complete feed - is projected to 1980.

The paper is organized around each of these objectives which are presented below in sections 2.0 through 6.0.

2.0 HOMOGENEOUS LIVESTOCK PRODUCING REGIONS

At the present time, a number of alternative regional specifications within Ontario are being used. The most commonly used specification is one developed by the Ontario Ministry of Agriculture and Food (O.M.A.F.) which divides the province into five geographical areas.[1/] Analysis of regional trends for beef cattle, dairy cattle, hogs and poultry indicates that very little change in density and location of production among these broad regions took place from 1951 to 1971. However, observation of individual county data shows that substantial trends within the regions took place over this period. Because of this observation, an alternative set of regions consisting of counties which have had similar changes in the level, location and density of livestock production was developed.

The method used for this analysis has had substantial adoption in fields such as geography, zoology and ecology for grouping together many diverse items each of which has a number of descriptive characteristics. In the present case, the items to be grouped were the 54[2/] counties and districts in Ontario. The descriptive characteristics for each county were annual inventories at June 1 for the years 1960 to 1967 of dairy cattle, beef cattle, beef steers and heifers, hogs, and

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[1/] See [15] for a listing of the counties and districts included in each region.

[2/] In 1972 this number changed to 53 when counties Welland and Lincoln were combined to form county Niagara.

fowl (broilers and layers). A computer program which groups counties that are similar in inventory trends for these characteristics was used for the analysis. The program proceeds by a step-wise mechanism. It begins by comparing production levels of each of the five types of livestock in each of the 54 counties. The two counties which are most similar are then grouped together and the remainder are recompared to find the next best group or pair. This procedure continues until an "optimum" grouping pattern is determined. This analysis resulted in thirteen relatively homogeneous regions.

A mathematical specification of the grouping procedure and a brief literature review concerning its development and use are presented below in sections 2.1 and 2.2. The reader who is not interested in the mathematical specification may safely ignore these sections and proceed to section 2.3 where the results of the grouping analysis are presented, and to section 3.0 where regional trends from 1961 to 1971 are analyzed.

2.1 Methods of Regionalization

A wide range of procedures for classifying observations which have a number of characteristics has been forthcoming in recent years. Much of the early work was done by physical scientists interested in the field of taxonomy. Taxonomy, by definition, is the arrangement of a set of objects into a system of classes on the basis of some measurement on the objects. Perhaps the classical work summarizing the biological taxonomists' approach to classification is that of Sokol and Sneath [20]. More recently, geographers have developed a keen

interest in classification methods for use in regionalization of areal units (i.e. regional taxonomy). Excellent reviews of past work in regional taxonomy have been written by Spence and Taylor [19] and Stimson [24]. Spence and Taylor have defined two basic approaches to regional taxonomy.[1/] These are:

a) clustering methods,

b) hierarchical grouping methods.

2.1.1 Clustering Methods

In clustering methods, the objective is to find groups whose members are as similar as possible using some predetermined measure of similarity. Many different procedures for clustering exist (see [12], [17], and [7]). There are three basic elements to all clustering computer programs:

a) a method of initiating clusters,

b) a method of allocating new individuals to existing clusters,

c) a stopping rule to determine when further allocation is unwarranted. (See Stimson [24])

The principle advantage of clustering methods is that allocation of

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[1/] A third method, called matrix extraction, is also listed by Spence and Taylor. However, matrix extraction methods are normally considered to be a first step in a more comprehensive taxonomic analysis. Thus, these procedures are not considered here. McQuitty [14] and Bonner [2] have developed matrix extraction procedures as a first step in analyses using clustering or hierarchical methods.

particular units to groups is not irrevocable. That is, individual units can be allocated to an existing cluster in an early iteration, but then reallocated to another at a later iteration until a global optimum is attained. The main disadvantage, as shown by Lance and Williams [11], is that clustering techniques are essentially trial and error procedures which necessitate continuous re-comparison of all the elements to be grouped. This results in substantial computational inefficiency when large problems are analyzed.

2.1.2. Hierarchical Methods

Hierarchical methods differ from clustering methods in that they determine the most efficient grouping at each iteration of a progressive synthesis or subdivision of a population. In other words, they seek to optimize elements that are to be combined in a series of steps instead of optimizing the number of groups. Fisher [5] and Pocock and Wishart [16] have warned that determination of optimal groups in a stepwise synthesis via the hierarchical approach has the disadvantage that its solution may not attain a global optimum. Said differently, since elements, once grouped, cannot be reassigned to new groups as in clustering methods, solutions may be local optima. On the other hand, Stimson [24] argues that most hierarchical analyses find a local optimum which approximates the global. Because of this, the disadvantage of finding a local optimum is offset by a substantial saving in computational efficiency when a hierarchical approach is used

for relatively large problems. In view of its substantial computational efficiency, a hierarchical method was selected for the present study.

Stimson asserts that hierarchical methods, as a class, have two broad characteristics. First, they are divisive or agglomerative - i.e. they follow a strategy of progressive subdivision or progressive fusion. Second, they are either monothetic (i.e. every group may be defined by the presence or absence of a selected attribute) or polythetic (i.e. every group may be defined by the similarity of overall attribute structure). In practice only divisive monothetic and agglomerative polythetic procedures are useful (see Williams, Lambert and Lance [28]). Several procedures for divisive monothetic analysis have been reviewed by both Spence and Taylor and Stimson. These will not be discussed here since the problem at hand is polythetic in nature.

Agglomerative polythetic methods progressively fuse individuals on the basis of a similarity coefficient. Lance and Williams [11] outline alternative procedures which include similarity coefficients derived from correlation coefficients, squared Euclidean distance, non-metric coefficients and an information statistic. Several applications of these methods have been made in geography. For example, Berry [1] has used them in his analysis of interregional product flows in India and Spence [18] has used a procedure developed by Ward [27] to classify British counties on the basis of unemployment patterns. Several other applications are discussed in the review articles of Spence and Taylor and Stimson.

To the authors' knowledge, only a few applications of hierarchical procedures have been made in economics. However, their diversity highlights the wide range of potential uses of the technique. For example, King [8], [9] has used them to classify factors which influence stock price behaviour. MacAulay and Williams [13] used an agglomerative analysis in an unpublished study of migration and land use patterns in Australia. Similarly, Buckwell and Hazell [3] used a hierarchical technique to classify similar farms for a representative firm programming supply analysis.

Before proceeding to a mathematical statement of the hierarchical procedure employed in this study, one characteristic of both hierarchical and clustering methods should be noted. MacAulay and Williams [13] have pointed out that taxonomy is purely a descriptive technique without any statistical significance beyond the assurance that objects grouped together will be similar. However, when diverse objects are classified into homogeneous groups, such groupings may facilitate meaningful analysis of underlying economic forces.

2.2 Mathematical Formulation of the Hierarchical Procedure

Our objective of specifying an alternative regionalization of Ontario's livestock producing counties included the simultaneous consideration of two types of economic data. First, groups of counties with similar livestock densities were desired since the density of livestock production affects feed mill operation through its affect on distribution costs. Second, groups of counties with similar trends in

production were desired so that predictions could be obtained. This section mathematically describes the hierarchical procedure employed to obtain the regionalization.

Specifically, the general procedure for hierarchical analysis using a Euclidean distance measure of similarity is presented in subsection 2.2.1. In subsection 2.2.2 a modification of the basic procedure to include analysis of time series data is introduced. Finally, rationalization of the hierarchical procedure with data used for the present study is explained in subsection 2.2.3.

2.2.1 The General Hierarchical Procedure

The procedure developed here is based on one first formulated by Ward [27] for a single characteristic and later modified to group objects with more than one characteristic by Veldman [26].[1/] Veldman describes the method as an iterative procedure in which N objects are measured on a profile of K different variables to find alternative optimum groups of the objects at each iteration from 2 to N-1.

Means and variances of the K variables are standardized to avoid different scaling effects. The program finds groups at each iteration which maximises mean inter-group differences and minimizes mean intra-group differences in the K standardized variables where differnces and similarities are measured in Euclidean distances.

The program proceeds by listing each of the N objects with a

[1/] Veldman also presents the computer program for this procedure.

characteristic profile on the K variables. At this stage the error within each group (at this point a group is one object) is zero. Then a matrix of potential errors is computed for each possible pair of objects from the differences in the variables. Mathematically this can be depicted as,

$$PE_{ij} = \sum_{k=1}^{K} (A_{ik} - A_{jk})^2 / PN_{ij} \qquad (2.1)$$

where, PE_{ij} = the potential error resulting from grouping the ith and jth objects

A_{ik} = the value of the kth variable on the ith object

PN_{ij} = the number of objects in the potential group

i,j = (1, 2,.....N), the number of objects

k = (1, 2,.....K), the number of variables.

After the matrix of potential errors has been calculated, the decision to group is made on the basis of a value reflecting objective function. The objective function is designed to deal with the problem of profile similarity and utilizes the total within-group variation as the function to be minimally increased at each step in the process. The criterion for selection of objects to be grouped is thus to select the pair of objects which minimizes X where X is the potential error less the error within the two groups proposed for grouping, or,

$$\text{Min } X = PE_{ij} - (PE_{ii} + PE_{jj}) \qquad (2.2)$$

At the first iteration PE_{ii} and PE_{jj} are, as discussed above, equal to zero. But the process is repeated iteratively until all N objects are grouped together. At each iteration a new matrix of

potential errors is computed as in equation (2.1) and objects are grouped according to the resultant minimum value of X from equation (2.2).

One limitation of the procedure is that it does not provide a criterion for selecting the optimum number of groups. However, at each iteration the total within group error is calculated. This is equal to,

$$E = \sum_{p=1}^{P} PE_p \qquad (2.3)$$

where, E = total within group error;

p = (1, 2,.....P), the number of groups at each iteration.

Employing this total error computation, the user heuristically selects the iteration which increases the total within group error by the largest amount as the optimum iteration and therefore the optimum grouping pattern. This procedure is followed on the grounds that when within group error is increased substantially, the procedure is grouping two unlike objects. Thus, a greater degree of homogeneity is attained by selection of the earlier iteration.

2.2.2 Addition of Time Series Considerations

Since our objective in this study was to regionalize Ontario counties on the basis of trends in livestock densities, a technique for incorporating time series was necessary. In reviewing the literature on past applications of the hierarchical method, no application using time series data was discovered. However, we suggest that the simple procedure of incorporating each county's annual variable levels as separate variables performs this task adequately. Using this approach,

the computational procedure presented in subsection 2.2.1 is altered in that equation (2.1) is respecified as

$$PE_{ij} = \sum_{k=1}^{K} \sum_{t=1}^{T} (A_{ikt} - A_{jkt})^2 / PN_{ij} \qquad (2.4)$$

where, PE_{ij}, A, PN, (i,j,k), and K are the same as in equation (2.1) and $t = (1, 2, \ldots .T)$ the number of years of time series data. Equations (2.2) and (2.3) are then altered by the addition of a time series subscript (t).

2.2.3 Specification of Variables in the Present Study

Following the computational procedure outlined above, variables used in the present study can now be defined. The objects to be grouped are the 54 counties and districts of Ontario. Data used to derive the characteristic variables are annual inventories of five livestock classes for each county obtained from [15]. These are:

1) annual inventory of hogs
2) annual inventory of beef steers and heifers
3) annual inventory of beef cattle
4) annual inventory of dairy cows
5) annual inventory of hens and chickens.[1/]

Given our interest in inventory densities, a rough measure of density was obtained by specifying the livestock inventory per arable acre of farm land in each county. This ratio provided the characteristic variables included in the analysis. A time series for each livestock

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[1/] All inventory figures are reported as at June 1 of a given year.

class per arable acre was then developed for the eight year period from 1960 through 1967. Data for years after 1967 could not be used because poultry inventories were not reported on a county-wise basis for inter-censal years.

Using the procedure described above, a matrix consisting of 54 objects and 40 variables was obtained for the grouping analysis. Relating this to the notation in equation (2.4) we obtain values of N, K, and T of 54, 5 and 8 respectively.

2.3 Results of the Hierarchical Analysis

The hierarchical procedure was run for fifty-three iterations and the optimum grouping of counties at each iteration noted. As discussed in subsection 2.2.1 the total within group error (E in equation (2.3)) is calculated and printed out at each iteration and the criterion for selecting the "optimum" number of groups is to select the iteration at which the total within group error is changed by the greatest amount. In the present analysis the iteration which resulted in the largest change in E occurred when there were eight groups of counties.

Counties included in the eight groups are presented in Table 1. It will be noted that Groups 1 and 5 have been subdivided into regions which are geographically contiguous. Group 1, which includes the largest number of counties, is a particularly interesting conglomerate which can be used to provide some idea of how the grouping procedure differentiates between counties. All of the counties included in Group 1 are relatively low density livestock producing areas. Furthermore, as we will point

TABLE 1: Eight Groups Resulting From Hierarchical Model

Region 1

A	B	C	D		E
Essex	Halton	Peterborough	Muskoka	Haliburton	Grenville
Kent	Peel	Lennox and	Parry Sound	Kenora	Dundas
	Sincoe	Addington	Sudbury	Tamiskaming	Russell
			Algoma	Rainy River	Prescott
			Manitoulin	Cochrane	Glengarry
			Nippissing	Thunder Bay	

Region 2

Lambton
Middlesex

Region 3

Elgin
Perth
Waterloo
Wellington

Region 4

Oxford
Brant

Region 5

A		B	
Norfolk		Dufferin	Durham
Haldimand		York	Northumberland
Niagara (Lincoln and Welland have been combined)		Ontario	Prince Edward
Wentworth		Victoria	Hastings

Region 6

Huron

Region 7

Bruce
Grey

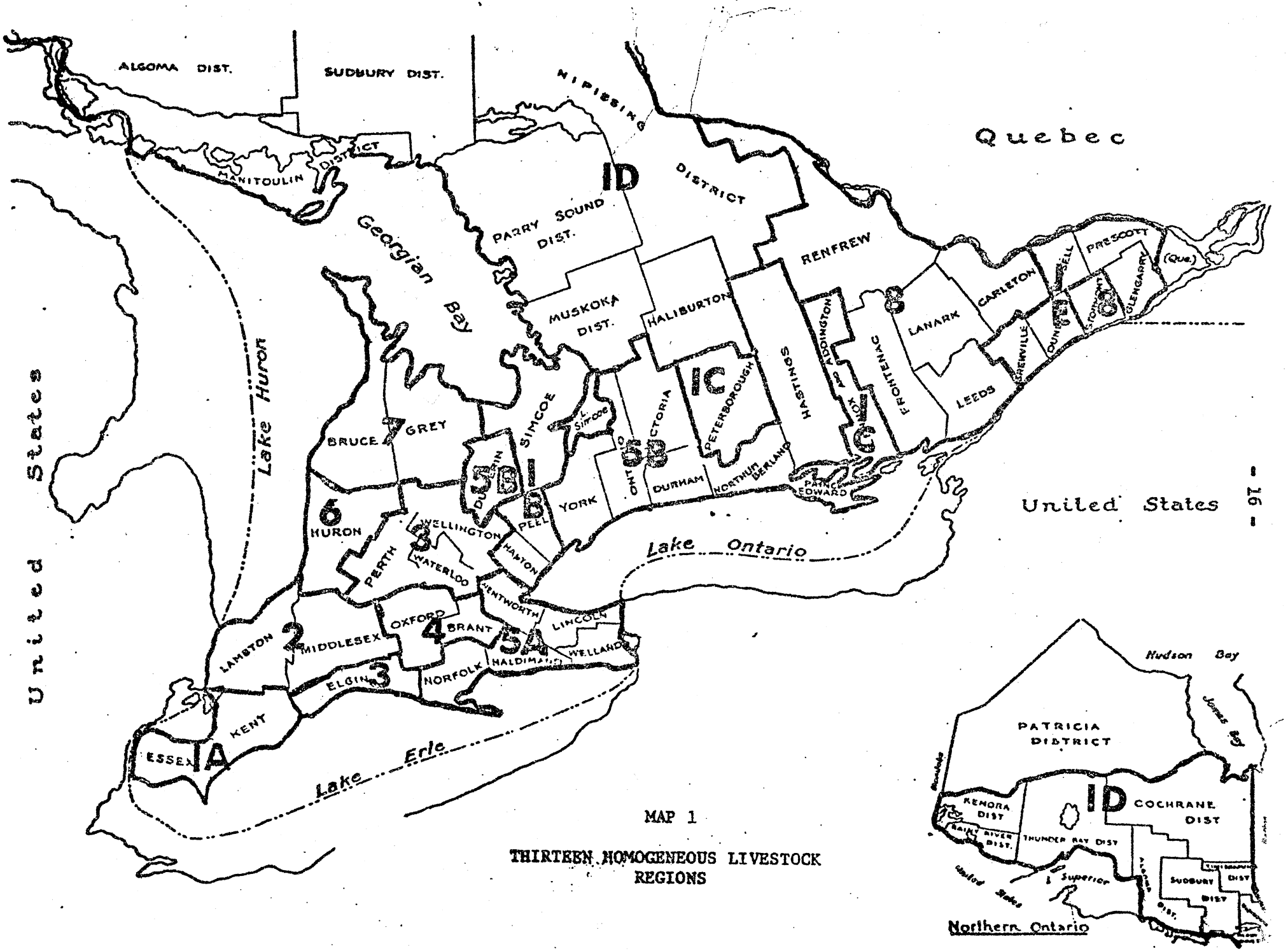
Region 8

Renfrew
Leeds
Frontenac
Carleton
Lanark
Stormont

out below, most of them have continued to become less important over the past decade in most livestock categories. Reasons for their low livestock densities are varied. Several of the counties in this group are those in the Northern most part of the province where relatively little agricultural activity takes place. Others, namely Essex and Kent, are among the most highly commercialized agricultural counties in the province, but are becoming increasingly specialized in cash crop production. The remaining counties, located in central of eastern Ontario represent regions which practice relatively extensive farming operations resulting , again, in low density livestock production patterns.

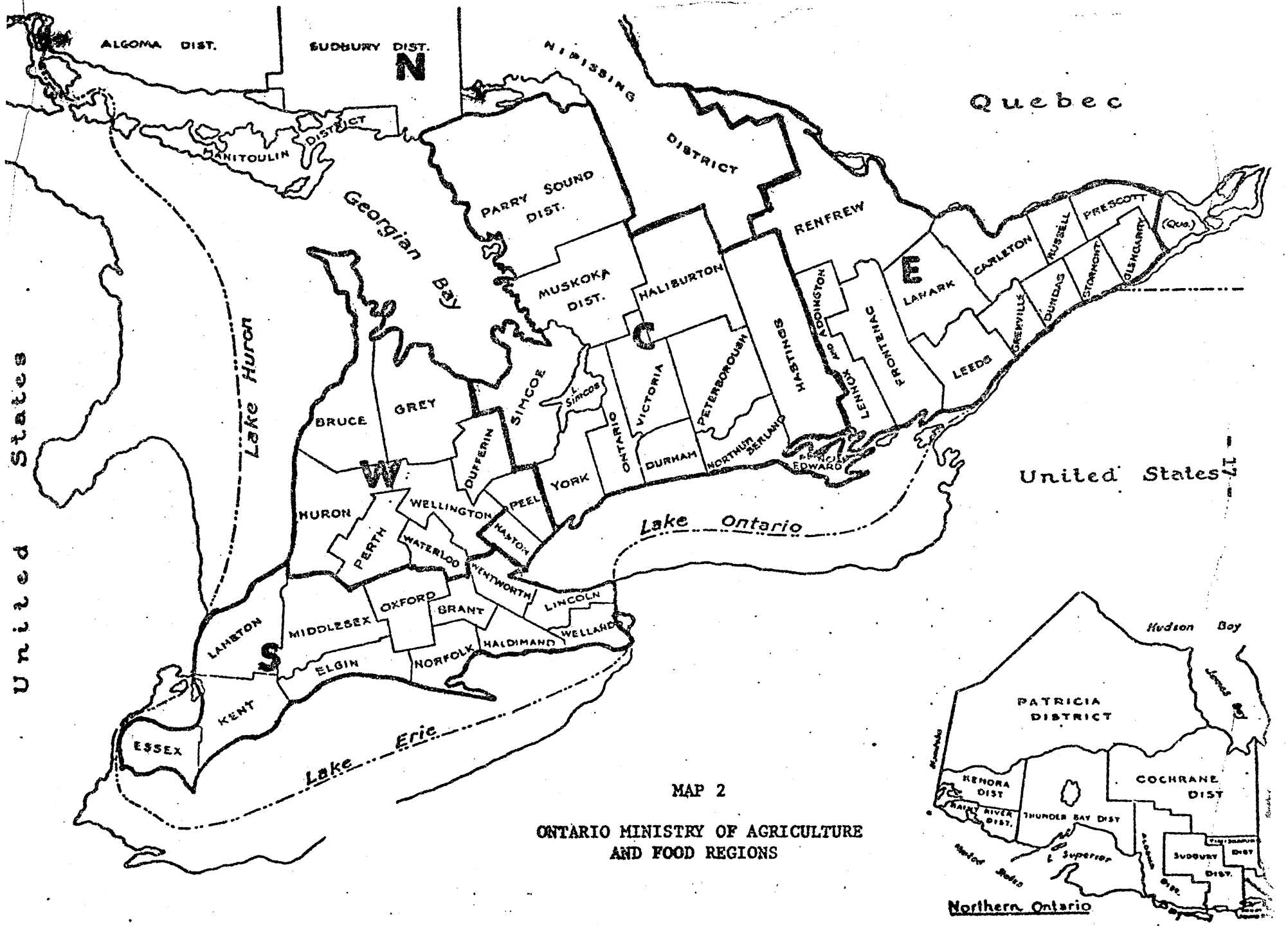
Since such a large number of counties were included in Group 1, it was subdivided into five geographically contiguous regions which will serve as the basis of the discussion throughout the remainder of this report. Similarly, Group 5 which primarily included counties surrounding Lake Ontario, was subdivided into contiguous eastern and western regions.

The hierarchical grouping results are compared to the existing OMAF regions in maps 1 and 2. Two important conclusions about the hierarchical regions arise from such a comparison. First, in many cases regions cut across the OMAF boundaries. This indicates that while the OMAF regions are neatly contiguous, counties included in a region are not necessarily similar in their production characteristics. Second, and most important, the aggregate regions devised by OMAF are usually divided into smaller, more homogeneous regions by our analysis. The



MAP 1

THIRTEEN HOMOGENEOUS LIVESTOCK REGIONS



MAP 2

ONTARIO MINISTRY OF AGRICULTURE
AND FOOD REGIONS

implications of this will be dealt with at some length in the following section. However, an example here will assist in underlining the effects of this homogeneity in assessing trends in production patterns. Regions 1A, 2 and 5A are all included in OMAF's Southern Ontario region. If all three regions were included as one in an analysis charting changes in production trends, the analysis would mask the fact that region 1A has experienced a relative decline in importance in all livestock categories during the past decade, while region 2 has become less important in turkey and beef cow-calf operations but increased substantially in hog production, and region 5A has become the province's largest producing area for turkeys and broilers. In short, the hierarchical analysis allows us to pinpoint specific areas in which substantial shifts in production patterns have taken place while the broader geographic divisions tend to average out much of the change.

3.0 TRENDS IN LIVESTOCK INVENTORIES - 1961-1971

The thirteen regions delineated in section 2.4 will serve as the basis for regional livestock and feed demand projections. In this section, trends and interregional adjustments which have occurred over the past decade are assessed for the major livestock classes.

In order to assess the degree of change in livestock production patterns in the past decade, a simple analysis was conducted to indicate the changes in proportion of each of six livestock classes which were represented by each of the thirteen regions from the beginning to the end of the past decade. Data used for the analysis are June 1 inventories as reported in [15]. Two year inventory totals were used where available in an attempt to even out any reporting or cyclic fluctuations in the data.[1/] This analysis will be discussed by livestock class below.

3.1 Turkey Inventories

Regional turkey inventories for 1961 and 1971 and percentage changes in inventory and concentration are presented in Table 2.[2/] Percentage change in inventory is the percentage change in absolute

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[1/] It should be noted that 1961 and 1971 inventories are actually obtained from the agricultural census and should, therefore, be reliable.

[2/] Turkey inventories for 1969 and 1970 were not included since intercensal county-wise estimates were stopped in 1968.

TABLE 2: Regional Turkey Inventories 1961 and 1971.

Region	1961		1971			
	Inventory (No. Head)	Percentage of Provincial Total	Inventory (No. Head)	Percentage of Provincial Total	Change in Percentage of Total 1961-71	Percentage Change in Inventory 1961-71
1A	317,548	11.6	126,578	3.4	-8.2	-60.1
2	642,012	23.4	704,994	18.7	-4.7	9.8
3	557,661	20.3	618,131	16.4	-3.9	10.8
4	211,185	7.7	621,255	16.5	8.8	194.2
5A	231,652	8.4	990,937	26.3	17.9	327.8
6	80,684	2.9	246,464	6.5	3.6	205.5
7	139,002	5.1	90,527	2.4	-2.7	-34.9
1B	232,818	8.5	213,792	5.7	-2.8	-8.2
1C	5,666	.2	1,312	0	-.2	-76.8
1D	96,071	3.5	20,952	.6	-2.9	-78.2
5B	155,402	5.7	127,212	3.4	-2.3	-18.1
8	39,278	1.4	3,144	.1	-1.3	-92.0
1E	36,077	1.3	0	0	-1.3	-100.0
Province	2,745,056	100	3,765,414	100	-	37.2

inventory level for each region, while the measure of concentration is the percentage of all turkeys in the province which is represented by an individual region.

The information in Table 2 indicates that a substantial shift took place in the location and concentration of turkey production in the past decade. Three regions, 4, 5A, and 6, all experienced increases of from 200 to over 300 per cent during the decade. At the same time, several other regions experienced substantial declines in both inventories and percentage of the provincial total. Regions 2 and 3 had modest increases in inventories, but very substantial decreases in their per cent of the total.

The results of this shift in production location leave a production pattern with over 80 per cent of turkey inventories produced in five western and southern regions and almost none in the central, northern and eastern areas.

3.2 Chicken Inventories

During the decade of the sixties the chicken industry developed into two specialized types of production; the broiler and the layer. As a result, census definitions changed to accomodate this development and the 1971 census included both broiler and layer categories while the 1961 census did not. Because of the change in definition it was necessary that our analysis include all chickens as a single category.

Inventory changes for the period are presented in Table 3.

TABLE 3: Regional Hen and Chicken Inventories 1961 and 1971

Region	1961		1971			
	Inventory (No. Head)	Percentage of Provincial Total	Inventory (No. Head)	Percentage of Provincial Total	Change in Percentage of Total 1961-71	Percentage Change in Inventory 1961-71
1A	1,311,374	5.3	1,120,218	3.6	-1.7	-14.6
2	2,121,453	8.6	3,028,460	9.6	1.0	42.8
3	4,742,728	19.2	6,627,560	21.0	1.8	39.7
4	1,552,368	6.3	1,343,943	4.3	-2.0	-13.4
5A	3,315,566	13.4	6,309,069	20.0	6.6	90.3
6	1,916,690	7.8	2,574,932	8.2	.4	34.3
7	1,408,814	5.7	1,276,010	4.0	-1.7	-9.4
1B	1,955,463	7.9	1,746,438	5.5	-2.4	-10.7
1C	474,611	1.9	542,150	1.7	-.2	14.2
1D	598,508	2.4	750,457	2.4	0	25.4
5B	3,403,214	13.8	3,836,158	12.2	-1.6	12.7
8	1,011.286	4.1	923,762	2.9	-1.2	-8.6
1E	896,168	3.6	1,430,806	4.5	.9	59.7
Province	24,708,245	100	31,509,963	100	-	27.5

This information indicates that regions 3, 5A, and 1E experienced substantial increases in production while production shifted away from a number of other regions. This has resulted in an increased concentration of production in three regions around Lake Ontario - regions 5A, 5B, and 1E - and in two southwestern regions - regions 2 and 3. Taken together, these five regions represented over 67 per cent of total inventories in 1971.

3.3 Swine Inventories

As with the poultry categories, significant changes in swine production location occurred during the 1960's. Table 4 contains the average 1960-61 and 1970-71 inventories and their percentage changes for the thirteen regions. Information in Table 4 indicates that while inventories over the entire province increased by 26.2 per cent, five regions in southern and western Ontario had increases substantially higher than the average. Two regions (1A and 1B) had modest gains in inventory. Those remaining each has substantial declines in inventory. The result of these changes is a strong trend toward concentration of the hog industry in the thirteen county area of southwestern Ontario included in regions 2, 3, 4, 5A and 6. In 1970-71, these thirteen counties represented 62 per cent of the province's total hogs, an increase from approximately 49 per cent in 1960-61.

3.4 Beef Inventories

Beef production, probably because of the production cycle and the "land base" nature of beef production has not undergone as much

TABLE 4: Regional Hog Inventories 1961 and 1971

Region	1961		1971			
	Inventory (No. Head)	Percentage of Percentage Total	Inventory (No. Head)	Percentage of Provincial Total	Change in Percentage of Total 1961-71	Percentage Change in Inventory 1961-71
1A	121,862	6.8	131,795	5.9	-.9	8.2
2	138,685	7.8	252,265	11.2	3.4	81.9
3	393,944	22.1	618,447	27.5	5.4	57.0
4	125,329	7.0	172,585	7.7	.7	37.7
5A	100,843	5.7	165,575	7.4	1.7	64.4
6	110,084	6.2	176,099	7.8	1.6	60.0
7	199,074	11.2	189,704	8.4	-2.8	-4.8
1B	123,115	6.9	133,359	5.9	-1.0	8.3
1C	31,912	1.8	23,262	1.0	-.8	-27.1
1D	3[illegible],789	1.7	20,717	.9	-.8	-32.7
5B	272,462	15.3	253,968	11.3	-4.0	-6.8
8	78,165	4.4	64,491	2.9	-1.5	-17.5
1E	56,909	3.2	48,722	2.2	-1.0	-14.4
Province	1,783,170	100	2,250,986	100	-	26.2

TABLE 5: Regional Beef Cow and Heifer Inventories 1961 and 1971

Region	1961		1971			
	Inventory (No. Head)	Percentage of Provincial Total	Inventory (No. Head)	Percentage of Provincial Total	Change in Percentage of Total 1961-71	Percentage Change in Inventory 1961-71
1A	14,878	3.0	10,949	1.6	-1.4	-26.4
2	56,293	11.2	63,644	9.2	-2.0	-13.1
3	57,260	11.4	78,793	11.4	0	37.6
4	11,453	2.3	20,647	3.0	.7	80.3
5A	12,282	2.4	19,260	2.8	.4	56.8
6	37,426	7.4	51,974	7.4	0	38.9
7	74,200	14.7	103,081	14.9	.2	38.9
1B	43,374	8.6	56,723	8.2	-.4	30.8
1C	14,393	2.9	15,336	2.2	-.7	6.5
1D	33,239	6.6	52,058	7.5	.9	56.6
5B	95,780	19.0	116,891	16.8	-2.2	22.0
8	42,509	8.4	90,750	13.1	4.7	113.5
1E	10,433	2.1	18,924	2.7	.6	81.4
Province	503,518	100	694,077	100	0	37.8

adjustment toward regional specialization within Ontario as have the preceding livestock categories. Beef cow and heifer inventories are presented in Table 5. Data in Table 5 indicates that five regions (4, 5A, 1D, 8 and 1E) all had percentage increases in inventories considerably higher than the provincial average over the past decade. However, three of these regions, (4, 5A and 1E) had very low base inventories in 1960-61. Several other regions had percentage increases in inventory similar to the provincial averages of 37.8 per cent and regions 1A and 2 experienced absolute declines in inventory. The result of these changes appears to be a trend toward more cow-calf production in the northern and eastern parts of the province, although region 3 in the southwestern portion of the province continues to include a substantial number of cow and heifer inventories. The four largest producing regions (3, 7, 5B and 8) represented 56 per cent of the total inventory in 1970-71, up slightly from 1960-61.

Although there were relatively large increases in steer inventories over the period (32.4 per cent provincial increase), only slight changes in concentration occurred (see Table 6). The major change was a further increase in the importance of region 6 (Bruce and grey counties) in steer production. This change resulted in a slight increase in the concentration of beef feeding activities in the four western Ontario regions 3, 4, 6 and 7 which represented 53 per cent of the provincial total inventory in 1970-71.

3.5 Dairy Inventories

Milk production increased in Ontario during the 1960's. However, because of genetic and feeding improvements, production increased while the number of dairy animals decreased, as is evidenced by a decrease in inventories of 18.9 per cent (see Table 7) from 1960-61 to 1970-71. While dairy inventories were generally decreasing over this period, information in Table 7 indicates that very little regional adjustment occurred. Adjustment in the dairy industry tends to proceed relatively slowly because of the large and specialized investment in dairy facilities. Also, during part of the 1960's dairy quota policies probably tended to restrict regional adjustments.

The information in Table 7 shows that the only substantial increases in concentration of dairy inventories took place in region 3 in southwestern Ontario and region 1E, the eastern most counties of the province. These changes, along with continued large percentages of the total inventory in regions 5B and 8, have resulted in a concentration of 56.4 per cent of total inventories in these four regions (i.e. 3, 5B, 8 and 1E).

3.6 Summary

In this section we have attempted to delineate important regional trends and adjustments in livestock production which have taken place in thirteen regions of Ontario in the past decade. Specification of the thirteen relatively homogeneous regions using hierarchical grouping analysis has enabled us to document important

TABLE 6: Regional Beef Steer Inventories 1961 and 1971

Region	1961		1971			
	Inventory (No. Head)	Percentage of Provincial Total	Inventory (No. Head)	Percentage of Provincial Total	Change in Percentage of Total 1961-71	Percentage Change in Inventory 1961-71
1A	24,574	5.1	31,984	5.0	-.1	30.2
2	52,593	10.8	69,982	10.9	.1	33.1
3	85,649	17.7	114,041	17.8	.1	33.1
4	21,873	4.5	28,350	4.4	-.1	29.6
5A	10,819	2.2	14,083	2.2	0	30.2
6	51,950	10.7	58,608	9.1	-1.6	12.8
7	81,919	16.9	135,033	21.0	3.1	64.8
1B	27,077	5.6	38,842	6.1	.5	43.5
1C	9,546	2.0	10,905	1.7	-.3	13.7
1D	16,283	3.4	13,298	2.1	-1.3	-18.3
5B	64,665	13.3	82,537	12.9	-.4	27.6
8	36,213	7.5	38,637	6.0	-1.5	6.7
1E	3,791	.8	5,445	.8	0	43.6
Province	484,799	100	641,752	100	0	32.4

TABLE 7: Regional Dairy Cow and Heifer Inventories 1961 and 1971

Region	1961		1971			
	Inventory (No. Head)	Percentage of Provincial Total	Inventory (No. Head)	Percentage of Provincial Total	Change in Percentage of Total 1961-71	Percentage Change in Inventory 1961-71
1A	24,995	1.9	12,428	1.2	-.7	
2	72,764	5.6	56,686	5.4	-.2	-22.1
3	160,148	12.3	153,321	14.5	2.2	-4.3
4	84,317	6.6	71,560	6.8	.2	-15.1
5A	88,638	6.9	66,965	6.3	-.6	-24.5
6	48,133	3.7	44,902	4.2	.5	-6.7
7	91,162	7.1	72,479	6.8	-.3	-20.5
1B	81,379	6.3	58,337	5.5	-.8	-28.3
1C	38,435	3.0	31,225	3.0	0	-18.8
1D	78,038	6.1	48,223	4.6	-1.5	-38.2
5B	181,458	13.9	144,491	13.7	-.2	-20.4
8	192,274	14.8	151,975	14.4	-.4	-21.0
1E	154,212	11.9	145,574	13.8	1.9	-5.6
Province	1,304,848	100	1,055,164	100	0	-18.9

regional adjustments which were masked in other, more aggregate regional classifications. We can conclude from this analysis that much of the relatively intensive livestock production activities such as turkey, chicken swine and beef (steer) production has become increasingly concentrated in a fifteen county area in Western Ontario roughly bordered by Lambton county to the West, Bruce and Grey to the North, and Wellington to Niagara in the East. At the same time, the more extensive enterprises, including beef cow and dairy operations have shown some tendency to move toward central and eastern Ontario. If these trends are to continue in the future, they will have important implications for the size and location of the feed industry.

4.0 INVENTORY PROJECTIONS FOR 1980

Many factors can cause changes in livestock production over a long period of time. Among these factors are changes in consumer demand, changes in government policies and developments in related commodity production. With such factors in mind, a number of alternative econometric formulations were fitted to the regional livestock data to attempt to estimate projection equations. In most cases, these formulations resulted in equations with relatively high coefficients of determination. However, many of the structural coefficients were unreliable. Furthermore, many of the long term variables are unquantifiable and, therefore, impossible to incorporate in econometric analysis.[1/] Given these problems, the projections were made on the basis of simple linear time trends. Time series for each livestock class varied. Projections for each livestock class are discussed below.

4.1 Beef Projections

Beef projections were based on time trends fitted to data for the period from 1945 through 1971. Projections for cows and heifers are presented in Table 8 along with the standard error of forecast for each and the percentage each region represents of total

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1/ Conceptually, a more reasonable approach would have been to construct a spatial programming model on which sensitivity analysis could be used to test hypothesis concerning alternative variables.

TABLE 8: Regional Projections of Beef Cow and Heifer Inventory to 1980

Region	Number of Beef Heifers		Number of Beef Cows		Total of 1. & 2.	Percentage of Provincial Total
	1. Projection	Standard Error of Forecast	2. Projection	Standard Error of Forecast		
1A	6,600	1,684	11,694	4,376	18,354	2.1
2	34,372	3,007	52,531	8,246	86,903	9.8
3	49,962	4,393	46,337	8,234	96,299	10.9
4	14,621	2,109	9,202	1,118	23,823	2.7
5A	9,845	1,323	14,599	1,443	24,444	2.8
6	35,759	3,807	26,684	6,685	62,443	7.1
7	60,174	8,981	65,654	10,265	125,828	14.3
1B	30,482	1,812	48,985	5,218	79,467	9.0
1C	8,674	916	20,850	1,629	29,524	3.3
1D	16,094	3,582	54,525	4,655	70,619	8.0
5B	49,685	5,741	111,143	12,271	160,828	18.2
8	23,344	3,447	61,672	4,401	84,016	9.5
1E	6,167	1,751	13,938	1,704	20,105	2.3
Province	344,839		537,814		882,653	100

provincial inventories. [1/] The total inventory projection of 882,623 represents an increase of 21.4 per cent from the 1970-71 average. The regional projections imply that the trend observed from 1960-71 toward increased concentration of cow and heifer inventories in the central and northern parts of the province will continue. Most regions located in these areas have increased concentration at the projected levels relative to western and southern regions (See Table 5).

Beef steer projections are presented in Table 9. The total provincial inventory of 857,302 represents an increase over 1970-71 of 23.5 per cent. These projections imply that the trend toward increased specialization will continue in the western and southern parts of the province. Projections for regions 3, 4, 6 and 7 indicate that they will continue to increase their shares of total inventories (see Table 6). At the projected levels for 1980, these four regions represent 56.9 per cent of total inventory as opposed to 53 per cent in 1971.

4.2 Dairy Projections

Regional dairy projections and standard errors of forecast are presented in Table 10. These indicate that dairy inventories over the province will fall by approximately 10 per cent as compared to a decline of 18.9 per cent from 1960-61 to 1970-71. Regionally, the projections indicate that there will be some reversal in the trend toward increased dairy production in central and eastern Ontario observed

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1/ Standard error of forecast (S.E.F.) is similar to a standard deviation. The S.E.F. represents the bounds above and below the forecast within which the inventory level will fall with a 65 per cent probability.

TABLE 9: Regional Projections of Beef Steer Inventory to 1980

Region	Number of Steers	Standard Error of Forecast	Percentage of Provincial Total
1A	48,836	5,721	5.7
2	91,377	10,745	10.7
3	167,721	13,349	19.6
4	44,177	4,967	5.2
5A	22,397	4,213	2.6
6	90,444	8,226	10.5
7	176,352	2,285	20.6
1B	31,346	5,625	3.7
1C	14,009	2,179	1.6
1D	14,611	5,093	1.7
5B	102,747	10,407	12.0
8	45,734	7,014	5.3
1E	7,551	1,266	.9
Province	857,302		100

TABLE 10: Regional Projections of Dairy Inventory to 1980

Region	Number of Heifers		Number of Cows		Total of 1. & 2.	Percentage of Provincial Total
	1. Projection	Standard Error of Forecast	2. Projection	Standard Error of Forecast		
1A	760	1,785	4,246	3,983	5,006	.5
2	11,057	2,233	34,514	6,862	45,571	4.8
3	41,607	5,560	118,875	10,864	160,482	16.9
4	19,101	2,322	59,020	4,800	78,121	8.2
5A	16,652	2,548	53,165	4,595	69,817	7.3
6	8,057	1,226	34,923	4,330	42,980	4.5
7	10,022	2,037	59,417	5,500	69,439	7.3
1B	13,894	3,331	35,555	5,767	49,449	5.2
1C	5,496	1,421	14,858	3,582	20,354	2.1
1D	4,934	2,827	28,482	9,091	33,416	3.5
5B	27,817	6,820	70,916	20,637	98,733	10.4
8	31,110	5,857	91,688	11,890	122,798	12.9
1E	36,116	3,378	117,637	10,538	153,753	16.2
Province	226,623		723,296		949,919	100

in Table 7. Regions 3, 4, 5A, 6 and 7 in the western and central parts of the province all show increased shares of provincial inventory. At the same time the percentage of inventory in all central, northern and eastern regions except region 1E are projected to decline.

4.3 Poultry Projections

Regional projections for turkey, broiler and hen inventories are presented in Table 11. Unlike the preceding projections, the trend equations for poultry projections were not based on annual observations from 1945 to 1970. Time series data were not available over the entire period and much of the data which were available were judged to be unreliable. For these reasons, the projections are based on observations derived in the following manner. For hens and turkeys, county wise census observations from 1961, 1966 and 1971 were obtained. Then observations from intercensal years were obtained from Statistics Canada's Production of Poultry and Eggs [22]. These observations were for Ontario as a whole. To transform the total Ontario statistics into county wise observations, county proportions from census years were used to adjust the provincial statistics for two years before and after the census year. For example, county wise proportions from the 1966 census were used to derive county observations for 1964, 1965, 1967 and 1968 from the provincial totals. These resulted in eleven observations for each county. In the case of broilers, data from 1966 through 1972 were obtained from the Poultry Market Report [4]. These were in the form of total production in Ontario. The Ontario figures were then allocated by county on the basis of annual broiler quotas as reported

TABLE 11: Regional Projections of Poultry Inventory to 1980

Region	Turkeys	Percentage of Provincial Total	Broilers	Hens	Total Broilers and Hens	Percentage of Provincial Total
1A	55,427	1.3	239,423	279,914	519,914	1.6
2	548,539	12.7	664.797	2,401,808	3,066,605	9.2
3	602,945	13.9	5,587,724	1,464,305	7,052,029	21.2
4	865,263	20.0	906,362	266,800	1,173,162	3.5
5A	1,567,003	36.2	6,627,839	1,941,292	8,569,131	25.7
6	337,581	7.8	2,191,970	800,000	2,991,970	9.0
7	53,710	1.2	1,092,175	122.760	1,214,935	3.6
1B	196,353	4.5	1,367,811	191,374	1,559,185	4.7
1C	1,416	0	416,814	286,531	703,345	2.1
1D	1,000	0	0	354,378	354,378	1.1
5B	105,233	2.4	3,024,740	871,695	3,896,435	11.7
8	0	0	0	753.126	753,126	2.3
1E	0	0	96,911	1,383.997	1,480,908	4.4
Province	4,334,470	100	22,216,566	11,117,980	33,334,546	100

in Ontario Broiler Marketing Board annual reports.

The turkey projections indicate a 15 per cent increase in total inventories for the province as a whole compared to a 37 per cent increase from 1961 to 1971 (see Table 2). Regionally, it appears that regions 3, 5A and 6 will continue to specialize in turkey production. Only these three regions have projected increases in their share of total inventory. This essentially follows the conclusion that was drawn from the analysis of trends which took place during the 1960's. Together the three regions are projected to account for 64 per cent of total inventories compared to 49.3 per cent in 1971 (see Table 2).

Broiler and layer projections indicate a projected increase in poultry inventories of 5.8 per cent in 1980. Individual regional projections in Table 11 show that regions 3, 5A and 6 will continue to increase their shares of total inventory to the extent that they will account for 56 per cent in 1980 as compared to 49 per cent in 1971.

4.4 Swine Projections

Swine projections are presented in Table 12. Time series data from 1955 to 1970 were employed in estimating the trend equations. A shorter time series was used for hogs than for beef and dairy because of changes in the nature of the pork market. A number of studies have indicated that per capita pork consumption declined during the 1950's but increased during the 1960's. As a result production tended to decline or remain static in the earlier period but increased during the 1960's. Since recent estimates have resulted in income elasticities of

TABLE 12: Regional Projections of Swine Inventory to 1980

Region	Hogs Under Six Months 1.	Standard Error of Forecast	Hogs Over Six Months 2.	Standard Error of Forecast	Total of 1. & 2.	Percentage of Provincial Total
1A	116,451	19,863	33,661	5,167	150,112	6.3
2	214,351	15,984	57,173	4,299	271,524	11.4
3	601,946	37,307	136,943	11,101	738,889	31.1
4	149,233	11,940	44,445	3,069	193,678	8.2
5A	143,161	9,554	41,182	4,141	184,343	7.8
6	126,320	9,732	30,654	3,354	156,974	6.6
7	126,062	16,424	27,593	7,974	156,716	6.6
1B	100,826	13,319	31,748	5,228	132,574	5.6
1C	12,179	4,069	4,630	1,493	16,809	.7
1D	7,721	1,769	1,764	1,101	9,485	.4
5B	225,810	29,891	66,003	11,777	291,813	12.3
8	30,937	7,218	9,469	3,852	40,426	1.7
1E	20,630	8,337	13,606	2,695	34,244	1.4
Province	1,875,647		498,871		2,374,518	

demand in the .3 to .5 range [30], it was assumed that per capita consumption will continue to increase during the 1970's. Thus, observations for 1945 through 1954 were deleted from the projection equations.

The projections indicate an increase of approximately 6 per cent over 1970-71 inventory levels in 1980. Regionally, the trend toward increased concentration of inventories in western Ontario is projected to continue to 1980. As a whole, the western counties included in regions 1A through 5A are projected to account for 65.8 per cent of inventories in 1980 as opposed to 59.7 per cent in 1970-71.

4.5 Evaluation of the Projections

Simple trend projections are extremely naive. Their only underlying theory is that the factors which have caused past trends will continue into the future. Insofar as this assumption is a valid one, it would appear that the foregoing projections are reasonable, albeit somewhat conservative. Projected changes in livestock inventories are somewhat smaller than those which occurred in the past decade. Therefore, the projections could be quite conservative - particularly given the buoyant markets which have been observed in the past two years. At the same time, the projections imply that the largest growth areas within the province will be southern and western Ontario for all livestock classes except beef cows. This conclusion seems reasonable in view of trends which are taking place in Ontario.

The antithesis of using simple trend analysis for projections

is embodied in the statement that everything depends on everything else. To a great extent the authors find themselves in agreement with this statement. Many and diverse factors will influence livestock production in Ontario in the future. Among these are: livestock and feedgrain production technology; domestic and international demand for livestock products; changes in comparative advantages within Ontario, between Ontario and the rest of Canada, between Canada and the U.S.; marketing board policies; and federal policies pertaining to livestock and feedgrains which may affect the production of livestock. Predictions should conceptually depend on all of these. However, since all these must also be predicted, and since many of them are behavioral instead of economic variables, such a task would appear to be overwhelming. Thus, it would appear that simple extrapolations, such as this analyis has undertaken, may be the best guide to the future.

5.0 FEED RATIONS AND THE PROCEDURE FOR FEED CONSUMPTION PROJECTIONS

Feed consumption projections are developed in section 6.0. These are based on livestock numbers projected in section 4.0 and recommended nutrient and feed requirements as compiled by Economics Branch, Canada Department of Ariculture.[1/] Daily nutrient and feed requirement coefficients by category of livestock are presented in Table 13 as are the sources of the information and explanatory notes concerning the animals for which the diets were developed. Pounds per day fed are based on nutrients available in an average diet for each class of livestock.

Feed consumption projections using the pounds of feed per day for each livestock class except beef and dairy were developed as follows. First, two assumptions were made.

Assumption 1. The inventory level projected for June 1, 1980, is the same for each day in the year. In other words, total annual feed consumption is based on the June 1 inventory. No seasonality is considered.

Assumption 2. Aggregate statistics indicate that there has been a trend toward on-farm mixing. For example, for all of Canada in 1963, 54.5 per cent of complete feed equivalents were distributed as macro premixes of supplements. In 1970, these categories represented 61.5 per cent of shipments [23]. Similarly, a survey of Ontario feed mills indicated that feed manufacturers (primary mills) distributed 53.7 per

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1/ Obtained through personal correspondance with Economics Branch personnel.

TABLE 13: Nutrient Requirements of Livestock

	Weight Fed	Protein	Ether Extract	Calcium	Phosphorus	Metabolizable Energy
	-lbs./day-	%	%	%	%	-kcal./lb. of feed-
Milk cows[1/]	26.0	12.6	2.0	.41	.30	1,006
Beef cows[2/]	18.7	5.3	2.0	.14	.14	740
Dairy yearlings[3/]	18.4	7.7	2.0	.29	.22	880
Beef Heifer[4/]	17.9	11.0	2.0	.28	.22	1,090
Calves[5/]	5.5	11.0	2.0	.34	.28	1,065
Steers[6/]	15.2	11.0	2.0	.33	.24	1,090
Old pigs[7/]	6.3	14.25	2.0	.60	.40	1,500
Young pigs[8/]	4.1	15.00	2.0	.63	.61	1,442
Broilers[9/]	.150	21.4	7.025	.872	.423	1,424
Laying Hens[10/]	.250	15.0	1.0	2.75	.50	1,300
Turkeys[11/]	.270	23.25	6.1	.95	.55	1,410

11/ Maintenance and Milk production for a 1,320 lb. dairy cow. Source: National Academy of Sciences (NAC), Nutrient Requirements of Dairy Cattle, 1971.

2/ Dry Pregnant Mature Beef Cow Weighing 1,100 lbs. Source: NAC, Nutrient Requirements of Beef Cattle, 1970.

3/ Growth and Maintenance of a 660 lb. Dairy Heifer. Source: See No. 1.

4/ Growth and Maintenance of a 660 lb. Beef Heifer. Source: See No. 2.

5/ Nutrients Required on an average for growing steers and growing heifers weighing 330 lbs. Source: See No. 1.

6/ Growth and Maintenance of a 660 lb. steer. Source: See No. 1.

7/ A weighted average of rations for bred gilts and sows and of lactating sows (75% and 25% respectively). Source: Nutrient Requirements of Breeding Swine, NAC.

8/ A simple average (based on pounds of feed consumed) of each weight class of growing pigs. Source: Nutrient Requirements of Growing and Finishing Swine, NAC.

9/ Starting and finishing rations used in the ratio of 3:1 of feed consumption. Source: 1972 Poultry Feed Formulaes, Ontario Department of Agriculture, Page 72.

10/ Simple average of Maintenance and Egg production for Breeding and Laying Hens. Source: Nutrient Requirements of Poultry, NAC.

11/ Average for 12-13 lb. birds. Source: See No. 9, Page 90.

cent of complete feed equivalents as premixes or supplements direct to farms in 1965 and 64.4 per cent direct to farms in 1971. Their distribution pattern through dealers indicated that in both 1965 and 1971, approximately 95 per cent of the complete feed equivalents were shipped as premixes or supplements [21]. These figures indicate that there is a strong trend toward increased utilization of premixes and supplements and, thus, that the importance of on-farm mixing is growing. A number of studies regarding on-farm mixing have suggested that farmers who use as little as 60 to 75 tons of feed per year can find it economical to mix their own feeds using supplements or premixes for a protein base [25], [29]. Given the trend noted above and the results of previous research, an assumption had to be made concerning the extent of on-farm mixing so that separate demands could be calculated for complete feed and supplements and premixes. The assumption was made that farms which require more than 100 tons of complete feed per year would mix on farm and those requiring less would purchase complete feeds,[1/] as explained below. Given extension recommendations, the 60 to 75 ton range would seem more logical. However, it is felt that the decision to mix on the farm is more than simply a matter of capital budgeting which the studies cited above used in their analysis. Other factors such as the availability of feed grains on the farm, demands for farm labour

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[1/] The allocation of demand between complete feeds and concentrates is based on 1971 census farm size distribution. The allocation procedure will be outlined below.

in other enterprises, and the extent of vertical coordination will also affect the adjustment toward on-farm mixing. Thus, the 100 ton figure is used to allow a margin for resistance to adjustment.

A second reason for using the 100 ton figure is that the livestock inventories used in the projections are for June 1. There is considerable seasonality of production for several livestock categories. As a result, June 1 inventories are normally higher than the annual average. Thus, the number of livestock representing a consumption level over the year of 100 tons based on June 1 inventories will allow for lower inventory levels on farms during other times of the year. It will be noted in section 6.0 that even with this adjustment margin, the projections indicate a substantial change in the proportion of feed which will be mixed on farms in 1980.

Using these assumptions, feed consumption projections by livestock type and region were developed through the following steps.

1. Projected livestock numbers for each county were obtained (i.e. Tables 8 to 12 in Section 4).
2. Enterprise size distributions by county were obtained from the 1971 Census of Agriculture to determine the proportion of livestock enterprises which fall in the greater and less than 100 ton categories.[1/]
3. Proportions of supplement and premix shipments from feed

1/ The minimum number of animals of each class necessary for 100 tons of feed is developed in [6].

manufacturers were obtained from the 1971 Shipments of Livestock and Poultry Feeds [23] to determine the relative proportions of concentrates shipped as supplements and premixes for Ontario.

4. Projected livestock numbers for each county were proportioned based on step 2 to determine the numbers raised on farms which would purchase a) complete feeds and b) supplements and premixes.
5. For farms which purchase complete feeds, the number of livestock were multiplied by pounds of feed fed per day (from Table 13) and then by 365 to obtain annual consumption.
6. For farms which purchase concentrates, complete feed equivalents were obtained as in step 5. These were then broken down, using step 3, into quantities of supplement and premix needed to provide the protein base for the projected complete feed equivalents. Conversion ratios for supplements and premixes are 400 pounds of supplement per ton and 150 pounds of premix per ton.

The procedure outlined above was also used to obtain projected cattle feed consumption, but with the adjustment outlined below. Pounds of feed fed per day in Table 13 includes the weight fed from all feed sources. Quantities for hogs and poultry are assumed to be either from feed grains or concentrates. For cattle, nutrients can be obtained from these sources as well as hay, pasture, haylage and silage. Thus, if the figures from Table 13 were used to project mixed feed consumption, a

substantial overestimate would be obtained. To overcome this problem, estimates of the feedgrain and concentrate portion of the ration for each class of cattle were obtained from the work compiled by the Economics Branch, Canada Department of Agriculture. These provided an average daily ration by cattle class whcih were then combined with the inventory projections to project regional consumption of cattle feed in 1980.

To test the validity of our projection procedure, the feeding rates were applied to 1971 livestock inventories and compared with 1971 feed distribution statistics as reported by Statistics Canada in [23]. Our procedure resulted in estimated feed consumption for all livestock classes combined of 3,585,705 tons of complete feed equivalents for Ontario. This was 18.6 per cent greater than the total distribution reported by Statistics Canada. However, the research reported in [21] inferred that Statistics Canada underestimated 1971 feed distribution by approximately 20 per cent. Therefore, it is judged that the feeding levels used in this study are reasonable.

6.0 FEED CONSUMPTION PROJECTIONS

Projections resulting from the procedure discussed above are presented in Tables 14 through 18 below. A brief discussion of each follows.

6.1 Projected Poultry Feed Consumption

Feed consumption by region for turkeys, layers and broilers is presented in Tables 14, 15 and 16.

The projections call for a total consumption in the province of 1,276,997 tons (complete feed equivalents) for all poultry feeds. This represents an increase of 19.4 per cent over the 1971 level as reported in [23]. The relative breakdown between consumption of complete feeds and concentrates is projected to change substantially by 1980. In 1971, Statistics Canada figures indicated that approximately 43 per cent of the complete feed equivalents of poultry feed was purchased as concentrates. Survey results reported in [21] indicated that approximately 66 per cent of shipments from feed manufacturers were in the form of concentrates during the same year. The 1980 projection calls for 91 per cent of the complete feed equivalents to be distributed as concentrates. This degree of change is probably somewhat overstated for two reasons. First, many poultry operations do not grow their own feedgrains and thus, find purchasing complete feeds more convenient. Second, a relatively high proportion of poultry producers are affected by some degree of vertical coordination from feed manufacturers which often includes a contract to purchase complete feeds.

TABLE 14: Regional Projection of Feed Consumption for Turkeys to 1980 (Tons)

Region	Complete Feed	Supplement	Premix
1A	10.9	97.9	167.3
2	247.7	964.1	1,647.1
3	266.6	1,059.9	1,810.8
4	743.0	1,508.1	2,576.4
5A	288.7	2,725.4	4,655.9
6	14.9	598.3	1,022.1
7	.4	8.3	14.1
1B	348.1	335.8	573.6
1C	69.8	0	0
1D	40.3	0	0
5B	144.6	181.5	310.0
8	0	0	0
1E	0	0	0
Province	2,175.1	7,479.4	12,777.3

TABLE 15: Regional Projections of Feed Consumption for Layers to 1980 (Tons)

Region	Complete Feed	Supplement	Premix
1A	3,637.5	328.8	561.7
2	17,643.3	3,309.8	5,654.3
3	18,683.5	1,732.5	2,959.7
4	2,877.1	334.6	571.7
5A	10,186.9	2,821.8	4,820.6
6	0	0	0
7	2,463.1	113.0	193.0
1B	2,413.5	22.7	388.6
1C	4,007.1	326.4	557.6
1D	4,599.4	416.5	711.5
5B	9,648.9	1,084.4	1,852.5
8	8,687.8	924.2	1,578.9
1E	8,424.0	1,969.9	3,365.3
Province	93,272.2	13,384.7	23,215.2

TABLE 16: Regional Projections of Feed Consumption for Broilers to 1980 (Tons)

Region	Complete Feed	Supplement	Premix
1A	1,668.9	191.8	300.4
2	2,287.2	572.8	978.6
3	1,987.1	5,435.2	9,285.1
4	1,016.5	856.6	1,463.4
5A	2,670.9	6,435.6	10,994.1
6	414.0	2,145.3	3,664.9
7	1,280.1	1,030.3	1,760.0
1B	609.8	1,326.0	2,265.3
1C	65.0	408.4	697.7
1D	0	0	0
5B	2,728.5	2,612.6	4,463.2
8	0	0	0
1E	3.2	95.4	163.0
Province	14,731.3	21,109.9	36,035.7

6.2 Projected Swine Feed Consumption

Projected consumption of swine feeds by region is presented in Table 17. Total complete feed equivalents for the province, when calculated from the complete supplement and premix projections, amount to 1,929,367 tons. This represents an increase of 116 per cent above the total reported by Statistics Canada for 1971 [23]. On the surface, it would appear that the projections represent a considerable discrepancy over present consumption levels. However, it should be pointed out the feed industry survey ([21, Table 30]) indicated that considering only shipments direct to farms by 23 of 32 primary feed manufacturing plants and 6 of 10 premix manufacturers, total complete feed equivalents of hog feeds reported by the survey, was 12.5 per cent greater than the Statistics Canada report. Thus, it would appear that the official statistics are grossly understated and therefore, that the 1980 swine projections are reasonable estimates of feed consumption needs, given the projection of hog numbers.

The 1980 projections indicate that 60 per cent of complete feed equivalents for hog feeds will be distributed as concentrates. Official statistics for 1971 show that the percentage in that year was 86 per cent. If the understatement of total distribution in official statistics noted above is mainly a failure to correctly assess the distribution from local mills, then it may be concluded that the 86 per cent figure is probably high since local mills would tend to distribute a larger percentage of their feeds as complete feeds rather than supplements.

TABLE 17: Regional Projections of Feed Consumption for Hogs to 1980 (Tons)

Region	Complete Feed	Supplement	Premix
1A	46,171.3	2,056.8	5,162.2
2	70,294.6	4,064.1	10,200.1
3	203,304.1	10,747.2	26,973.2
4	27,752.8	1,311.2	3,290.8
5A	55,290.4	2,562.5	6,431.3
6	46,022.5	2,209.6	5,545.6
7	124,710.0	1,471.5	3,693.2
1B	49,640.5	1,586.1	3,980.7
1C	9,352.8	121.6	305.1
1D	5,530.9	62.0	155.6
5B	102,357.9	2,864.9	7,190.2
8	24,483.0	501.6	1,258.9
1E	18,653.5	295.0	740.3
Province	783,563.2	29,854.9	74,927.2

6.3 Projections for Cattle Feed Consumption

Projections for cattle feed by region and feed type are presented in Table 18.

The quantities in Table 18, when converted to complete feed equivalents, represent 1,380,440 tons for the province. This represents a projected increase of approximately 55 per cent over the 1971 levels reported by Statistics Canada [23].[1/] An increase of this magnitude reflects the substantial increase in beef cow, heifer and steer inventories which were projected in section 4.0.

The 1980 projections indicate that approximately 85 per cent of the complete feed equivalents will be distributed as concentrates. This compares to Statistics Canada estimates that approximately 90 per cent of 1971 complete feed equivalents were distributed as concentrates in 1971. Thus, it appears that no substantial change in the relative proportions of concentrates and complete feeds will occur.

[1/] Statistics Canada reported an increase of approximately 16 per cent in 1972 over 1971.

TABLE 18: Regional Projections of Feed Consumption for Cattle to 1980 (Tons)

Region	Complete Feed	Supplement	Premix
1A	3,178.8	370.7	257.5
2	9,152.3	4,094.0	2,843.8
3	24,883.2	14,524.3	10,089.5
4	12,684.4	7,023.6	4,879.4
5A	25,476.4	5,278.2	3,667.0
6	5,588.9	4,186.4	2,907.7
7	11,100.5	6,786.3	4,713.8
1B	10,339.2	4,240.8	2,946.1
1C	6,285.6	1,608.6	1,117.5
1D	9,359.2	2,876.3	1,997.9
5B	24,779.7	8,207.4	5,701.1
8	29,921,9	10,264.7	7,130.8
1E	32,470.4	12,776.6	9,192.7
Province	205,220.5	82,237.9	57,444.9

7.0 SUMMARY AND CONCLUSIONS

This paper has focused on projecting regional livestock numbers and feed consumption levels in Ontario to 1980. In section 2.0 an alternative methodology for establishing regional groupings of counties which reflect trends and densities in livestock production was discussed and its results were presented. It was determined that the five region breakdown presently used by the Ontario Ministry of Agriculture and Food is aggregated to the point where within region aggregation tends to mask changes in livestock production patterns. A relatively simple procedure (called hierarchical analysis) used for classification of units with multiple characteristics into homogeneous groups was employed (and modified to include time series data) to determine an alternative set of regions. This analysis resulted, for this report, in thirteen regions within the province.

In section 3.0, trends and changes in concentration of each class of livestock were assessed by region to determine the extent and nature of change in livestock production patterns which took place from 1961 through 1971. Several substantial adjustments toward regional specialization were noted from this analysis, Adjustments were found to be strongest in the poultry categories while less pronounced adjustments were found in the hog and fed beef categories and there was very little adjustment in the cow-calf and dairy categories. Section 4.0 included the results of simple trend projections which were used to indicate the magnitude of regional livestock inventories which can be

expected in 1980. This section also discussed several limitations of the analysis.

In section 5.0 feed consumption figures developed by Economics Branch, Canada Department of Agriculture for use in their national model of agriculture were presented by livestock class. These were subsequently used to develop the regional projections of feed consumption with a procedure outlined in section 5.0. Regional feed consumption projections for 1980 were calculated by region and livestock class in section 6.0. Projections were made in terms of consumption of complete feeds, supplements and premixes. These were compared to reported 1971 distribution by Statistics Canada and to 1971 distribution patterns as determined by survey data.

This analysis leads us to the following conclusions.

First, the livestock categories with the highest projected growth rates have been and will continue to be, the beef and fowl categories while swine production is projected to grow at a lower rate and the dairy category is projected to continue to decline, but at a lower rate than during the past decade.

Second, adjustments toward regional production specialization have occurred at a more rapid rate for the fowl categories than for the others. This would lead to the inference that, with the exception of the poultry producing areas, most regions of Ontario will continue to have a varied mix of livestock enterprises. At the same time, there is a definite trend toward intensification of livestock raising in Southern and Western Ontario that has not occurred in the central, Northern and

Eastern parts of the province.

Third, the feed consumption projections indicate that farm demand for feeds will continue to change in nature to include a larger concentrate component. The extent of this change will depend, in part, on such marketing arrangements as vertical coordination.

Finally, the projected mix of livestock enterprises in most areas of the province, will tend to encourage continued reliance on multi-purpose feed plants. The poultry producing areas may be an exception to this trend.

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