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Structural Changes in Alberta Cereal Agriculture Systems Between 1971 and 1981

by

Keir John Packer

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ABSTRACT

The purpose of this research was to appraise the effects of the Western Grain Transportation Act on the structure of commercial cereal agriculture in Alberta.

Four objectives were established. The first was to develop a farming system classification; the second was to determine changes in the materials and organization of the farming systems; the third was to further disaggregate the farming systems by volume of sales to determine factors motivating change; and the final objective was to develop a simulation model that indicated the adjustments required to compensate for a cost increase or a grain price decline.

The results indicated rapid changes in the organization of all farming systems in the 1970s. There was a major shift in industry composition in central and southern Alberta. Strong differences in the structure of farming systems were noted between regions.

Disaggregation by farm size indicated that over the decade barriers to continuous capital/labour substitution had been overcome at large farm sizes. The unit cash cost curve indicated economies of size and showed a major cost price squeeze. Sales per acre and gross margins per acre were found to be positively correlated with volume of sales. The gross margins per acre function declined at all but the largest sales categories over the decade.

The simulations indicated that a 20 percent cost increase required an increase in sales of 12 percent in 1971

and 25 percent in 1981 to compensate. An output price drop of 20 percent required an 80 percent sales increase at small farm sizes and a 120 percent increase at large sized farms.

There was strong evidence of polarization. The bottom 50 percent of the industry generated lower sales and margins than the top 1 percent of producers. Rates of structural adjustment in the bottom half of the industry were negligible compared to the top producers.

The results have implications in terms of: the effects of macro-economic variables on structural change and productivity; the impact of the WGTA and cost squeeze on the industry; the effectiveness of size expansion as a method of accommodating environmental pressure; and the validity of programs that are not farm size or region specific.

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Table of Contents

Chapter Page

I. INTRODUCTION 1

A. Context of the Research 1

B. Purpose 4

C. Objectives 4

D. Results 6

E. Organization 7

II. BACKGROUND LITERATURE 9

A. Economic and Agricultural Development 9

B. Factors Hypothesized to Motivate Structural Change in Alberta 13

Cost Price Squeeze 13

Relative Factor Prices 15

Economies of Size 15

Intensification 20

C. Factors Facilitating Structural Change 22

D. Summary 26

III. METHODS AND DATA 28

A. Methods 28

General Systems Theory 29

Farming Systems Classification 31

Testing the Validity of the Classification System 34

Relationship Between Structural Variables and Size 35

Adjustments to Cost Increases and Price Decreases 40

Sectoral Development 41

B. Data 41

Variables Used in the Study 42

Regions Investigated for Alberta 44

Weather and Crop Conditions in 1970 and 1980 46

C. Results 48

IV. CLASSIFICATION OF PRODUCERS INTO FARMING SYSTEMS .50

A. Tests Utilized to Distinguish the Parts on the Basis of the Structural Variables 50

Testing Hypothesis: Two Means, Large Samples 52

Testing Hypothesis: Two Distributions, Large Samples 54

B. Results of Tests of Differences Between Parts .55

V. RESULTS - DESCRIPTIVE COMPARISONS OF CEREAL AGRICULTURE: 1971 AND 1981 63

A. Introduction 63

B. Structure of Farms and Operator Characteristics 63

Number of Producers 63

Farm Size as Measured by Improved Area 66

Land Rental 67

Organization 69

Operator Age 69

Cropping Pattern 71

Labour Use 75

Off-farm Work 75

Machinery Use 77

Value of Sales 77

Gross Margins 79

C. Structural Ratios 79

Machinery per Acre of Improved Land 79

Capital per Person-Year of Labour 81

Capital per Dollar of Sales 81

Sales per Acre 83

Sales per Year of Labour 84

Gross Margin per Acre 85

D. Summary of Changes Between 1971 and 1981 85

VI. RESULTS: INFLUENCE OF SIZE AND TIME ON STRUCTURAL VARIABLES 91

A. Introduction 91

B. The Capital Labour Ratio 93

C. Sales per Acre 107

D. Economies of Size 117

E. Gross Margins per Acre 129

F. Summary of Relationships and Changes Over Time 141

VII. DISTRIBUTION OF SALES, GROSS MARGIN AND RATES OF STRUCTURAL ADJUSTMENT 146

A. Introduction 146

B. The Distribution of Sales and Gross Margin ...146

C. Adjustments to Price Decreases and Cost Increases in 1971 and 1981 151

D. Summary 161

VIII. SUMMARY WITH IMPLICATIONS 163

A. Purpose, Objectives and Hypotheses 163

B. Procedures Followed 166

C. Results 167

D. Implications of Results 172

E. Research Issues 174

BIBLIOGRAPHY 176

APPENDIX A 182

APPENDIX B 186

APPENDIX C 187

APPENDIX D 189

List of Tables

Table Page

IV.1 Average cropping and cattle intensities for commercial grain producers in each class for the province of Alberta, 1971 and 1981 51

IV.2 Number of producers in each class for Alberta in 1971 and 1981 62

IV.3 Cropping and cattle intensities in each class for Alberta in 1971 and 1981 62

V.1 The number of commercial grain farms in each class for CD's 5, 10 and 15 and the provincial total, 1971, 1976 and 1981 64

V.2 Average cropping and cattle intensities for commercial grain producers in each class for CD's 5, 10 and 15 and the provincial total of Alberta, 1981 64

V.3 Average improved area per farm (in acres) for commercial grain farms in each class for CD's 5, 10 and 15 and the provincial total of Alberta, 1971 and 1981 68

V.4 Percentage of commerical grain farms renting land in each class for CD's 5, 10 and 15 and the provincial total of Alberta, 1971 and 1981 68

V.5 Percentage of total farm area rented on commerical grain farms in each class for CD's 5, 10 and 15, 1971 and 1981 70

V.6 Percentage of commercial grain farms organized as individual proprietorships in each class for CD's 5, 10 and 15 and the provincial total for Alberta, 1971 and 1981 70

V.7 Average age of for commercial grain farmers in each class for CD's 5, 10 and 15 and the provincial total for Alberta, 1971 and 1981 71

Table		Page

V.8 Area in various crops in CD's 5, 10 and 15 and provincial average in acres and as a percentage of improved area, 1971 and 1981 73

V.9 Average labour use in commercial grain farms in each class for CD's 5, 10 and 15 and the provincial total in person-years, 1971 and 1981 76

V.10 Average number of days of off-farm work for commercial grain farms in each class in CD's 5, 10 and 15 and the provincial total for Alberta, 1971 and 1981 76

V.11 Average value of machinery employed per commercial grain farm in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981 78

V.12 Average sales per commercial grain farm in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981 78

V.13 Average gross margin per farm for commercial grain farms in each class for CD's 5, 10 and 15, and the Provincial average, in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981 80

V.14 Average value of machinery employed per improved acre for the commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981 80

V.15 Average value of machinery per year of labour for the commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981 82

V.16 Average value of machinery per dollar of sales and the of real change between 1971 and 1981 for commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981 84

Table		Page

V.17 Average sales per acre of improved land for commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981 86

V.18 Average sales per year of labour for commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981 86

V.19 Gross margin per improved acre for commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981 87

VI.1 The number of commercial grain producers in each sales category for the four classes and the CD aggregates in CD's 5, 10 and 15 in 1971 and 1981 94

VI.2 Machinery used per year of labour for commercial grain producers in each class category for the four classes and the CD aggregates in CD's 5, 10 and 15 in 1971 and 1981 96

VI.3 Equations describing the relationship between the capital/labour ratio and volume of sales for the four commercial classes and the CD aggregates in CD 5 in 1971 and 1981 101

VI.4 Equations describing the relationship between capital/labour ratio and volume of sales for the four commercial classes and the CD aggregates in CD 10 in 1971 and 1981 102

VI.5 Equations describing the relationship between capital/labour ratio and volume of sales for the four commercial classes and the CD aggregates in CD 10 in 1971 and 1981 103

VI.6 Labour use per commercial grain farm, stratified by volume of sales, Alberta average, 1971 and 1981 106

Table Page

VI.7 Sales per acre of improved land for commercial grain producers in each class category for the four classes and the CD aggregates in CD's 5, 10 and 15 in 1971 and 1981 108

VI.8 Equations describing sales per acre related to farm sales for classes of commercial grain farms in CD 5 in 1971 and 1981 114

VI.9 Equations describing sales per acre related to farm sales for classes of commercial grain farms in CD 10 in 1971 and 1981 115

VI.10 Equations describing sales per acre related to farm sales for classes of commercial grain farms in CD 15 in 1971 and 1981 116

VI.11 Cash costs as a proportion of sales for commercial grain producers in each class category for the four classes and the CD aggregates in CD 5 in 1971 and 1981 118

VI.12 Cash costs as a proportion of sales for commercial grain producers in each class category for the four classes and the CD aggregates in CD 10 in 1971 and 1981 118

VI.13 Cash costs as a proportion of sales for commercial grain producers in each class category for the four classes and the CD aggregates in CD 15 in 1971 and 1981 119

VI.14 Equations describing the relationship between the unit cash costs and volume of sales for the four commercial classes and the CD aggregates in CD 5 in 1971 and 1981 124

VI.15 Equations describing the relationship between the unit cash costs and volume of sales for the four commercial classes and the CD aggregates in CD 10 in 1971 and 1981 125

Table		Page

VI.16 Equations describing the relationship between the unit cash costs and volume of sales for the four commercial classes and the CD aggregates in CD 15 in 1971 and 1981 126

VI.17 Unit cash costs per dollar of sales for CD aggregates as estimated from equations for CD's 5, 10 and 15 for various sales levels in 1971 and 1981 and the relative and absolute change in cost per dollar of sales 127

VI.18 Gross margin in dollars per acre for commercial grain producers in each class category for the four classes and the CD aggregates in CD's 5, 10 and 15 in 1971 and 1981 130

VI.19 Equations describing the relationship between gross margin in dollars per acre for commercial grain producers in each class category for the four classes and the CD aggregates in CD 5 in 1971 and 1981 136

VI.20 Equations describing the relationship between gross margin in dollars per acre for commercial grain producers in each class category for the four classes and the CD aggregates in CD 10 in 1971 and 1981 137

VI.21 Equations describing the relationship between gross margin in dollars per acre for commercial grain producers in each class category for the four classes and the CD aggregates in CD 15 in 1971 and 1981 138

VI.22 A comparison of sales per acre, gross margin per acre and total gross margin per farm (in dollars) for farms of 500, 700 and 1,500 acres using the four cropping systems in CD's 5, 10 and 15, 1981 140

Table		Page
VII.1	The proportion of total sales and gross margin generated by each sales percentile grouping for commercial grain farms in Alberta in 1971 and 1981 expressed as a percentage and accumulated percentages	147
VII.2	The area, cropping intensity and sales per acre for producers in each percentile, based on provincial average data in 1971 and 1981	149
VII.3	Value of sales required for a commercial grain farm to be in selected sales percentiles in Alberta in 1971 and 1981	151
VII.4	The sales, margins per acre, capital, area, sales per acre, for CD aggregates in CD's 5, 10 and 15 at the $50,000 sales volume, before and after adjustments to a 20 percent cost increase, 1971 and 1981	153
VII.5	The sales, margins per acre, capital, area, sales per acre, for CD aggregates in CD's 5, 10 and 15 at the $150,000 sales volume, before and after adjustments to a 20 percent cost increase, 1971 and 1981	154
VII.6	Equations describing the relationship between volume of sales and structural variables for the CD aggregate in CD 5, 1971	156
VII.7	The sales, margins per acre, capital, area, sales per acre, for CD aggregates in CD's 5, 10 and 15 at the $50,000 sales volume, before and after adjustments to a 20 percent price decrease, 1971 and 1981	158
VII.8	The sales, margins per acre, capital, area, sales per acre, for CD aggregates in CD's 5, 10 and 15 at the $150,000 sales volume, before and after adjustments to a 20 percent price decrease, 1971 and 1981	159

List of Figures

Figure Page

III.1 Census Divisions in Alberta with particular emphasis on farming areas in southern Alberta (CD 5), central Alberta (CD 10) and northern Alberta (CD 15) 45

IV.1 Criteria for classifying commercial grain farms 51

IV.2 Numbers in each class in 1971 and 1981 51

IV.3 Results of Kolmogorov-Smirnov tests for differences between farming systems in CD's 5, 10 and 15, 1971 56

IV.4 Results of Kolmogorov-Smirnov tests for differences between farming systems in CD's 5, 10 and 15, 1981 59

IV.5 Criteria for classifying commercial grain producers into classes 61

VI.1 Machinery value per year of labour stratified by sales volume in CD 5, 1971 98

VI.2 Machinery value per year of labour stratified by sales volume in CD 5, 1981 98

VI.3 Machinery value per year of labour stratified by sales volume in CD 10, 1971 99

VI.4 Machinery value per year of labour stratified by sales volume in CD10, 1981 99

VI.5 Machinery value per year of labour stratified by sales volume in CD 15, 1971 100

VI.6 Machinery value per year of labour stratified by sales volume in CD 15, 1981 100

VI.7 Sales per acre of improved land stratified by sales volume in CD 5, 1971 111

VI.8 Sales per acre of improved land stratified by sales volume in CD 5, 1981 111

Figure Page

VI.9 Sales per acre of improved land stratified by sales volume in CD 10, 1971 112

VI.10 Sales per acre of improved land stratified by sales volume in CD 10, 1981 112

VI.11 Sales per acre of improved land stratified by sales volume in CD 15, 1971 113

VI.12 Sales per acre of improved land stratified by sales volume in CD 15, 1981 113

VI.13 Cash costs per dollar of sales stratified by sales volume in CD 5, 1971 121

VI.14 Cash costs per dollar of sales stratified by sales volume in CD 5, 1981 121

VI.15 Cash costs per dollar of sales stratified by sales volume in CD 10, 1971 122

VI.16 Cash costs per dollar of sales stratified by sales volume in CD 10, 1981 122

VI.17 Cash costs per dollar of sales stratified by sales volume in CD 15, 1971 123

VI.18 Cash costs per dollar of sales stratified by sales volume in CD 15, 1981 123

VI.19 Gross margin in dollars per acre of improved land stratified by sales volume in CD 5, 1971 133

VI.20 Gross margin in dollars per acre of improved land stratified by sales volume in CD 5, 1981 133

VI.21 Gross margin in dollars per acre of improved land stratified by sales volume in CD 10, 1971 134

Figure | Page

VI.22 Gross margin in dollars per acre of improved land stratified by sales volume in CD 10, 1981 134

VI.23 Gross margin in dollars per acre of improved land stratified by sales volume in CD 15, 1971 135

VI.24 Gross margin in dollars per acre of improved land stratified by sales volume in CD 15, 1981 135

I. INTRODUCTION

A. Context of the Research

Alberta cereal agriculture underwent major structural change between 1971 and 1981. This thesis attempts to quantify the changes that took place during that decade.

The scope of the issues involved in structural change is large as witnessed by recent works by Brinkman[1] and the USDA.[2] One reason for the wide scope is the need for two levels of abstraction when studying the structure of agriculture. At the farm level, the elements of the system include land, labour, materials, and capital in its broadest sense. The distinctiveness of individual farms is determined by the organization and relative proportions of these inputs. Features of individual farms include farm area, volume of sales, levels of capital and labour used, as well as the organization of production, including cropping rotation and legal description. At the industry level, elements of the system are the individual farms. The structure of the cereal agriculture system as a whole is determined by the composition of the individual farms and the ownership pattern, concentration of resources and

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[1]Brinkman, G. L. and Warley, T.K., **Structural Change in Canadian Agriculture: A Perspective**. Ottawa: Agriculture Canada, June 1983: pp. 1-17.

[2]U.S.D.A., **A Time to Choose**, Summary Report on the Structure of Agriculture. United States Department of Agriculture, Washington, D.C., January 1981: pp. 15-18; and **Structure Issues of American Agriculture**. Report No. 438, United States Department of Agriculture, Washington, D.C., November 1979: pp. 2-23.

distribution of revenue associated with that composition.

For purposes of analysis, it is essential to separate the components that make up the commercial cereal production system in Alberta. Disaggregating to the individual level is not practical. Using aggregates of all producers obscures details required to perceive change in composition of the industry. Work in farming systems provides a basis for classifying producers into relatively homogeneous groups. These homogeneous groups or farming systems provide the basic unit of study.

This thesis reports research on aspects of the structure of individual farming systems and the industry as a whole. Determinant factors of structure such as a cost price squeeze, relative factor prices, economies of size and technical change are employed as a basis for understanding the changing structural features of both levels of the industry.

The elements and organization of the farming systems and the industry as a whole affect the performance of the commercial grain production system. Allocative efficiency, improvements in productivity, flexibility, profitability and renewability of agriculture are performance variables that are affected by the interaction of organization of agriculture and its social, economic and physical environment.

The structure of the industry is important to society because of the large economic benefit and extensive social benefits attributable to a viable agricultural sector in Western Canada. The viability of the industry rests largely on its ability to generate and adopt technical changes and structural forms that enhance productivity and efficiency. To fully realize the benefits of new technology, adjustments to the organization of farms are required. Barriers to adjustment may slow the adoption of new technology and reduce its effectiveness when adopted. This situation is graphically illustrated in many LDC's. In Western Canada, factors environmental to the farming system can greatly slow structural changes affecting rates of technical change and productivity growth. Environmental factors include the domestic economy, world markets, politics, sociocultural values and beliefs, and atmospheric conditions.

Beyond the economic importance of structural change in agriculture are the social and ideological implications. The number of people farming and the pattern of ownership of resources used in agriculture greatly affect the vitality and quality of rural life. The interplay of changing beliefs and values on social benefits on an agricultural structure lead to arguments about the ideals for the whole future of farming in Alberta. The focus of this thesis is nevertheless on the economic questions of structure. Some value-loaded implications of continued change are pointed out in the discussion of results.

B. Purpose

The primary purpose of the research was to determine the effects of the Western Grain Transportation Act (WGTA) on the structure of commercial cereal agriculture in Alberta. The WGTA represents increasing transportation costs for grain producers through the remainder of the century. Some form of adjustment will be required to compensate for these additional costs.

The secondary purpose of the research was to illustrate the structure of agriculture. A great deal of literature from the United States indicates that the cumulative effects of an ad-hoc approach to agricultural policy was the development of structural features that were not desired or even considered by policymakers.

To prevent a similar blind progression in Alberta, it is important to understand the structure of cereal agriculture and the direction and importance of change, as that system attempts to maintain viability in a changing environment. This thesis provides a perspective setback from the actual daily events in agriculture so that a larger long-term view of the industry in Alberta can be witnessed.

C. Objectives

There are four objectives this study will attempt to meet. The first objective is to determine the importance of cropping intensity as a defining feature of farming systems. A classification system based on the intensity of cropping was used to isolate structurally different groups of producers. It is hypothesized that intensity of cropping is a fundamental structural feature that will determine other variables.

The second objective is to report the structural characteristics of commercial grain production systems identified in the initial classification. The changes in the characteristics and relative number of producers in each system in 1971 and 1981 will give an indication of the direction of structural change at the farming system and industry levels.

The third objective is to determine the relationship between several structural variables and farm size as measured by volume of sales. These relationships will indicate the direction in which some determinants of structure are working. The variables expected to be related to size include the capital/labour ratio, unit cash costs, sales per acre and gross margin per acre. These relationships will provide insight into the effects of capital for labour substitution, technical change, economies of size and the cost price squeeze on the structure of cereal agriculture in Alberta.

The final objective is to anticipate structural changes required by the commercial cereal agriculture system to overcome cost increases or price declines. The simulation technique will provide an indication of the direction and magnitude of reactions to forces such as the cost squeeze and the WGTA.

D. Results

The farming system classification was tested using parametric and non-parametric tests. The results validated a four category system, based on the improved area in crop, fallow and forage, for separating producers into different farming systems.

The relationship between sales volume and a number of structural features such as the capital/labour ratio, sales per acre, average variable costs, and gross margin per acre were tested in 1971 and 1981. The results indicated that the barriers limiting continuously greater substitution of capital for labour at large sizes of farms in 1971 had been overcome by 1981. The average variable cost curve shifted vertically upward and increased in slope, indicating a cost price squeeze. The largest volume producers consistently had the lowest cost of production. Increases in sales per acre between 1971 and 1981 did not compensate for higher costs. Gross margins per acre declined at all but largest sales categories. If producers had not substantially increased size, their margins per acre declined (see Chapter VI).

Industry structure as a whole was also studied. The distribution of sales, gross margin, and rates of structural adjustment in different sales percentiles were evaluated. The results indicated an increasing concentration of sales and gross margin in the top 20 percent of the industry. The concentration came at the expense of the bottom 50 percent with the mid-section retaining its original share. The rates of adjustment in features such as area, sales per acre, and cropping intensity indicate a polarization of the industry into two sectors, an economically viable sector changing rapidly and another sector that is essentially static and not adjusting. The dividing line is at approximately $50,000 of sales in 1981 (see Chapter VII).

The adjustments required to maintain 1981 gross margins per acre in the face of cost increases and price decreases for grain (WGTA) were assessed. The simulation indicates that adjustments required to neutralize cost increases have doubled since 1971 as variable costs became a large proportion of product value. The adjustment required to offset grain price decreases has remained constant, but are large relative to cost changes. It is estimated that in 1981 a 5 percent decline in output price would require a 25 percent increase in total farm sales to regain the initial gross margin per acre (see Chapter VII).

E. Organization

The thesis is organized into eight chapters. The first chapter sets out the subject of the research. The second chapter discusses the background literature on the subject of economic development and the forces behind structural adjustment. The third chapter outlines the actual methods and data used in the study. Chapter IV was used to develop and test a farming systems classification which was used in the remainder of the thesis. In Chapter V, the structural features of various farming systems are compared in 1971 and 1981. The relationship between farm size as measured by sales and a number of variables were determined in 1971 and 1981 in Chapter VI. Based on the relationships established in Chapter VI, a simulation was developed in Chapter VII to gain insight into changes in structure required to compensate for the WGTA and cost price squeeze. Chapter VIII discusses the policy implications of the results.

II. BACKGROUND LITERATURE

A. Economic and Agricultural Development

The structural changes that have taken place in Alberta between 1971 and 1981 can be studied from a development perspective. The literature on economic growth and development shows a consistent emphasis on the need for accumulation of capital as a source of growth. The formation of capital allows for applied innovation and the division of labour which offset the tendency of diminishing returns to capital and labour. This view is held by both classical and modern economic growth theorists.

The earliest classical authors, Smith, Malthus and Ricardo, expected diminishing returns to incremental increases in the use of capital and labour relative to land, both as new land of lower quality was opened (extensive margin) and as more inputs were used on a constant land area (intensive margin). The classical economists saw the land base and its fertility as inelastic, and agricultural technology was viewed as essentially static. In the classical model, diminishing returns to labour and capital applied to an inelastic supply of land represented a fundamental constraint to growth.[3]

The major economic development authors of the 19th century were primarily "stages theorists" from the German

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[3]Hayami, Y. and Ruttan, V., **Agricultural Development: An International Perspective.** Baltimore: Johns Hopkins Press, 1985: pp. 13-15.

school. The important theorists included Fredrich List and Karl Marx. Marx divided his stages of development based on the production technology in use. Unlike the classical authors, Marx believed technology could be applied to agriculture to offset diminishing returns. Marx saw the potential economies of size in agriculture as well as rotations which integrated livestock and crops to enhance nutrient cycling as evidence that diminishing returns to labour and capital could be overcome. In fact, the transformation of agriculture from a peasant to an industrial structure was a critical step in economic development, in his view.[4]

Boserup,[5] in her study of preindustrial agricultural systems, also departed from the classical model. Boserup suggested that a pattern of continuous development from more extensive to intensive agricultural systems was normal. The sharp distinction between cultivated and uncultivated land implied by extensive and intensive margin was replaced by a concept of increasing frequency of cropping and by changes ranging from forest and brush fallow to multicropping systems in which two or more crops are grown in one year. In the view of Boserup, soil fertility is a dependent variable responding to intensity of land use, rather than a determinant of the intensity of land use. From Boserup's perspective, the agricultural production was not as

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[4] Ibib., p. 17.
[5] Boserup, E. **The Conditions of Agricultural Growth.** London: Aldine Publishing Co., 1965.

inelastic as earlier feared by the classical economists.

Ruthenberg[6] agrees with Boserup in the sense that he sees intensification as a common evolutionary feature of agricultural systems. However, he does not see soil fertility necessarily increasing with use. "Permanent farming carried out on impoverished soils may well be considered a final stage in the land use development process." Ruthenberg concludes that even when all imaginable measures open to pre-machine man are applied to retain fertility in tropical areas, it is apparently not possible to avoid decreasing returns to labour when land use is intensified within the traditional state of agriculture, In this sense, Ruthenberg agrees with classical economists.

Ruthenberg and most modern theorists agree that substantial improvements of arable agriculture have been made through technical progress.[7] Diminishing returns are no longer inevitable consequences of increased production. The modern view that growth in agricultural production beyond extensification is possible has been embodied in a number of recent economic growth models. Rostows' "leading sector" model, the "dualist" models of Rannis and Fei, the "high payoff" model of Shultz and the "induced innovation" models

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[6]Ruthenberg, H. **Farming Systems of the Tropics.** Oxford: Oxford University Press, 1976, pp. 1-162.

[7]The modern view that the diminshing returns to capital and labour as applied to land can be postponed to the point that they do not interfere with economic growth is dependent upon the availability of energy. The substitution of fossil energy for land has been the dominant process in the development of modern agriculture. Depletion of energy stocks without development of a substitute would certainly give the classical model renewed relevance.

of Hayami and Ruttan all see growth in agricultural production without diminishing returns as central to economic development. The dualist models specifically study the interaction between the traditional agricultural sector and the industrial sector during the process of transformation. The induced innovation model in particular attempts to explain the forces that are responsible for technical and institutional adjustments that help increase productivity.

Hayami and Ruttan suggest that institutions are important in the process of agricultural development. Providing the organization that can overcome diminishing returns to land becomes the focus of policy. Their hypothesis is that induced innovation will cause institutions to adjust in a manner conducive to economic growth.[8] Whether or not this is universally true remains to be seen. The notion that institutions[9] are the force behind and barriers to economic progress is important to cereal production in Alberta as these can be changed by human action.

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[8]Hayami, Y. and Ruttan, V., op. cit., pp. 73-114.
[9]Institutions can include property rights, social customs, the organization of government, research institutions, channels for movement of goods and knowledge, economic organization etc.

B. Factors Hypothesized to Motivate Structural Change in Alberta

As agriculture has evolved in industrial societies, human institutions have become important determinants of the productivity of agricultural systems. The farmer and the systems he controls are no longer solely responsible for maintaining soil fertility, constructing capital goods, and developing new techniques. As industrialization has progressed, human systems environmental to agriculture have come to dominate as structural influences. Human systems provide nutrient supplies, capital goods, new techniques, markets for products and inputs. It is not surprising that most literature on structural change in agriculture focuses on institutional arrangements as the major forces behind change.

Brinkman lists the factors he believes are determinants of structure in Canada.[10] The list includes: exchange arrangements between agriculture and other sectors, technical change, relative factor prices, interest rates, land values, commodity programs, subsidies, tax policies and many others. In Alberta, many of the factors described by Brinkman can be witnessed.

Cost Price Squeeze

During the 1970s, a major motivation for structural change was the worsening terms of trade between agriculture and other sectors of the economy. Recent publications by

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[10]Brinkman, G.L. and Warley, T.K., op. cit., p. 56.

Veeman[11] and Manning[12] on productivity graphically illustrate the worsening terms of trade in agriculture. Veeman points out that there is strong historical evidence that farmers adopt new technology as a means of overcoming adverse movements in terms of trade.[13] Veeman's study indicated a significant negative relationship between terms of trade and productivity, though he did not suggest a cause and effect relationship.

Cochrane's "treadmill theory" offers an explanation for this phenomena:

> "The high value society places on technological advance guarantees a continuous outpouring of new technologies. The incentive to reduce cost on the many small farms across the country guarantees a rapid and widespread adoption of the new technologies. Rapid and widespread adoption of farm technological advance drives aggregate supply relation ahead of expanding demand relation in peace-time, and given the high inelastic demand for food, farm prices fall to low levels and stay there for long periods."[14]

Cochrane suggests there is a disequilibrium that is not correcting in agricultural markets. This chronic cost price squeeze represents a major motivation for adjustment by producers.

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[11]Veeman, T.S. and Fantino, A. "Productivity Growth in Western Canadian Agriculture: Empirical Measurement, Underlying Causal Influences and Policy Implications," Unpublished final report presented to the Agricultural Research Council of Alberta (Farming For the Future), 1985: pp. 42-44.
[12]Manning, T.W., "The Effects of Rising Energy Prices on Grain Production," Unpublished paper, Department of Rural Economy, University of Alberta, August 1984: pp. 11-12.
[13]Veeman, T.S. and Fantino, A., **op. cit.**, p. 42.
[14]Cochrane, W.W., **Farm Prices: Myth and Reality.** Minneapolis: University of Minnesota Press, 1958: p. 107.

Relative Factor Prices

In addition to the cost price squeeze, another feature of developed economies is a tendency for wages to increase relative to the price of capital. In this situation, there is an incentive to substitute capital for labour in the production process.

In Alberta, the relative proportion of capital and labour used changed dramatically in the 1970s. There was a great increase in the level of capital used per year of labour. The census information for 1981 also shows the disappearance of the feature of diminishing substitution of capital for labour at large farm sizes so evident in the 1960s.

The change in capital/labour substitution at large farm sizes suggest that induced technical innovation has taken place. Hicks argued that differences in the relative price of factors of production could influence the direction of invention and innovation.[15] Unlimited substitution of capital for labour in 1981 indicates technology has developed to reduce labour use, particularly at large farm sizes.

Economies of Size

Economies of size are associated with mechanized production processes. Two types of size economies are noted in the literature.

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[15]Hicks J.R., **The Theory of Wages**, London: Macmillan and Co., 1932: pp. 124-125.

Technical economies arise when there are indivisibilities in the production process and excess quantities of some inputs are being used. Farm machinery, for instance, is only available in lumpy or discrete units; it cannot be purchased in fractional amounts. Further increases in output can be obtained by utilizing idle machinery. The increase in output does not require a proportionate increase in the input, hence unit cost with respect to machinery inputs decrease.

Pecuniary economies of size occur when large volume producers are given a price discount that is not available to those farmers purchasing smaller quantities. The average costs of such inputs will be less for the larger farms. Larger producers can also obtain superior prices and grades for their product.

Technical economies of size will exist over the range of input usage for which the marginal productivities of the inputs are increasing. Continued increases in the use of inputs including management will result in proportionately greater increases in output. Economies of size may be limited beyond a certain level of outputs. Theoretically a point is reached where the marginal productivity of some inputs is negative. Hence, successive increases in the use of these inputs will result in a decrease in output and the output will therefore be produced at a higher average cost.

There are several methods of measuring farm size. Input usage, land area, or volume of sales, have all been used in studies of economies of size.[14] In the Alberta situation, large variations in land quality between regions make land area a meaningless measure of size. Volume of sales as the conventional measure of size in microeconomic cost analysis provides consistent results.

There are three approaches used in the estimation of cost curves. These were outlined by Anderson and Powell[15] and include:

1. Synthetic approach;
2. Direct analysis, cost/output observation;
3. Indirect analysis, estimated production or cost function.

Methods based directly on cost/output observations or statistical estimation of cost functions are used in this thesis. Direct methods do not involve the explicit modelling of firms' productive processes. Most often direct empirical studies have used cross-sectional data from a range of firm sizes.

The most common procedure used in the direct empirical studies involves fitting an ordinary least squares (OLS) regression line through observed points. This method is called the "statistical cost approach." The statistical cost approach involves a possible source of bias in making inferences about the long-run average cost. Stigler

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[14] Jensen, K., "An Economic View of the Debate on Farm Size in Saskatchewan," Cdn. J. Agric. Econ., Vol. 32, 1984: pp. 188-189.

[15] Anderson, J.R. and Powell, R.A. "Economies of Size in Australian Farming," Aus. J. Ag. Econ., Vol. 17, 1973: pp. 1-16.

demonstrates that if some costs are fixed in the short-run, and if output is subject to chance fluctuations, then cross-sectional data may indicate a fall in average costs as output is enlarged, even if firms are not in a situation where real economies of size exist.[18] This is not a problem if the results of empirical analysis are viewed as expected cost functions and not as technological frontiers.[19]

Recent studies in industrialized agriculture have been conducted by Hall and Leveen,[20] Longworth and McLeland,[21] and Flemming and Uhm.[22] The Hall study investigated economies of size in irrigated California agriculture. The study was a direct analysis using census cost figures. They found that the frontier efficiency was constant. However, small producers tended to be further from the frontier than large producers. In the long-run, the average cost curve was relatively flat after initially declining rapidly. The costs in the highly mechanized irrigated crops generally continued to decline slowly throughout the entire range of surveyed farm sizes, which may have been due to factors other than technical phenomena.

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[18] Stigler, G.J., **The Theory of Price**, New York: Macmillan and Co., 1967: pp. 143-144.

[19] Longworth, J.W. and McLeland, W.J., "Economies of Size in Wheat Production," **Review of Marketing and Agricultural Economics**, Vol. 40, 1972: p. 54.

[20] Hall, Bruce F. and Leveen, Phillip E., "Farm Size and Economic Efficiency: The Case of California," **Amer. J. Agric. Econ.**, Vol. 60, 1978: pp. 589-600.

[21] Longworth, J.W. and McLeland, W.J., **op. cit.**, pp. 53-65.

[22] Flemming, M.S. and Uhm, I.H. "Economies of Size in Grain Handling in Saskatchewan and the Potential Impact of Rail Rationalization Prospects," **Cdn. J. Agric. Econ.**, Vol. 30, 1982: pp. 1-19.

Fleming and Uhm used Canfarm data to estimate an average production cost model on Brown, Dark Brown and Black soils. They found that economies of size existed for grain farms in Saskatchewan, as represented by their sample.

Longworth and McLeland conducted a farm survey of 104 grain farms in Australia. Size was represented by volume and area of farms. They applied a statistical cost approach to estimate three functional forms: second degree polynomial, a power function and a rectangular hyperbola. The power function provided the best fit. These authors concluded that economies of size existed up to 1,000 acres. Between 1,000 and 2,500 acres, no significant decline in costs was observed.

The survey article by Anderson and Powell[23] into size economies in Australian grain production indicates that initial rapid declines in average costs exist over a relatively small size range for farms before assuming a nearly constant or slightly declining cost for larger sizes. These cost studies illustrate that producers in the smallest categories will be most hindered in attempts to accumulate capital financed from margins.

There are three methods of increasing the effective size of a farm expressed as volume of sales. A producer can increase the land base, increase the cropping frequency or increase the use of other inputs relative to land. In Alberta producers have used all three options.

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[23]Anderson, J.R. and Powell, R.A., **op. cit.**, p. 13.

Intensification

Hayami and Ruttan suggest that on a world scale, the era of expansion has passed and growth in animal and crop production must come from increases in the frequency and intensity of cultivation.[24] In order to sustain growth, a transition from resource exploitation to resource conservation is required.

The transition from extensive to intensive systems requires many more adjustments than just the change in frequency of cropping. Farming system authors such as Ruthenberg[25] and Grigg[26] focus on farming systems and changes associated with intensification. Intensification requires changes in institutions such as land ownership, degree of commercialization, capital use, social customs and actual farming practices, particularly as they relate to fertility maintenance and crop selection.

Recent literature in the Western Canadian context indicates that increased frequency and the intensity of cropping are expected to be important sources of increased production. The Canadian Wheat Board projected an annual domestic and export demand for all grains of 50 million metric tonnes (mmt) by 1990, 37 percent more than was produced on average during the 1977-81 period.[27] The Canada

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[24] Hayami, Y. and Ruttan, V., **op. cit.**, pp. 44-45.
[25] Ruthenberg, H., **op. cit.**, pp. 1-16.
[26] Grigg, D.B., **The Agricultural Systems of the World.** Cambridge: Cambridge University Press. 1974: pp. 1-9.
[27] Canada Grains Council, **Prospects for the Prairie Grain Industry, 1990.** Winnipeg: Canada Grains Council, November 1982: p. 1.

Grains Council reported that 48 percent of the projected increase in production between 1980 and 1990 would come from the reduction of summerfallow and 30 percent would come from improved yields. Only 22 percent of increased production is expected to come from land base expansion.[28]

The process of intensification is expected to have positive impacts on soil fertility where it is agronomically possible.

Loyns and Carter state:[29]

> "There is concern that the basic soil resource is undergoing depletion and degradation. Salinity, erosion and organic matter losses are the major sources of soil degradation which is partially or primarily management related (excess tillage/summerfallowing). Solutions include continuous or extended cropping, reduced summerfallowing, reduced or zero tillage, or increased use of forages. It is generally perceived that reductions of fallow also provide environmental benefit."

In Western Canada, intensification of production is seen as a primary source of increased production in the future. In the sense that intensification requires changes in the organization of farming systems, the process represents another force behind structural change.

The process of intensification represents a response to economic, agronomic and technological realities. Intensity of cropping may represent a structural feature and a force for change simultaneously.

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[28] **Ibid.**, pp. ii-xiii.
[29] Loyns, R. and Carter, C., "Grains in Western Canadian Economic Development to 1990." Paper prepared for the Economic Council of Canada, Ottawa, 1984: pp. 59.

C. Factors Facilitating Structural Change

Structural change would seem to be a necessary, but not sufficient, condition for new technologies to be effective and for systems to adjust to new environmental realities. There are two types of environmental factors affecting structural change: those that are fairly permanent and those that change rapidly. Institutional and climatic features tend to change slowly, however, markets and macro-economic variables can change rapidly.

The institutional environment of Alberta agriculture is not stagnant but the rate of change is relatively slow. The private property system, research and extension infrastructure, the credit and material supply systems did not change greatly in the 1970s. The marketing channels for grain, livestock and supply managed commodities were also relatively stable. It can be debated whether all these institutions favour or hinder technical and structural change. For the purpose of this thesis they are considered constant in the 1971 to 1981 period. The macro-economic variables are not constant and have changed greatly since the 1970s.

According to Brinkman, some of the most critical factors are real interest rates, the rate of inflation and land values.[30] There were substantial differences between the 1970s and 1980s in terms of these variables. The 1970s was a period with favorable conditions for structural

[30] Brinkman, G.L. and Warley, T.K., op. cit., pp. 63-65.

change. Real interest rates were low and even negative for much of the period. Land values increased more rapidly than inflation, making land an attractive investment. Despite worsening terms of trade, the net farm income level rose through the decade.

The 1980s by contrast appears to be a period of unfavorable conditions for structural change. While the factors motivating change are as great as they were in the 1970s, other factors present obstacles. Real interest rates have risen to historically high levels of 6 to 7 percent. Land values have declined in real terms, discouraging expansion through purchase. Net farm incomes have declined reducing the potential for capital formation. In addition, the WGTA represents a 5 to 10 percent drop, **ceterus paribus**, in grain price to the producer by 1995, leading to reduced income in the future.[31]

The importance of income to capital formation and the structural changes of the 1970s cannot be over-emphasized. Most of the technical advances promoted productivity by increasing farm size (total sales) while maintaining constant labour use per farm. Capital substitution for labour was the dominant process. Tostlebe, in his study on capital formation emphasizes the critical relationship between capital formation and income for American agriculture.[32]

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[31] Lewis, A., "Method of Payment Not Important: Hall Member," **Western Producer**, August 6, 1985: p. 8.

[32] Tostlebe, A. **Capital in Agriculture, Its Formation and Financing Since 1870.** New Jersey: Princeton University

"The remarkably consistent relationship of gross capital formation to gross income emphasizes the outstanding importance of the latter, both as a source of new capital and as an incentive for investment in new capital. With few exceptions, income has provided much more of the money invested in successive 5-year periods than have other sources combined. Furthermore, the amount of new capital that can be financed by borrowing is closely related to income."

Income is an important factor in structural change as it facilitates and motivates adjustment. In the 1970s, despite worsening terms of trade after 1974, incomes actually increased, thus rewarding producers who had changed their production technology and structure. Non-adjusting producers witnessed a decline in gross operating margins over the decade.

In a situation where there is constant or increasing income available for producers who change, and a declining income available to those that retain a constant organization, a polarized industry tends to develop. Ehrensaft, et al,[33] Tweeten,[34] and Heady[35] have all noted this tendency. One segment of the industry adapts new methods and develops sufficient income for an acceptable lifestyle, capital formation and structural adjustment. At

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[32](cont'd) Press, 1957: pp. 149-151.
[33]Ehrensaft, P., LaRamee, P., Bollman, R. and Buttel, F., "The Microdynamics of Farm Structural Change in North America: The Canadian Experience and Canada-U.S.A Comparisons," **Amer. J. Agric. Econ.**, Vol. 66 (5), 1984: pp. 823-835.
[34]Tweeten, L. "Diagnosing and Treating Farm Problems," in Hillman, J. (ed.), **United States Agricultural Policy, 1985 and Beyond**. Tuscon, Arizona: University of Arizona Press, 1984: pp. 19-47.
[35]Heady, Earl O., **Agriculture Policy Under Economic Development**, Ames: Iowa State University Press, 1962.

the same time, a large segment of the industry lacking entrepreneurial skills, vitality, risk capacity, or initial resources, does not adopt new methods and structural forms rapidly. This sector becomes non-viable in commercial terms and cannot supply sufficient income from within for an adequate living or capital formation. Heady describes this situation:

> "As agriculture becomes more commercialized and specialized, and as factor prices further extend the substitution of mechanization and its attendant scale economies for labor, this gap in opportunity between farm firms will grow. Those operating on a corporate basis, or with financial structure allowing access to supply of investment funds under comparable conditions, have greatest opportunity for gain from technological research. Those starting with low initial equity and dependent on capital accumulation through meager savings of households will be increasingly excluded from gains of publicly or privately produced research. In fact, it is upon this group that the costs of progress, over the total range of gains and sacrifices, fall with greatest weight. With speed in the rate of development and capitalization of agriculture, this burden promises to fall on a broadening group of farm operators."[34]

This polarization is behind many of the issues in agriculture today. It is important to separate these segments for policy purposes. Each has unique needs and goals. Attempting to satisfy the needs of all farms with a singular policy has failed in the past.

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[34] Ibid., pp. 566-567.

D. Summary

Economic development literature has evolved from the view of land as a constraining factor of production in pre-machine times to seeing institutions as the factor most affecting production in the scientific era. The primary forces behind structural change in industrial agriculture are: the worsening terms of trade between agriculture and other sectors of the economy; the relatively high cost of labour compared to capital; and the technical, pecuniary and external economies of size inherent in the machines and inputs used in agriculture. Most of these factors are determined by systems environmental to agriculture.

In a situation of worsening terms of trade, "technical change" has been a dominant force in maintaining profitability and viability. "Technical change" includes research and development, extension and adoption, and finally, structural adjustment to realize the full potentialities of technology. A large portion of increased productivity and the sustained profitability of the industry in the 1970s is explained by structural adjustments that facilitated increases in volume of sales per farm. The increase was facilitated by the expansion of farm area and an increase in the intensity of cropping.

The importance of structural change to the productivity and profitability of the industry suggests that barriers to structural adjustments could affect the industry. External factors such as high interest rates, declining land markets, and low product prices reduce the potential for size-based adjustment. Institutional factors like the WGTA simultaneously increase the need for structural adjustment while reducing the income available to finance such a change.

III. METHODS AND DATA

A. Methods

The methods followed in this study involve several diverse fields. Initially, literature of General Systems Theory was studied. This literature describes the basic behavioral and evolutionary features of open systems. Several authors have attempted to apply general systems concepts to agriculture. Ruthenberg[37] is particularly notable in this regard, although other authors such as Grigg[38] and Whittlesey[39] have done substantial work on the evolution and classification of agricultural systems. In studying the development of farming systems, these authors generally used some form of classification to group different farming activities into systems. A classification system was developed for Alberta based on the methods used by Ruthenberg. Data from the census was obtained from Statistics Canada and parametric and non-parametric tests were used to test the validity of the classification system. A final four system classification based largely on cropping intensity was devised.

The structural features of farms in each farming system in three agroclimatic regions and provincial averages were determined in 1971 and 1981. The structural changes that

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[37]Ruthenberg, H., op. cit., pp. 1-34.
[38]Grigg, D.B., op. cit., pp. 1-9.
[39]Whittlesey, D., "Major Agricultural Regions of the Earth," **Annals of the Association of American Geographers**, Vol. 26, 1936: pp. 199-240.

took place in the decade and the distribution of producers among farming systems were noted. Then the relationship between volume of sales and unit cash costs, capital/labour ratio, sales per acre, gross margins per acre, machinery use and farm area respectively were tested. The functional form and significance of the relationship was determined using weighted least squares. The significance of change was tested using the Chow test. Based on these relationships factors motivating change such as the cost price squeeze, economies of size and capital/labour substitution were evaluated.

By combining the farming systems classification and the estimates of the functions above for each system, it was possible to determine the economic advantage of intensification of different sizes of farms in 1981. It was also possible to determine structural adjustments required to maintain constant gross margins per acre in the face of increasing input costs and declining grain prices.

General Systems Theory

This study was premised on concepts of general systems theory (GST). GST maintains that certain features are evident in all complex open systems. Understanding these principles will help to appreciate the evolution of farming systems. The principle features of open systems are described by the works of Boulding[40] and von

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[40] Boulding, K. **Beyond Economics**, Ann Arbor: University of Michigan, 1968: pp. 85-97.

Bertalanffy.[11]

By definition, open systems must exchange energy and matter with their environment. Open systems tend to maintain energy levels higher than the environment by concentrating energy available from the environment within system boundaries. A steady state is often achieved through self-regulation of the system, despite variations in energy flows. Open systems tend to be goal directed and can achieve a final condition from different starting positions and along various evolutionary paths. Many systems tend to close to the environment as they mature. Closing is accomplished by reducing energy flows over time through expansion of the boundaries of the system to encompass services provided by the environment. Ruthenberg points out that for many agricultural systems, the climax condition is a low level steady state with minimal energy flows and most functions internal to the farming system. The Alberta farming system is very juvenile relative to this concept of the mature condition.

General Systems Theory emphasizes the importance of relationships within systems and between a system and its environment. The reductionist approach to science is seen by general system authors to be problematic in the study of complex open systems. Simplification of systems of low complexity such as solar systems and clockwork is effective. However, when the essential features of the system are its

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[11]von Bertalanffy, L., **General Systems Theory**, New York: George Braziller Inc., 1968: pp. 70-84.

internal and external relationships, the reductionist approach tends to obscure essential features. Von Bertalanffy has made this point in a biological context and it appears to be applicable in social sciences.

> "Since the fundamental character of living things is organization, the customary investigation of the single parts and processes cannot provide a complete explanation of vital phenomena. This investigation gives us no information about the coordination of parts and processes. The chief task of biology must be to discover the laws of biological systems (at all levels of organization)."[42]

The conventional neoclassical marginal analysis has many of these reductionist deficiencies and was not used in this study of structure. The approach used addresses the problem of identifying the elements, structure and environmental force motivating and facilitating adjustment at the farming system and industry levels.

Farming Systems Classification

Farm operations are systems because several activities are closely related to each other by the use of the farmer's labour, land and capital, by risk distribution and by joint use of management capacity.[43] Each farm is a system oriented towards production. When studying agricultural structure to determine changes through time and the direction of development, the difficulty presented by medium number systems emerge. There are too many individual systems to analyze each individually, yet the variation among these

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[42] Ibid., p. 289

[43] Ruthenberg, H., op. cit., p. 2.

systems is too great for averages of the total aggregate to provide a true picture. There is a need for some method of classifying farms that utilizes similar systems of production into groups or farming systems, so generalizations can be made. Statistics can be applied to farming systems which represent homogeneous groups with a relatively small loss of information.

The classification of farming systems is dealt with in literature on agricultural typology. Most of the work in this field has focussed on the preliminary steps of classifying farming systems on a global scale and describing these systems. In 1936, Whittlesey produced the first widely accepted agricultural classification of the world.[44] He introduced six criteria which he used in classification. These were:

- crop and livestock association;
- methods of cropping;
- intensity of land use, levels of capital and labour used;
- organization;
- degrees of commercialization;
- types of building structures.

Using these criteria, he defined nine agricultural systems worldwide. Whittlesey's system has been used to the present time, despite arguments for more rigorous criteria. In 1977, Grigg[45] published a major book on the evolution of farming

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[44] Whittlesey, D., op. cit., pp. 199-240.
[45] Grigg, D.B., op. cit., p. 2.

systems based on the original systems described by Whittlesey.

In 1976, Ruthenberg[46] was the first farming systems author to apply general systems theory in the analysis of farming systems. The criteria used for classification by Ruthenberg included most of the variables described by Grigg and Whittlesey. The focus of Ruthenberg's work was tropical rather than world agriculture. He used concepts of goal oriented behavior, system boundaries, activities, a steady state and vitality or dynamic forces in the analysis of the evolution of tropical farming systems.

Based on the work of these farming systems authors, a classification system for Alberta commercial grain farms was developed. The features of importance in classifying producers according to Ruthenberg are: degree of commercialization, source of water for cropping, the intensity of cropping,[47] and the leading livestock and cropping activities.

Commercial grain farms are defined in this study as having a minimum of 320 acres of land and at least 100 acres of grain. These criteria eliminated nearly half of all the census farms. In 1971 there were 34,268 commercial grain farms compared to 62,702 census farms. By 1981, the number of commercial grain farms had declined to 30,006 compared to 58,056 census farms. In 1981, the area encompassed by these commercial grain farms amounted to 25 out of the 31 million

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[46]Ruthenberg, H., op. cit., pp. 1-16.
[47]Cropping intensity = area cropped ÷ arable land.

total improved acres in the province. Those excluded were either small scale farmers, feedlots or ranches with no grain. Even with these restrictions, 7,940 or 26 percent of commercial grain farms had sales below $25,000 in 1981. The source of water for cropping was not used in classification. The regions of focus are primarily dryland regions and for that reason, source of water was not considered.

The classification system used the area in crop, forage and fallow to divide producers into four farming systems. Producers were first divided between continuous cropping and fallow cropping systems at the 12 percent level of fallow or higher. Each of those groups was then subdivided in two at the 10 percent level of forage in the rotation. The classification system was based on cropping intensity, but indirectly indicates the degree of livestock integration as producers with large forage components tend to have livestock.**

Testing the Validity of the Classification System

To test the validity of the classification system and the uniqueness of the farming systems, probability distributions for 10 structural variables were analyzed. To supplement this analysis, a set of 20 variables with standard errors and means for census division aggregates of each farming system were also obtained. The two data sets were developed for the six farming systems in all 15 census

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**See Chapter IV for clarification.

divisions in 1971 and 1981.

The data described above was used in two tests of significance concerning the difference between farming systems. The Kolmogorov-Smirnov test compared the cumulative frequency distributions of the twenty variables for each of the farming systems within each census division. The Z-test was used to determine the significance of differences based on the cross-tabulated variables.

It was discovered that several of the systems were redundant. The classification based on three distinctions in the level of forage was reduced to only two. Four structurally different farming systems were identified. Results are in Chapter IV.

After the final classification was decided upon, census data were used to provide profiles of average producers in each farming system. Census Divisions 5, 10 and 15 were selected as representative of major agricultural regions of Alberta. The comparability of census years 1971 and 1981 was also investigated. The results are reported in Chapter V.

Relationship Between Structural Variables and Size

The relationship between volume of sales and (a) unit cash cost; (b) the capital/labour ratio; (c) sales per acre; (d) gross margin per acre; (e) area; and (f) machinery used respectively were estimated using weighted least squares regression.[4] The forms, significance of relationship, and

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[4] The definition of these variables is given in Appendix A.

significance of change over time were tested.

To model the relationship between the structural variables and size, weighted least squares regression was used because the number of observations in each sales category was different. For example, there were different numbers of producers with sales between $50,000 and $99,000 than in the $200,000 to $249,000 sales class for fallow grain classes in CD 5. According to Koutsoyiannis,[50] if the number of observations in each group is different, then the error of the 'grouped function' will be heteroscedastic and OLS will not be the appropriate method of estimation.

The corrective action in this case is the transformation of the original grouped observations.[51] The procedure used amounted to the application of Weighted Least Squares (WLS) where group frequencies are weights for group means.

Two points are important with this procedure. The variance of estimates of b's obtained from grouped data are larger than the variance of the b's obtained from the application of OLS to the ungrouped observations. The larger variance is due to the loss of information included in the variation of the observations within each sample, which is unknown if the data are given in grouped form.

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[50] Koutsoyiannis, A., **Theory of Econometrics**. Hong Kong: Macmillan and Co., 1981: pp. 285-292.

[51] 'The corrective action is the transformation of the original grouped observations (group-means), by dividing Y_j and X_j by $\sqrt{1/n_j}$.

Secondly, the overall correlation coefficient in the "grouped" model is higher than in the ungrouped regression. Since the basic sample is the same in both "grouped" and ungrouped regression, the higher R^2 obtained from the grouped model is misleading. The higher the degree of aggregation, the stronger the correlation will deceptively appear to be. This reflects the fact that group means tend to cluster closer around the regression line than the individual observations. This is a noted weakness with the procedure.

Several functional forms were tested for each variable as it related to size. As mentioned earlier, unit cash costs, the capital/labour ratio, sales per acre, gross margin per acre, machinery per farm, and farm area were the variables used. The functional forms were limited to linear, power (log linear), and second degree polynomial:

linear	$Y_i = a + bX + e_i$
log linear	$\log Y_i = a + b_i \log X_i + e_i$
	which is a linearized form of
	$Y_i = aX_i^k + e_i$
2nd deg. poly.	$Y_i = a + bX_i + cX_i^2 + e_i$

The linear function suggests the relationship is constant throughout the range of observations. The log linear form suggests the direction of the relationship is constant in sign, but the rate of change differs depending on what point is taken. The greatest rate of change occurs closest to the origin. The second degree polynomial will reverse the sign of the relationship as it moves away from the origin. The key features are the sign of the relationship and its form.

Change in unit cash costs should be negative in sign as costs decline with increased size. The form could be logarithmic indicating continuous economies of size, or, second degree polynomial indicating diseconomies of size. Economic theory suggests a linear function is unlikely.

The relationship between size and the capital per year of labour ratio should be positive. In other words, farms with more sales use larger amounts of capital per year of labour. The form of this relationship is uncertain **a priori**. The second degree polynomial form would accommodate the possibility of barriers to the continuous substitution of capital for labour at large farm sizes. The logarithmic form could be used for the absence of any impediment, economic or technical, to the use of continually greater levels of capital per unit of labour as volume increases.

Sales per acre are postulated to increase with the volume of sales generated by the farm. Recent evidence from Edwards[52] supports this counter-intuitive hypothesis. There is no reason to anticipate any particular form to the relationship although monotonicity is presumed for testing purposes.

The combined effect of lower costs and higher sales per acre as volume increases points towards a positive relationship between gross margin per acre and total sales volume. Because costs and sales tend not to be second degree

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[52] Edwards, C., "Productivity and Structure of U.S. Agriculture," **Agric. Econ. Research**, Vol 37 (3), 1985: pp. 1-11.

polynomial in form, the gross margin function will probably be linear or logarithmic and positive in sign. The logarithmic form testing for relatively rapid gains in margin between $15,000 and $75,000 in sales followed by more modest rates of increase was used. The linear form testing a constant rate of increase in margin with volume was also applied.

Machinery per farm and farm area are positively related to volume of sales and could intuitively be either linear or logarithmic in functional form.

The significance of change in the relationships in these functions between 1971 and 1981 were tested using Chow's procedure. The Chow Test indicates a change in the intercept or slope of a function using an F-statistic. The test did not indicate which coefficients have changed nor was it applicable if functional forms were different. The procedure of the test is described by Koutsoyiannis.[53]

The first step involves pooling both samples and estimation of a "pooled function". The second step involves individual estimation of separate samples representing different time periods.

Finally, an F-statistic can be developed from the following equation:

$$F^* = \frac{[e^2p - (\Sigma e^2_1 + \Sigma e^2_2)] / K}{(\Sigma e_1^2 + \Sigma e_2^2) / (n_1 + n_2 - 2K)}$$

Compare F^* with $v_1 = K$ and $v_2 = (n - n_2 - 2K)$. If $F^* > F_{.95}$ reject the null hypothesis of no significant difference. The

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[53]Koutsoyiannis, A., op. cit., pp. 164-168.

forms of all equations must be the same to perform the Chow test.

The results of estimated equations, functional forms and significance of change are reported in Chapter VI.

Adjustments to Cost Increases and Price Decreases

Based on the estimated relationships, it was possible to simulate adjustments required to overcome cost increase and/or price decreases.[34] The procedure involved determining the margin per acre at $50,000 and $150,000 of sales. The area, capital, and sales per acre were also determined at those sales values. The gross margin per acre function was then re-estimated after a 20 percent cost increase. The new gross margin per acre function was then forced to yield a gross margin per acre value equal the original function. A new value of sales was determined. This new sales value was substituted into the original area, capital, and sales per acre function to determine the adjustments required to compensate for a 20 percent cost increase in 1981. The same procedure was followed for a 20 percent output price decline. The benefit of intensification as a possible adjustment was also examined. The margins for farms in different systems but with similar area were compared (see Chapter VII).

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[34] See Chapter VII for more detailed information.

Sectoral Development

To determine if the industry is displaying polarized development, cross-tabulated variables stratified by percentiles were used. These data indicated income and cost distribution across percentiles as well as rate of change in volume of sales, cropping intensity and farm area (see Chapter VII).

B. Data

The study of structural change in Alberta's agriculture has been difficult in the past because published statistics included many producers who fit the minimum census definition of a farm without serious commercial involvement. The census definition of a farm requires only $2,500 of sales and no minimum land base. Recent policy improvements in Statistics Canada now enable the Census of Agriculture to be retabulated to focus research on commercial farming based on physical area or sales. The retabulation process allows producers in each census division (CD) to be classified by volume of sales, farming system, or according to many other convenient distinguishing features as shown by the innovative work of Bollman.[55] Structural changes between 1971 and 1981 can be quantifiably studied across sales groups and farming systems using retabulation. The Census of Agriculture is the most complete and flexible data base for

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[55]Bollman, R., "Alternative Definitions of a Farmer." Paper presented to the Annual Workshop of the Canadian Agricultural Economics and Farm Management Society, Saskatoon, August 25-26, 1983: pp. 20-38.

this type of study.

Variables Used in the Study

There were four different groups of variables used in the study. The first set of variables was reported in frequency distributions for the farming systems in each census division. These variables were used in the non-parametric tests for significance of difference between farming systems. The variables included:

- improved area
- rented area
- owned area
- labour use
- age of operator
- off-farm work
- farm area
- capital stock
- asset value

The intervals established and other frequency distributions not tested are reported in Appendix A, along with the definitions of all variables used.

A second set of structural variables was used for parametric tests to distinguish the farming systems. These variables are aggregate ratios for each farming system in each census division. The ratios in this case were accompanied by information on the standard error of the mean. These variables included:

- sales per farm
- expenditure per farm
- gross margin per farm
- machinery per acre
- machinery per dollar of sales
- sales per acre
- sales per year of labour

After a classification system was developed, the change in structure between 1971 and 1981 was measured. A third set of structural variables for each farming system in each census division was observed in 1971 and 1981. The variables used for this purpose included:[56]

- number of producers
- cropping intensity
- cattle intensity
- labour use
- off-farm work
- operator age
- improved area
- organization
- proportion of producers renting
- proportion of improved area rented
- machinery per farm
- machinery per acre
- machinery per year of labour
- sales per farm unit
- sales per year of labour
- sales per acre of improved land
- gross margin per farm

To gain a more detailed picture of structural change over time, a fourth set of the variables was stratified by volume of sales. Stratification allowed any size relations in variables and adjustments to be noted. The relationship between size and the following variables was tested:[57]

- machinery per year of labour
- unit cash cost per dollar of sales
- total machinery per farm
- improved farm area
- sales per acre
- gross margin per acre

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[56]All dollar values were reported in 1981 terms. 1971 dollar values were inflated by the CPI, which was 2.37, for purposes of comparison.
[57]Ibid.

Regions Investigated for Alberta

The census allows structural variables to be developed in all regions independently and as provincial aggregates. The difficulty was reporting the massive amounts of data available. Earlier work by Packer and Apedaile[58] indicated large regional variations within Alberta in the organization of agriculture. To facilitate reporting and to gain meaningful results, one representative census division was reported for each of the south, central and northern regions of Alberta. Figure III.1 illustrates the geographic location of these census divisions in Alberta.

Census Division 5 represents southern Alberta, operating primarily under dryland conditions on Dark Brown Chernozemic soils.[59] This census division extends east of Calgary, from north of Lethbridge to just south of Red Deer. Drumheller is the largest urban centre. The climate is classified as dry, sub-humid with between 356 and 406 mm of precipitation annually. The soil type is predominantly Dark Brown Chernozemic. The frost-free period in Census Division 5 is 100-120 days per year.

Census Division 10 represents a large number of central Alberta farms on Black Chernozemic soils. This census division extends east of Edmonton to the

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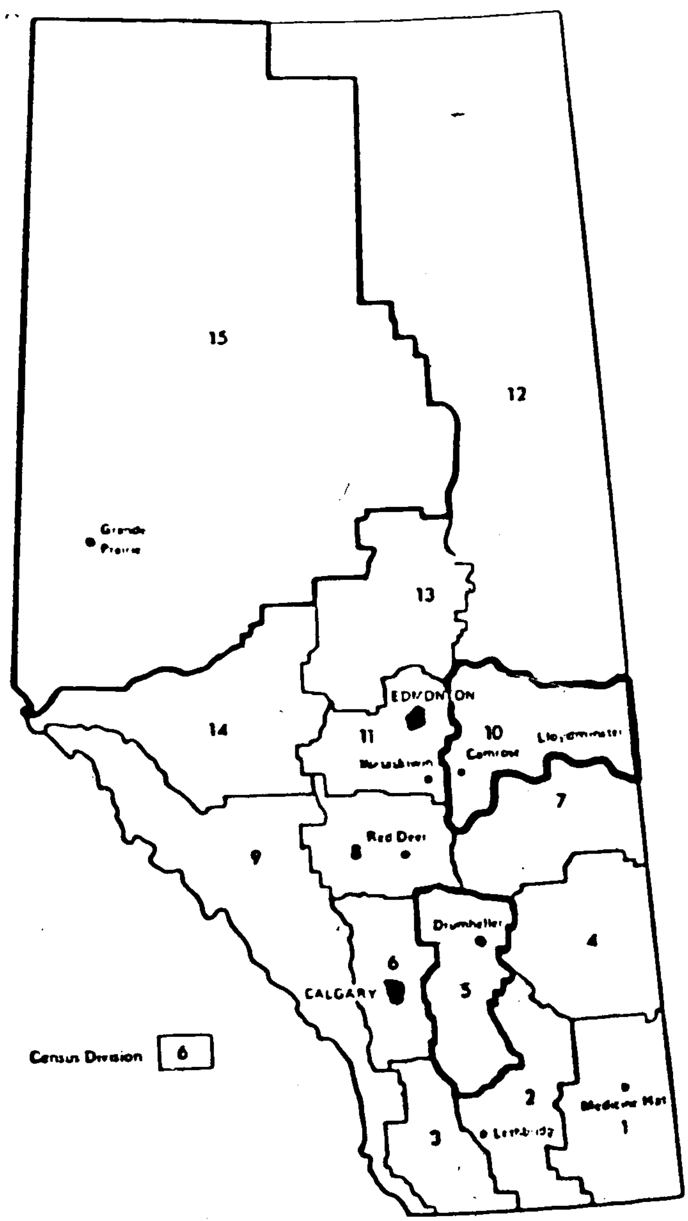
[58] Packer, K. and Apedaile, L.P., "Structural Characteristics of Peace River Grain Producers: Coping with Higher Freight Rates," Occasional Paper No. 10. Department of Rural Economy, University of Alberta, Edmonton, January 1985: pp. 19-23.

[59] Alberta Agriculture, **Alberta Farm Guide**, Edmonton: Alberta Agriculture, Communications Branch, 1976: pp. 5-31.

Figure III.1: Census Divisions in Alberta with particular emphasis on farming areas in southern Alberta (CD 5), central Alberta (CD 10) and northern Alberta (CD 15).



Alberta/Saskatchewan border. Camrose, Lloydminister and Vegreville are the largest urban centres in the census division. The climate is classified as moist sub-humid with between 381 and 457 mm of precipitation annually. The soil type is predominantly Black Chernozemic. The frost-free period in Census Division 10 is 80-100 days per year.

Census Division 15 is the largest in the province and includes about 5,000 commerical farms on predominate Gray Luvisolic soils. It is located in the northwest portion beginning at the mid-point of the province and extending north to the Northwest Territories. Most of the land in CD 15 is not farmed. The land which is farmed has been settled more recently than other areas of the province. Grande Prairie is the largest urban centre. The climate includes both dry sub-humid and moist sub-humid types. The precipitation varies from 356 mm to 508 mm annually. The frost-free period in the major cultivated area is 75-90 days per year.

These census divisions are representative of major farming areas of the province and avoid the influence of large urban centres.

Weather and Crop Conditions in 1970 and 1980

The census gathers information on economic variables such as sales and expenses for the twelve month period previous to June 1st in the census years 1971 and 1981. For this reason crop conditions in the past season are important in the interpretation of the results. Questions dealing with current status such as farm area, cropping patterns and operater characteristics are answered as they existed on June 1st of the census year.

Conditions in 1970 yielded above-average crops for most grains in most parts of Alberta.[10] Low moisture was reported in the Peace region during the growing season. Despite this, yields in CD 15 exceed the 1969 levels. CD's 5 and 10 had adequate moisture through the growing season and harvest weather was good. Yields of most grains exceeded the past ten year average.

In 1980, record yields in most crops were recorded across the province.[11] Even though spring moisture levels were low in most regions, early rain encouraged farmers to seed more acres. Summerfallow was reduced to record low levels. Dry conditions prevailed in the Peace (CD 15), except for the harvest season when above-average rains reduced cereal quality and yields to below 1979 levels. Early frost and poor harvesting conditions reduced yield prospects in central and northern areas of the province. Warm harvest conditions in CD 5 helped complete a good year with yields higher than in 1979. Despite adverse soil moisture and harvest conditions, producers took off a record crop on a province-wide basis.

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[10]Alberta Agriculture, **Agriculture Statistics Yearbook.** Edmonton: Alberta Agriculture, Statistics Branch, 1969, 1970: pp. 1-2.
[11]**Ibid.**, 1980: pp. 1-4.

The evidence suggests that these years were not lacking comparability with respect to weather. It should be noted however, that the LIFT program was in effect in 1970. This program substantially reduced wheat production and increased fallow area in that year. In 1971, below normal levels of fallow were recorded. Desp[illegible] reduced wheat acreage, total cash receipts were only 3 percent lower in 1970 than in 1969.[12] From the late 1960s to the early 1970s was a period of low prices and incomes.

Certain important variables are not collected by the Census of Agriculture. The most important omissions include off-farm income, and debt load. These variables are essential to gaining a complete understanding of structure. The ability to match respondents in 1971 and 1981 is a strength of longitudinal data of Statistics Canada. Difficulty in getting matching data due to technical limitations was a problem in this research. The lack of longitudinal data prevented tracing the movement of producers to different farming systems and farm sizes. This tracing would have provided more insight to the structural changes associated with volume expansion.

C. Results

The results of the study are evaluated from a number of perspectives. The thesis is based on the premise that cropping intensity is a defining structural feature of

[12]Alberta Agriculture, **Statistics of Agriculture for Alberta 1969-1970**, 1970: p. 35.

farming systems. The results should verify or reject this hypothesis. If there are significant differences in the relative performance of systems, shifts by farmers among systems should be evident. Secondly, structural change in the farming systems and composition of the industry is premised to affect the productivity and profitability of the industry. The results should indicate if and how structural change enhanced the viability of the industry. Finally, it is hypothesized that structural changes occur in response to environmental forces such as technical change and the cost squeeze. Even if the causality cannot be established, the research should illustrate the structural implications of a continued cost squeeze, and lower grain prices under the WGTA.

IV. CLASSIFICATION OF PRODUCERS INTO FARMING SYSTEMS

Ruthenberg suggests a number of criteria that can be used to classify producers into farming systems.[43] The relevant criteria for Alberta include the intensity of crop rotation, the source of water supply, the primary cropping and livestock activities and level of commercialization. The primary criteria for classification in this project was cropping intensity. The level of commercialization was established by a minimum area criterion. Source of water supply was not considered important as dryland areas were the focus of the study. The degree of livestock integration is indicated indirectly by the amount of forage in the cropping rotation.

The commercial grain farms were classified into farming systems according to the level of fallow and forage in their crop rotation. Initially, a six category system was developed (see Figure IV.1). In 1971, the distribution was strongly weighted to fallow production and by 1981 there was nearly a balance between fallow and continuous production (Figure IV.2). The cropping and cattle intensities for these systems are given in Table IV.1.

A. Tests Utilized to Distinguish the Parts on the Basis of the Structural Variables

There are two types of statistical tests that can be used to determine whether two samples are from the same population. The most commonly used test is the Z test. The Z

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[43]Ruthenberg, H., op. cit., pp. 1-28.

Figure IV.1: Criteria for classifying commercial grain farms.

Fallow	≤ 10% forage	10-30% forage	>30% forage
≤ 12%	Class 1 Cont. Grain	Class 3 Cont. Ley	Class 5 Cont. Mixed
> 12%	Class 2 Fallow Grain	Class 4 Fallow Ley	Class 6 Fallow Mixed

Figure IV.2: Numbers in each class in 1971 and 1981

	cont. grain	*cont. ley*	*cont. mixed*	
1971	1375	2191	4842	24%
1981	4084	3593	6290	46%
	fallow grain	*fallow ley*	*fallow mixed*	
1971	12959	9087	3813	76%
1981	9616	4390	2033	53%
1971	41%	32%	25%	
1981	45%	25%	27%	

Table IV.1: Average cropping and cattle intensities for commercial grain producers in each class for the province of Alberta, 1971 and 1981.

	Class						
Year	1	2	3	4	5	6	Av.
	Cropping Intensities						
1971	0.93	0.59	0.74	0.53	0.45	0.30	0.55
1981	0.95	0.62	0.77	0.54	0.44	0.36	0.61
	Cattle Intensities						
1971	0.06	0.05	0.14	0.11	0.21	0.17	0.11
1981	0.04	0.04	0.13	0.10	0.24	0.15	0.10

test considers the difference between the means reletive to the standard errors of the two samples. It is a parametric test and requires at least categorical level data. The other test that can be utilized is a non-parametric test such as the Kolmogorov-Smirnov test (K-S). This test compares the absolute difference between the cumulative frequency distributions of the two samples. The K-S requires at least ordinal level data. Both tests allow statistical statements about the similarity of two samples. The following steps summarize the Z test (Mason).[4]

Testing Hypothesis: Two Means, Large Samples

1. *The Null Hypothesis:* Null $u_1 = u_2$
   Alternative $u_1 \neq u_2$
2. *Statistical test:* All members of the population are selected in the sample. The sample size exceeds 30 and is considered large. The population distributions are considered to be normal. The Z test is applied to test significance.
3. *Level of Significance:* The .05 level of significance has arbitrarily been chosen. The probability of a type 1 error is 5 percent. A type 1 error occurs when the null hypothesis is rejected when actually true.
4. *The Sampling Distribution:* The sampling distribution of the Z test presumes that if a large number of random

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[4] **Mason, R.D., Statistical Techniques in Business and Economics**, Homewood, Ill.: Richard D. Irwin Inc., 1974: pp. 336-349.

samples are selected from two populations, the distributions of the differences between the means (the critical ratio) will approximate the normal curve:

$$Z = \frac{x_1 - x_2}{s_1 + s_2}$$

$x_1 - x_2$ difference between the two sample means

$s_1 + s_2$ standard error of the differences between the two means

5. *The Decision Rule:* Using the Z test tables and the level of significance .95, it is possible to say that 95 percent of the Z value fall between -1.96 and 1.96 under the assumption that there is no significant differences between the two means. If the Z score exceeds 1.96, the differences in the means is not likely due to chance.

The Z test has a couple of inherent weaknesses. It tests only one measure of central tendency (the mean) relative to the measure of dispersion (the variance). It does not consider other aspects of the distribution. The test assumes the normal distribution of the population for the characteristics in question. To address the possibility of skewness or bimodal distributions, an alternative test can be used. The Kolmogorov-Smirnov test is not affected by non-normal distributions. This test measures the absolute difference between cumulative frequency distributions of the two samples. The following steps summarize the Kolmogorov-Smirnov test:[65]

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[65] Ibid., pp. 374-417.

Testing Hypothesis: Two Distributions, Large Samples

1. *The Null Hypothesis:* The Null hypothesis states that there is no significant differences between the members of the two samples. The alternative hypothesis states that there is a signficant difference between the members of the two samples. This is a two-tailed test; a one-tailed test is also possible.
2. *The Statistical Test:* The Kolmogorov-Smirnov two sample test is appropriate because the test scores are above the minimum required ordinal level. In most cases the data are categorical. The samples are generally large with over 40 observations.
3. *The Level of Significance:*

   Alpha = 0.10
4. *Sampling Distribution:* The critical values of N > 40 at 0.10 level of significance can be calculated as follows:

   $$1.22 \sqrt{\frac{n_1 + n_2}{n_1 * n_2}} = \text{critical value}$$
5. *The Decision Rule:* The two-tailed test is used so the null hypothesis will be rejected if the computed D statistic is equal to or greater than the critical. The D value is the largest absolute difference between the two cumulative frequency distributions.

B. Results of Tests of Differences Between Parts

The results of the (K-S) tests of significance of difference between the classes are reported in Figures IV.3 and IV.4. These Figures are a summary of all the K-S tests that were run on the sample distributions. The results are coded by plus and minus signs. A plus indicates a significant difference at the 90 percent level of confidence; a minus indicates no significant difference. There are nine squares in each block; each square represents a structural variable. The variables are arranged in the blocks as follows:

improved area	labour use	total farm area
rented area	age	capital stock
owned area	off-farm work	asset value

To determine the differences between classes, an original method of interpreting the results of the K-S test was utilized. A class with three or less of the structural characteristics different will be considered indistinguishable. Classes with four through six of the structural variables different will be considered moderately different. If a class has seven through nine characteristics different, it was considered totally unique. The results in Figures IV.3 and IV.4 provide the following information when interpreted in this fashion.

Figure IV.3: Results of Kolmogorov-Smirnov tests for differences between farming systems in CD's 5, 10 and 15, 1971.

Class	Class 1	Class 2	Class 3	Class 4	Class 5
Census Division 5					
2	+ – + + – + + – +				
3	– – – – – – – – +	+ – – – – – – – –			
4	+ – + – – + + – +	– – + – – + + – +	+ – + – – – – – –		
5	+ – + – + + + – +	– – – + – + + – –	– – – – – – – – –	– – – + – – – – –	
6	+ – + – – + + – +	– + + – – + + – +	– – + – – – + – +	– – – – – – – – –	– – – – – – – – –
Census Division 10					
2	+ + + – – – – + +				
3	+ – + – – + + + +	– – – – + + – – –			
4	+ + + – + + + + +	+ + + – + + – + +	+ – – – + – + – –		
5	+ + + – – + + + +	+ – + – + + + – +	+ – + – – + + – +	+ – + – + + + – –	
6	+ + + – – + + + +	+ + + – – + + + +	+ + + – + + + + –	+ – + – – + + – –	– – – – – + – – –

Figure IV.3: Continued

Class	Class 1	2	3	4	5
	Census Division 15				
2	+ + + − + + + + +				
3	− − + + − + + − +	− − − + + − + −			
4	+ + + + + + + + +	+ − + + − + + + +	+ + + − + + − + +		
5	+ + + + + + + + +	− − + − − + − − +	− + + − − + − + +	− − − − − − − − −	
6	+ + + + + + + + +	+ + + + + + + + +	+ + + − + + − + +	− − − − − + − − −	− − + − − + − − −

Classes 1 and 2 are each unique grain cropping systems. They have relatively high cropping intensities between 0.56 and 0.66 for the fallow grain class and between 0.95 and 0.95 for the continuous grain class. Each of these classes has livestock intensities below 0.07 or 7 cattle per 100 improved acres.

The structural features tested indicate classes 4, 5 and 6 are indistinguishable from each other in most cases. At low levels of cropping intensity below 0.55, the K-S test indicates the amount of fallow has no impact on the structure of the farming operation. These classes have moderate to high cattle intensities ranging from 0.17 to 0.24 on a provincial basis. Classes 4, 5 and 6 are always distinguishable from classes 1 and 2.

Class 3 is a transitional class between the grain and mixed extremes. It often has animal intensities exceeding those of classes 4 and 6. It also has cropping characteristics that are more intensive than the fallow grain class 2. This class is significantly different from the grain classes 1 and 2 in CD 10 and CD 15. On the other hand, it is similar to the livestock class 5 in CDs 5, 10 and 15. Class 3 is also similar to class 6 in CD 5 and CD 10. Between 1971 and 1981, classes 4 and 6 lost nearly half their total numbers, while classes 3 and 5 had substantial increases. The magnitudes and directions of these changes suggest that differences between fallow and continuous systems existed, but were not evident from the K-S test.

A number of ratios were also obtained with the mean and standard error, but no distributional information. These include: age, machinery value, land value, sales, gross margin, capital/labour ratio and sales per acre. If the distribution of the ratios is normal, it is possible to apply a Z test to determine the significance of differences between the four classes that are not unique according to K-S tests. When the Z test was applied to the ratios mentioned above in the selected census divisions, the results indicated that classes 4 and 6 are non-distinguishable in all the census divisions. Classes 3

Figure IV.4: Results of Kolmogorov-Smirnov tests for differences between farming systems in CD's 5, 10 and 15, 1981.

Class	Class 1	2	3	4	5
Census Division 5					
2	+ - + + + + - - -				
3	- - - - - - - - -	- - - - + + + - +			
4	+ - + - + + + + -	+ + + - - + + + +	+ - - - + + + - +		
5	- - - - + - + - -	- - - + - + + - -	- - - - + - - - -	+ - - - - - - - -	
6	+ - + - + - + - -	- - - - - - + - -	- - - - + - + - +	- - - - - - - - -	- - - - - - - - -
Census Division 10					
2	+ + - + + + - + +				
3	+ + + - + + + + -	+ - + + + + + - +			
4	- + + + + + + + +	+ - + - + + + + -	+ - - - + + - - +		
5	+ + + - + + + + -	+ + + + + + + + +	- - + - - - + + -	+ - - - + + - - +	
6	+ + + + + + + + +	+ - + - + + + - -	+ - + + + + + - +	+ - + - - - + - -	- - - - + + - - +

Figure IV.4: Continued

Class	Class 1	2	3	4	5
	Census Division 15				
2	+ - + - + - - + -				
3	+ - + - + + + - +	- - + - - + + + +			
4	+ + + + + + + +	- + + - + + + + +	- - - - + + - - +		
5	+ + + - + + + + +	- + + - + + + + +	- - - - + - - - +	- - - - - - - - -	
6	+ - + - + + + + +	+ - + - + + + + +	- - - - + + - - -	- - - - - - - - -	- - - - + - - -

and 5 are non-distinguishable in CD 5 and CD 10. In all the census divisions, classes 3 and 6 are significantly different from each other (see Appendix B).

The Z test reinforces most of the results obtained from the K-S tests. The primary difference between the two tests appears to be the significance of difference between classes 3 and 6, which are significantly different in all census divisions using the Z test and only different in CD 10 using the K-S test. Therefore, classes 3 and 5 were combined as were classes 4 and 6 giving rise to a new classification system emerges (see Figure IV.5). This final classification

Figure IV.5: Criteria for classifying commercial grain producers into classes.

Fallow	≤ 10% forage	> 10% forage
≤ 12%	Cont. Grain (1)	Cont. Mixed (3)
> 12%	Fallow Grain (2)	Fallow Mixed (4)

separates producers into four farming systems each having unique structural features. Table IV.2 illustrates the number of producers using a particular farming system. Table IV.3 illustrates the cropping and cattle intensities in each class.

Continuous grain farms (class 1) have 95 percent of their improved area in arable crop production. These farms have very little, if any, forage or fallow. Cattle numbers are very low averaging four head per 100 acres or about 32 head per farm.

Fallow grain farms (class 2) have only about 60 percent of their improved area in arable crop. These producers have less than 10 percent of land in forage, so fallow area makes up a significant portion of improved area. Cattle numbers are similar to those of continuous grain producers at four head per 100 acres or about 30 head per farm.

The continuous mixed farms (class 3) have a cropping intensity of 55 percent of improved area. However, the area not cropped is primarily forage as a maximum of only 12 percent fallow is permitted. This group has very high cattle intensities in the range of 20 head per 100 acres or about

Table IV.2 Number of producers in each class for Alberta in 1971 and 1981.

Year	Class 1	Class 2	Class 3	Class 4
1971	1375	12959	7033	12900
%	4	38	20	38
1981	4084	9616	9883	6423
%	14	32	33	20

Table IV.3 Cropping and cattle intensities in each class for Alberta in 1971 and 1981.

Year	Class 1	Class 2	Class 3	Class 4	Avg.
Cropping Intensities					
1971	0.93	0.59	0.54	0.48	0.55
1981	0.95	0.62	0.55	0.48	0.61
Cattle Intensities					
1971	0.06	0.05	0.18	0.13	0.10
1981	0.04	0.04	0.20	0.15	0.11

160 head per farm.

Fallow mixed farms (class 4) have the lowest average cropping intensity at 48 percent on average. This group has substantial areas in both fallow and forage. Cattle intensities are moderate at 15 head per 100 acres or about 100 head per farm.

V. RESULTS - DESCRIPTIVE COMPARISONS OF CEREAL AGRICULTURE: 1971 AND 1981

A. Introduction

This chapter presents the structural features of commercial grain farming systems in Alberta as developed from the classification system used in this research. This section documents divergent directions of development among these farming systems and produces evidence of large regional variability in the grain farming systems of the Province. The evolution of producers to new systems is evident and suggests that improved productivity may be a function of structural adjustment which is one aspect of technical change.

B. Structure of Farms and Operator Characteristics

Number of Producers

The change in distribution of grain producers among farming systems over time gave an indication of the direction in which producers were moving in terms of cropping intensity. Table V.1 gives a detailed breakdown of the distribution of producers in 1971, 1976 and 1981 in CD's 5, 10 and 15. Table V.2 gives the cropping and cattle intensities of these classes in 1981.

Table V.1 indicates a major shift in the farming systems used by Alberta grain producers. Generally speaking, all the continuous classes (1 and 3) doubled their

Table V.1: The number of commercial grain farms in each class for CD's 5, 10 and 15 and the provincial total, 1971, 1976 and 1981.

	Class 1	2	3	4	CD Total
1971					
CD 5	66	2,136	113	693	3,008
CD 10	170	2,240	550	2,393	5,353
CD 15	383	1,582	1,372	2,173	5,510
Prov.	1,375	12,959	7,033	12,904	34,268
1976					
CD 5	102	1,864	164	628	2,758
CD 10	235	1,851	714	2,022	4,822
CD 15	439	1,923	1,169	1,787	5,318
Prov.	1,928	11,237	8,432	9,852	31,501
1981					
CD 5	214	1,599	289	478	2,580
CD 10	764	1,439	1,138	1,101	4,442
CD 15	743	1,818	1,376	1,164	5,101
Prov.	4,084	9,616	9,883	6,423	30,006

Table V.2: Average cropping and cattle intensities for commercial grain producers in each class for CD's 5, 10 and 15 and the provincial total of Alberta, 1981.

	Class 1	2	3	4	CD Total
Cropping Intensities					
CD 5	0.99	0.60	0.61	0.48	0.60
CD 10	0.95	0.70	0.64	0.55	0.69
CD 15	0.95	0.68	0.89	0.40	0.65
Prov.	0.95	0.62	0.61	0.49	0.61
Cattle Intensities					
CD 5	0.07	0.04	0.15	0.10	0.06
CD 10	0.03	0.0[illegible]	0.15	0.15	0.09
CD 15	0.01	0.00	0.07	0.04	0.03
Prov.	0.04	0.04	0.15	0.11	0.10

representation over the decade. The fallow classes (2 and 4), on the other hand, showed declining numbers, as fallow producers were more likely to move out of the industry or into continuous systems.

The number of commercial producers declined in all the census divisions. In CD 5, numbers dropped by 14 percent; in CD 10 they dropped 17 percent; and CD 15 showed the smallest decline at 7 percent. The rates of change in the number of producers in the farming systems varied widely in different regions of the province.

For the continuous grain system, the number of producers increased provincially by 2.9 times in the decade. The average rate was exceeded in CD 5 at 3.2 times and CD 10 at 4.5 times. In CD 15, the increase was below average at only 1.93.

The extent of the fallow grain system declined provincially to 0.74 of its 1971 level. In CD's 5 and 10, the decline was nearly average at 0.74 and 0.64 respectively. In CD 15, the number actually increased by 1.15 times.

The extent of the continuous mixed class provincially increased by 1.4 times the number in 1971. Both CD 5 and CD 10 witnessed increases above average, at rates of 2.55 and 2.0 respectively. In CD 15, the number remained constant.

The fallow mixed class was the major source of declining farm numbers. This system had only 0.49 of its 1971 number. In CD 5, the decline was only 0.6, but in CD's

10 and 15, numbers fell by nearly the provincial average at 0.46 and 0.53 respectively.

The two continuous systems increased by about 3,000 members each, while the fallow grain system declined by 3,000. The fallow mixed class declined by 6,000 provincially. The movement of farms among systems and into and out of agriculture cannot be determined at this time. It appears that many producers either changed to the continuous system or entered that system from outside agriculture. A large number of producers changing to other systems or out of agriculture originated in the fallow classes ([illegible],4), particularly fallow mixed.

The movement of producers to different farming systems represents a structural adjustment likely to influence other structural variables. The remainder of this chapter will illustrate the structural differences and changes among these farming systems.

Farm Size as Measured by Improved Area

The increase in improved area per farm between 1971 and 1981 was 26 percent on a provincial average (Table V.3). The average sized commercial grain farm was 863 acres in 1981. The rate of increase varied among regions: in CD 5, area increased 20 percent; in CD 10 the area increased 30 percent; and in CD 15, it increased 28 percent. Farm sizes in CD's 10 and 15 both continued below the provincial average by about 150 acres in 1981. There is a small difference, on average, in size between fallow (2,4) and continuous producers (1,3), and no consistent pattern was discernible.

Land Rental

The proportion of producers renting land has increased in all census divisions (see Tables V.4 and V.5). The greatest increase of 10 percentage points from 50 to 60 percent of producers occurred in CD 10. In 1981, CD's 5 and 10 had similar proportions renting at about 60 percent of producers. In CD 15, the figure was much smaller at only 45 percent of producers.

The continuous producers had greater rates of increase in the proportion of producers renting. In 1981 the continuous producers exceeded the rates of rental reported by fallow producers. An opposite condition existed in 1971 on a provincial basis where there was no substantial difference between grain and mixed farms.

The proportion of farm area rented is reported in Table V.5. Despite increases in the frequency of rental, the proportion of farm area rented was nearly constant in CD's 5 and 15. In CD 10 the proportion of area rented increased signficantly from a low value of 22 percent up to a value of 30 percent. There was a tendency for southern producers to rent more of their land (36 percent) than northern, Peace River producers (26 percent).

Table V.3: Average improved area per farm (in acres) for commercial grain farms in each class for CD's 5, 10 and 15 and the provincial total of Alberta, 1971 and 1981.

	Class 1	2	3	4	Avg.
1971					
CD 5	607	935	959	1,065	954
CD 10	440	523	577	583	550
CD 15	347	538	562	624	565
Prov.	498	523	587	689	685
1981					
CD 5	1,073	1,140	1,078	1,206	1,141
CD 10	745	654	780	805	715
CD 15	615	704	753	780	724
Prov.	791	654	781	925	863

Table V.4: **Percentage of commercial grain farms renting land in each class for CD's 5, 10 and 15 and the provincial total of Alberta, 1971 and 1981.**

	Class 1	2	3	4	Avg.
1971					
CD 5	45	62	43	58	60
CD 10	51	50	46	52	50
CD 15	33	40	45	45	43
Prov.	47	56	51	54	54
1981					
CD 5	58	64	59	59	62
CD 10	63	54	64	58	60
CD 15	45	44	46	46	45
Prov.	60	58	59	58	59

Organization

The proportion of farms organized as individual proprietorships has declined in all regions of the province (Table V.6). The decline in the province as a whole amounted to 5 percent, from 88 percent to 83 percent. The greatest decline took place in southern regions and the smallest decline occurred in the Peace region.

In 1971 there was little difference among the classes of producers. By 1981, the continuous classes were consistently organized as corporations and partnerships more often than were fallow classes. The greatest declines in individual proprietorships occurred in the continuous classes. The primary explanation for this phenomenon appears related to farm size expressed by volume of sales generated by the classes. The continuous classes tended to have higher volumes of sales. There is a relationship between volume of sales and organization.

Operator Age

As shown in Table V.7, there has been a general decline in operator age in the past decade. The average age on a provincial basis declined by 1 year in the decade to 46.1 years of age. A drop of similar magnitude was noted in all census divisions. In CD 5 and CD 10, producers' ages matched the provincial average in 1981. The producers in CD 15 are the youngest in the province at 1.2 years below provincial average.

Table V.5: Percentage of total farm area rented on commercial grain farms in each class for CD's 5, 10 and 15, 1971 and 1981.

	Class 1	Class 2	Class 3	Class 4	Avg.
1971					
CD 5	41	40	27	37	38
CD 10	26	25	20	22	22
CD 15	25	28	28	26	27
1981					
CD 5	42	38	32	33	36
CD 10	37	30	29	25	30
CD 15	25	25	28	24	26

Table V.6: Percentage of commercial grain farms organized as individual proprietorships in each class for CD's 5, 10 and 15 and the provincial total for Alberta, 1971 and 1981.

	Class 1	Class 2	Class 3	Class 4	Avg.
1971					
CD 5	89	90	87	84	88
CD 10	92	93	86	91	91
CD 15	94	93	90	92	92
Prov.	90	90	85	88	88
1981					
CD 5	71	81	74	82	79
CD 10	83	89	83	89	87
CD 15	88	90	86	90	89
Prov.	80	85	81	86	83

Table V.7: Average age of commercial grain farmers in each class for CD's 5, 10 and 15 and the provincial total for Alberta, 1971 and 1981.

	Class 1	Class 2	Class 3	Class 4	Avg.
1971					
CD 5	47.5	47.2	45.1	47.3	47.1
CD 10	45.9	46.3	44.7	47.6	45.9
CD 15	44.7	46.4	45.5	46.6	46.0
Prov.	45.8	47.4	45.7	47.5	47.0
1981					
CD 5	40.9	46.3	44.7	47.6	45.9
CD 10	42.9	47.8	45.3	48.6	46.5
CD 15	42.7	45.1	44.2	46.7	44.9
Prov.	43.2	46.6	45.5	47.9	46.1

The change in age among the classes of producers indicates a selective movement of young producers into the continuous classes. In 1971, there was generally a small gap of 1 to 2 years between fallow and the younger continuous producers, particularly in the grain classes. By 1981 the age gap had increased to 2 or 3 years in most census divisions.

Cropping Pattern

The changes in cropping pattern between 1971 and 1981 are substantial (see Table V.8). They are sensitive to moisture conditions, prices and market opportunities, as well as to any possible longer-term structural trends. The proportion of improved land area in wheat has increased greatly in all the census divisions. The CD with the greatest proportion of area in wheat was CD 5 with 36 percent in 1981. The area seeded to wheat steadily diminishes through CD's 10 and 15. Barley has dropped as a proportion of area in CD 5, but increased in CD's 10 and 15 where it accounts for 24-30 percent of seeded area.

Rapeseed area declined in CD's 5 and 15 but increased slightly in CD 10. Provincially, rapeseed accounts for about 5 percent of improved area, down from 8 percent in 1971. Area in oats and other crops declined substantially in all census divisions over the decade.

Provincially, forage crops increased to 19 percent from 16 percent as a proportion of improved farm area. Regional differences were substantial as CD's 5 and 15 increased forage area, while it declined rapidly in CD 10. Summerfallow declined from 27 to 19 percent of improved area provincially. The decline was witnessed in all census divisions. The greatest drop was 8 percentage points in CD 5, followed by 5 percentage points in CD 10 and only 3 percentage points in CD 15. CD 10 has the lowest rates of fallow in 1981 at only 14 percent of improved area.

The change in cropping pattern can be summarized as a shift to wheat and barley, with reduction in oats, other crops and summerfallow accounting for area given up to wheat and barley. In CD's 5 and 15, forage area was increased slightly, but it declined substantially in CD 10.

Table V.8: Area in various crops in CD's 5, 10 and 15, and Provincial average in acres and as a percentage of improved area, 1971 and 1981.

Crop	1971 Area per farm (acres)	1971 Percent of improved area	1981 Area per farm (acres)	1981 Percent of improved area
Census Division 5				
Wheat	165	18	426	36
Oats	30	3	16	1
Barley	180	20	192	16
Rape	71	8	33	3
Forage	68	7	108	9
Other	62	7	58	5
Fallow	347	38	341	30
Cattle	67	--	72	-
Total Area[1]	923	--	1,174	-
Percent[2]		100		100
Census Division 10				
Wheat	75	12	193	27
Oats	64	10	52	7
Barley	104	17	174	24
Rape	44	7	72	10
Forage	194	31	105	14
Other	29	5	26	4
Fallow	120	19	102	14
Cattle	59	--	64	-
Total Area[1]	630	--	724	-
Percent[2]		100		100

....continued

Table V.8: Continued

Crop	1971 Area per farm (acres)	1971 Percent of improved area	1981 Area per farm (acres)	1981 Percent of improved area
		Census Division 15		
Wheat	49	9	138	19
Oats	60	16	26	3
Barley	117	20	216	30
Rape	109	19	85	12
Forage	111	20	131	18
Other	14	2	11	1
Fallow	115	20	125	17
Cattle	17	--	23	-
Total Area[1]	575	--	732	-
Percent[2]		100		100
		Provincial Average		
Wheat	92	14	226	26
Oats	42	6	36	4
Barley	143	22	208	24
Rape	52	8	45	5
Forage	107	16	164	19
Other	39	6	39	4
Fallow	179	27	163	19
Cattle	71	--	86	-
Total Area[1]	654	--	881	-
Percent[2]		100		100

[1]Totals may not equal values given elsewhere due to rounding.
[2]Percentages may not total 100 due to rounding.

Labour Use

The amount of labour used on commercial grain farms remained static for the decade in most census divisions (as shown in Table V.9).

The labour used per farm declined from southern Alberta (CD 5) at 1.17 man-years to the Peace region (CD 15) at 0.89 years per farm. Generally speaking, continuous operations used more labour and have increased labour use over the decade. Fallow producers use less labour and have tended to reduce labour use with time.

Off-farm Work

The levels of off-farm work have increased for the province as a whole to 39 days from 31 days per operator (see Table V.10). The off-farm work varies among census divisions. The greatest number of off-farm days was observed in the Peace region at 63, followed by CD 10 with 41 days and CD 5 with only 25 days. The increase for CD totals was not great in CD's 5 and 15 at only 10 to 15 percent. In CD 10, on the other hand, the increase was close to 70 percent, moving from 24 to 41 days on average.

Among the classes, differences emerge. The continuous classes have the highest level of off-farm work but the trend is toward less off-farm work. The fallow classes have low levels of off-farm work, but have experienced high rates of increase over the decade. Producers concentrating on grain generally work off the farm more than do mixed grain

Table V.9: Average labour use in commercial grain farms in each class for CD's 5, 10 and 15 and the provincial total in person-years, 1971 and 1981.

	Class 1	Class 2	Class 3	Class 4	Avg.
1971					
CD 5	0.98	1.14	1.65	1.35	1.20
CD 10	0.92	0.93	0.99	0.98	0.96
CD 15	0.88	0.85	0.87	0.90	0.88
Prov.	1.07	1.12	1.14	1.12	1.12
1981					
CD 5	1.26	1.12	1.33	1.17	1.17
CD 10	0.90	0.90	1.01	0.93	0.94
CD 15	0.82	0.86	0.93	0.92	0.89
Prov.	1.10	1.03	1.18	1.08	1.10

Table V.10: Average number of days of off-farm work for commercial grain farms in each class in CD's 5, 10 and 15 and the provincial total for Alberta, 1971 and 1981.

	Class 1	Class 2	Class 3	Class 4	Avg.
1971					
CD 5	44	23	24	17	22
CD 10	49	29	24	16	24
CD 15	82	61	59	50	58
Prov.	57	31	34	27	31
1981					
CD 5	34	38	20	17	25
CD 10	53	44	32	36	41
CD 15	78	64	61	55	63
Prov.	52	41	36	35	39

producers.

Machinery Use

The value of machinery used** per farm increased greatly in the 1970s (Table V.11). The provincial average per farm increased to $116,000 from $47,000 in 1971, an increase of 2.5 times. A distinction between fallow and continuous producers developed over the decade with continuous producers showing noticeably higher values of machinery used by 1981. In 1971, the distinction among classes was small. A north-south pattern is evident with southern producers using $132,000 of machinery, declining to only $92,000 in CD 15.

Value of Sales

Table V.12 reports the real value of sales per farm in 1971 and 1981. Sales per farm doubled provincially from an average of $41,000 to $82,000. The gap between the continuous and fallow producers widened considerably during the 1970s. The continuous producers had sales that averaged $20,000 to $30,000 above fallow producers provincially. In 1981, the north-south pattern reflecting farm size is evident. Average sales per farm declined from $98,000 in CD 5 to only $40,000 in CD 15. The difference between fallow and continuous systems diminished in the northern regions.

**All dollar values are reported in 1981 dollars; 1971 values were inflated by 2.37.

Table V.11: Average value of machinery employed per commercial grain farm in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981.

	Class 1	Class 2	Class 3	Class 4	Avg.
1971 (thousands of 1981 dollars)					
CD 5	41	55	58	64	56
CD 10	38	36	42	39	38
CD 15	27	35	38	40	37
Prov.	47	46	49	46	47
1981 (thousands of 1981 dollars)					
CD 5	154	130	145	122	132
CD 10	124	92	111	90	102
CD 15	90	88	94	94	92
Prov.	138	111	126	105	116

Table V.12: Average sales per commercial grain farm in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981.

	Class 1	Class 2	Class 3	Class 4	Avg.
1971 (thousands of 1981 dollars)					
CD 5	39	48	66	71	53
CD 10	30	25	41	32	30
CD 15	13	17	21	21	19
Prov.	42	38	50	41	41
1981 (thousands of 1981 dollars)					
CD 5	168	82	148	96	98
CD 10	75	51	91	51	65
CD 15	38	35	45	40	40
Prov.	93	63	101	71	82

Gross Margins

The doubling of sales per farm through the expansion of farm size and increased sales per acre has not led to a doubling of gross margins per farm (Table V.13). The provincial average gross margin per farm increased to \$51,000 from \$31,000, only 64 percent in real terms. The continuous classes, particularly the continuous mixed class, have much higher gross margins per farm than fallow classes and have increased more rapidly. The north-south pattern is evident again as margins are \$38,000 lower in CD 15 than in CD 5. This pattern has significant implications for adjustment and public policy in the north.

C. Structural Ratios

Machinery per Acre of Improved Land

Not only did machinery capital increase with farm size, but the value of machinery per acre also increased (Table V.14). The value of machinery per acre has increased on average across the province by about 2 times in the decade to \$133 from \$67. There is no distinction in this rate of increase between fallow and continuous producers. However, the continuous producers have values of capital per acre about 25 percent higher than fallow classes. The north-south pattern is not obvious in this case. The value of machinery per acre in CD's 5 and 15 is between \$114 and \$125. In CD 10, the value of machinery per acre is highest at \$142.

Table V.13: Average gross margin per farm for commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981.

	Class 1	2	3	4	Avg.
	1971 (thousands of 1981 dollars)				
CD 5	28	35	50	57	39
CD 10	23	18	31	24	22
CD 15	9	12	15	15	14
Prov.	31	28	37	31	31
	1981 (thousands of 1981 dollars)				
CD 5	109	48	92	61	60
CD 10	40	29	57	30	39
CD 15	21	19	26	22	22
Prov.	53	30	67	46	51

Table V.14: Average value of machinery employed per improved acre for the commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981.

	Class 1	2	3	4	Avg.
	1971 (in 1981 dollars)				
CD 5	66	58	63	60	58
CD 10	81	67	72	67	68
CD 15	71	64	67	62	64
Prov.	89	61	83	65	67
	1981 (in 1981 dollars)				
CD 5	142	112	134	99	114
CD 10	163	141	142	128	142
CD 15	145	124	125	118	125
Prov.	172	117	152	113	133

Capital per Person-Year of Labour

The value of machinery used per year of labour has increased in real terms by about 2.5 times in the decade (Table V.15). As noted earlier, labour use per farm remained constant on average. As a result the capital/labour ratio (K/N) increased by the same proportion as did machinery per farm. The continuous grain class has K/N values that are consistently higher than other classes averaging about $120,000 in 1981. The fallow grain producers have the second highest K/N averaging about $106,000 in 1981. Both the mixed classes have values below $100,000. The low labour requirements of grain classes tend to push up the K/N relative to mixed producers, given their similar machinery values. The rate of increase in K/N has also been greater for the fallow and continuous grain producers than the mixed producers. Among regions no consistent pattern is evident in either 1971 or 1981. CD 5 has the highest K/N in 1981 at $112,000 followed by CD 15 at $103,000 and CD 10 at $100,000.

Capital per Dollar of Sales

The value of machinery per dollar of sales (K/O) is the inverse of a partial productivity measure. If the value of machinery per dollar of sales has increased, it will signify diminishing returns to capital as applied to land or excess machinery capacity. This situation would be problematic unless compensated by increased productivity of other

Table V.15: Average value of machinery per year of labour for the commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981.

	Class				
	1	2	3	4	Avg.
	1971 (thousands of 1981 dollars)				
CD 5	41	47	36	47	47
CD 10	39	35	38	36	36
CD 15	28	40	43	44	41
Prov.	42	41	43	40	41
	1981 (thousands of 1981 dollars)				
CD 5	121	114	107	102	112
CD 10	124	96	100	89	100
CD 15	110	102	103	100	103
Prov.	123	106	98	96	104

inputs. Table V.16 indicates the K/O ratios in 1971 and 1981.

On a provincial basis, the machinery per unit of sales increased by 25 percent from 1.12 in 1971 to 1.41 in 1981. The continuous mixed producers have had the smallest increase in K/O at 19 percent and are at the lowest level in 1981. The continuous grain and fallow mixed producers appear to have similar K/O levels and rates of change. Only in CD 5 did the continuous grain class have a much lower value than the fallow mixed class. The fallow grain class invariably has the highest level of machinery per unit of sales. A north-south pattern is evident in these ratios. Producers have machinery output-values ranging from 1.33 in CD 5 to 1.56 in CD 10 and 2.30 in CD 15. This pattern was evident in both 1971 and 1981. The relatively low productivity of capital in northern regions raises questions about the suitability of both the technology and the farm structure in CD 15.

Sales per Acre

To determine the change in sales per acre of improved land, Table V.17 was developed. The provincial average sales per acre increased by 57 percent to $94 from $60 per acre in the decade. In 1971 and 1981, the continuous classes had higher levels of sales per acre in all census divisions and provincially. Generally speaking, the continuous classes had the highest rates of increase for sales per acre. The fallow classes had the smallest increases and lowest absolute levels in 1981. Regionally, CD 5 and CD 10 have similar levels of sales per acre between $86 and $91. CD 15 was particularly low at only $55. It is interesting to note that the provincial average sales per acre increased a greater percentage than did any single system because of a shift in weighting to the continuous classes.

The proportion of production from continous systems increased to 50 from 25 percent in the decade. The shift to continuous cropping represents a major manifestation of biological technology such as fertilizer use, improved breeds, and snow and soil management. This adjustment explains how sales per acre on aggregate increased more rapidly than they did for any single class.

Table V.16: Average value of machinery per dollar of sales and the real change between 1971 and 1981 for commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981.

	Class 1	2	3	4	Avg.
	(in 1981 dollars)				
Census Division 5					
1971	1.03	1.13	0.87	0.90	1.06
1981	0.91	1.57	1.00	1.27	1.33
Change[1]	0.88	1.39	1.15	1.41	1.25
Census Division 10					
1971	1.19	1.41	1.01	1.22	1.25
1981	1.63	1.81	1.33	1.77	1.56
Change	1.37	1.28	1.31	1.45	1.25
Census Division 15					
1971	2.12	2.05	1.81	1.88	1.91
1981	2.35	2.49	2.12	2.37	2.30
Change	1.10	1.21	1.17	1.24	1.20
Provincial Average					
1971	1.09	1.23	0.99	1.11	1.12
1981	1.47	1.73	1.18	1.46	1.41
Change	1.35	1.41	1.19	1.31	1.25

[1] 1981 ÷ 1971.

Sales per Year of Labour

Sales per year of labour is another partial productivity index (Table V.18). In the 1970s, the value of sales per year of labour increased 2 times up to $74,000 from $37,000. Again, the continuous classes display much higher levels and more rapid increases in sales per year of labour. The provincial average for continuous producers in 1981 was $85,000 compared to only $65,000 for fallow producers. Grain and mixed producers are not distinctive. A strong regional pattern emerges again as the sales per year of labour in 1981 declined from $84,000 in southern Alberta to $44,000 in CD 15.

Gross Margin per Acre

To account for changes in farm area, the margin per acre was calculated (Table V.19). The increase in provincial average gross margin per acre was only 31 percent up to $59 from $45 in 1971. The rate of increase in margin per acre is far below the rate of increase of sales per acre due to the cost price squeeze. Again the continuous classes have the highest margins per acre. The regional pattern is not apparent as CD's 5 and 10 have similar margins per acre at about $53. In CD 15, however, the value is much lower at only $30 in 1981. The difference between fallow and continuous systems is much smaller in CD 15 than in CD 5 and CD 10.

D. Summary of Changes Between 1971 and 1981

The past decade witnessed changes that were consistent with those taking place since the second world war in western Canada.[17] Commercial farm numbers declined by 15 percent in the decade to 30,006 producers. The area per farm increased as farm numbers declined and the improved area of

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[17] Veeman T.S. and Veeman, M.M., "The Changing Organization, Structure, and Control of Canadian Agriculture". **Amer. J. Agric. Econ.**, Vol. 60 (5), 1978: pp. 759-768.

Table V.17: Average sales per acre of improved land for commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average 1971 and 1981.

	Class 1	2	3	4	Avg.
1971 (in 1981 dollars)					
CD 5	65	51	72	67	55
CD 10	68	48	71	55	54
CD 15	33	31	36	33	34
Prov.	82	49	84	59	60
1981 (in 1981 dollars)					
CD 5	156	71	132	79	86
CD 10	100	78	116	71	91
CD 15	62	49	61	51	55
Prov.	117	67	130	76	94

Table V.18: Average sales per year of labour for commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981.

	Class 1	2	3	4	Avg.
1971 (thousands of 1981 dollars)					
CD 5	40	42	41	53	44
CD 10	33	25	38	30	29
CD 15	13	20	23	23	22
Prov.	38	33	43	36	37
1981 (thousands of 1981 dollars)					
CD 5	133	72	107	82	84
CD 10	76	53	82	51	64
CD 15	46	40	50	43	44
Prov.	84	61	85	65	74

Table V.19: Gross margin per improved acre for commercial grain farms in each class for CD's 5, 10 and 15, and the provincial average, 1971 and 1981.

	Class 1	2	3	4	Avg.
	1971 (in 1981 dollars)				
CD 5	46	37	52	53	41
CD 10	52	34	53	41	48
CD 15	26	22	27	24	25
Prov.	62	53	63	45	45
	1981 (in 1981 dollars)				
CD 5	101	42	85	51	53
CD 10	54	44	73	37	53
CD 15	34	27	35	28	30
Prov.	67	46	85	50	59

the province increased. Despite this increase in farm size, labour use per farm remained nearly constant over the decade. The operation of larger farms with constant labour was accomplished with a more than doubling in real value in machinery used per farm. The value of sales per farm doubled in the decade, but gross margin only increased 64 percent. This situation reflects an upward shift in the cost structure over the decade.

The farming system classification indicates conditions were favourable to the development of continuous farming systems. The size of continuous operations has increased from levels below those for fallow systems in 1971 to parity in 1981. The average age of continuous producers declined while fallow producers maintained a constant age. Continuous producers have expanded labour use and have reduced off-farm work since 1971. On the other hand, fallow producers have reduced labour use and increased off-farm work. In 1971 there was no consistent pattern in machinery use, sales, or gross margin per farm among farming systems. By 1981 continuous producers had higher levels of machinery, sales and margin per farm.

The motivating force behind the shift to continuous cropping and its apparent vitality may be revealed by several partial productivity indexes. Continuous systems had higher levels of machinery per acre of land and per year of labour in 1971 and 1981. Continuous systems were more capital intensive than fallow producers, but the value of sales per year of labour and per acre of land exceeded the fallow systems in both 1971 and 1981. The result is a low ratio of machinery per dollar of sales and a higher gross margin per acre of improved land in both 1971 and 1981 for continuous producers. These ratios help explain why continuous cropping systems expanded from 25 percent of producers to include 50 percent of commercial grain producers by 1981. This major change in farming system activities generated the increase in provincial average cropping intensity from 0.55 to 0.61 in 1981.

The location of grain activities in the province has a large influence on the average structure of farms and the degree of difference between continuous and fallow producers. Earlier work by Packer and Apedaile[44] indicated a

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[44]Packer, K. and Apedaile, L.P., op. cit., pp. 19-23.

structural gradient that was related to how far north the census division was located. Numerous variables declined in value in northerly sequence. Improved area, area of farm rented, and proportion of producers renting, all declined with northerliness. Farms tended to be smaller in the north and subsequently labour use, value of machinery, and sales and gross margins per farm, also were lower in more northerly census divisions. The smaller farm sizes may explain many of the low absolute values of the variables mentioned above. The levels of machinery per acre and per year of labour are not region specific. The low values for sales per acre, sales per year of labour and gross margin per acre and extremely high value of machinery per dollar of sales are not explained by different levels of capital. It appears that latitude and its influence on agroclimatic conditions significantly influence structure in regions of Alberta. Other factors such as time settled, access to markets and ethnic composition could contribute to the regional gradient. In addition to regional differences in structure, the degree of difference among farming systems is affected by location.

Generally speaking, the differences between fallow and continuous systems becomes smaller in the more northerly census divisions. For variables such as machinery, sales, and gross margin per farm, the differences between fallow and continuous systems narrow in the north. The same pattern is evident for sales per acre, sales per year of labour and gross margin per acre. Not only do the absolute values decline as one moves north, but so do the marginal differences among the farming systems.

The smaller difference among farming systems in terms of sales per acre, sales per year of labour and gross margins per acre may explain why CD 15 had the smallest increase in the number of continuous producers and the smallest decrease in the number of fallow farmers. The reason for the regional pattern and apparently small benefits from intensification is not immediately apparent. Perhaps farm sizes are below levels required to use current machinery efficiently. Or weather conditions may prevent gaining full benefits of current technology. Location factors inhibiting livestock numbers may prevent producers moving into the mixed continuous systems. Market outlets for forage and livestock in the north have not fully developed. In any case, this region does not appear receptive to intensification at this time.

The apparent province-wide shift in emphasis to continuous cropping provincially illustrates the importance of structure to productivity. In 1971 continuous systems had superior partial productivity indices. Given that technical capacity, a shift to more producers in that system could lift productivity with no change in available technology. Such a shift is a possible future adjustment to the WGTA and is important to understanding productivity changes.

VI. RESULTS: INFLUENCE OF SIZE AND TIME ON STRUCTURAL VARIABLES

A. Introduction

Chapter VI illustrates the relationship between volume of sales[''] and four structural variables. Of particular interest is the change in form, intercept, and slope of the relationships over time and space in Alberta. The changes are indicative of the forces acting upon the industry and the direction of reactive structural adjustments. The results are empirical as most of the variables considered are not explicitly described by neoclassical economic theory.

The method used involved grouping producers within each farming system into seven sales categories. The relationship between sales volume in dollars and the variables was estimated using weighted least squares regression (WLS). Three functional forms including linear, log linear and second degree polynomial were evaluated. The WLS estimation procedure tends to over-estimate the correlation coefficient and the standard errors of the estimated coefficients. These were unavoidable problems in the grouped model.

The counts of producers in each sales class are reported in Table VI.1. In 1971 continuous cropping systems were not practised at volumes above $150,000 in many cases. The categories with less than three observations in 1971

''The census definition of sales included: sale of agricultural products, CWB payments, and any cash payments for stabilization or insurance.

were considered missing cases in the WLS analysis. By 1981 the continuous systems were represented at all sales levels. The movement of producers to continuous cropping systems became technically and economically desirable at larger farm sizes during the 1970s.

The four structural variables expected to show a relationship to volume of sales include: the capital/labour ratio; sales per acre; unit cash cost; and gross margin per acre. The form and slope of most of these relationships can be anticipated on the basis of empirical research and economic theory. The K/N ratio is probably positively related to volume of sales initially. Barriers to increasing substitution of capital could exist; the form of the K/N ra[illegible] cannot be assigned **a priori**.

Sales per acre are positively related to volume of sales according to Edwards.[70] If the function is positively sloping through the observed range, it indicates no technical barrier to expanding farm size. If the function shifts upward, it is indicative of the improved technology, increased input use or higher output prices. A change in the slope of the function would indicate differential effects of technical change and input use at different sales ranges.

The cash cost function is likely downward sloping. Most empirical work indicates that unit cash costs and average total costs decline as sales volume expands.[71]

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[70]Edwards, C., **op. cit.**, pp. 1-11.
[71]Anderson, J.R. and Powell, P.A., "Economies of Size in Australian Farming," **Aus. J. Agric. Econ.**, Vol. 17, 1973: p. 13.

Gross margins per acre are a rough measure of profitability. Gross margin is the source of financing for capital formation and most structural adjustments. In economic theory there is no basis for anticipating the slope or form of the relationship. Empirical work by Miller suggests that margins increase with volume of sales.[72] A downward shift indicates a decline in the income per acre, while a change in slope indicates a change in economic conditions which do not affect all sizes of producers equally.[73]

B. The Capital Labour Ratio

The capital labour (K/N) ratio indicates the proportions of capital and labour used in the production process. Development theory suggests this ratio increases with economic growth and material standard of living. The force behind the increase is the change in the relative prices of capital and labour. Generally speaking, wages have increased relative to the cost of capital leading to a capital/labour substitution.

The values of machinery used per year of labour are reported in Table VI.2 which represents CD's 5, 10 and 15. The statistics reported in Table VI.2 are graphed in Figures

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[72]Miller, T.A., "Economies of Size and Other Growth Incentives," in **Structure Issues of American Agriculture**, U.S.D.A. Report 438. Washington, D.C.: United States Department of Agriculture, 1979: pp. 108-115.
[73]All dollar values are reported in 1981 dollars; 1971 values were inflated by 2.37.

Table VI.1: The number of commercial grain producers in each sales category for the four classes and the census division aggregates (Agg.) in CD's 5, 10 and 15 in 1971 and 1981.

Class	Year	Sales (thousands of 1981 dollars) <25	25-49	50-99	100-149	150-199	200-249	250+
Census Division 5								
1	1971	41	14	8	4	2*	0*	1*
1	1981	36	30	62	33	14	12	27
2	1971	786	274	462	113	31	21	22
2	1981	235	431	568	190	72	43	60
3	1971	28	36	30	5	7	0*	3*
3	1981	26	53	97	40	28	11	34
4	1971	160	191	165	45	22	12	36
4	1981	65	110	172	66	31	11	23
CD Agg.	1971	1015	1015	665	167	62	33	52
CD Agg.	1981	362	624	899	329	145	77	144
Census Division 10								
1	1971	125	28	18	3	1*	1*	2*
1	1981	201	209	180	36	33	18	37
2	1971	1696	472	180	32	13	7	9
2	1981	519	454	302	88	41	13	18
3	1971	246	167	94	16	7	1*	11
3	1981	236	301	341	138	48	24	29
4	1971	1217	701	232	40	17	5	12
4	1981	340	370	282	60	30	7	12
CD Agg.	1971	2384	1368	524	91	38	14	34
CD Agg.	1981	1296	1334	1105	372	152	66	96

....continued

Table VI.1: Continued

Class	Year	Sales (thousands of 1981 dollars) <25	25-49	50-99	100-149	150-199	200-249	250+
				Census Division 15				
1	1971	347	30	7	1*	0*	0*	0*
1	1981	393	170	125	34	12	3	6
2	1971	1292	254	51	7	0*	0*	0*
2	1981	903	519	305	57	21	4	9
3	1971	1020	276	56	12	2*	2*	2*
3	1981	583	380	297	61	29	7	19
4	1971	1603	425	98	14	5	0*	5
4	1981	537	324	229	42	17	10	5
CD Agg.	1971	4262	985	212	34	7	2	7
CD Agg.	1981	2416	1393	956	194	79	24	39

*Considered a missing case in the regression analysis.

VI.1 to VI.6.[74] The curves suggest that a relationship between sales volume and the K/N ratio existed in both 1971 and 1981. WLS regression confirms this relationship and determines the functional form. The form of the relationship has changed radically between 1971 and 1981. The equations reported in Tables VI.3 to VI.5 correspond to the data in Table VI.2 and graphs presented in Figures VI.1 to VI.6. The equation describing the K/N ratios have significant t-values at the 95 percent confidence level and correlation coefficients in excess of 0.80.

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[74] The lines on the graphs are drawn through the points and do not represent the equations.

Table VI.2: Machinery used per year of labour for commercial grain producers in each sales category for the four classes and the census division aggregates (Agg.) in CD's 5, 10 and 15 in 1971 and 1981.

Class	Year	Sales (thousands of 1981 dollars)						
		<25	25-49	50-99	100-149	150-199	200 249	250+
				Census Division 5				
1	1971	31	45	59	58	-	-	-
1	1981	63	106	114	117	127	156	152
2	1971	33	47	60	67	53	57	31
2	1981	56	84	116	141	147	150	191
3	1971	24	57	47	67	77	-	-
3	1981	68	64	103	121	146	185	110
4	1971	33	45	60	57	58	60	44
4	1981	54	83	101	127	141	98	151
CD Agg.	1971	33	47	60	64	57	58	31
CD Agg.	1981	57	83	112	134	144	148	152
				Census Division 10				
1	1971	31	45	53	37	-	-	-
1	1981	68	92	134	182	172	205	155
2	1971	29	45	55	64	62	44	17
2	1981	56	84	121	156	165	127	150
3	1971	29	42	47	46	51	-	53
3	1981	57	80	106	129	139	94	112
4	1971	29	41	50	61	54	76	25
4	1981	52	74	108	105	178	121	199
CD Agg.	1971	29	42	52	58	55	52	27
CD Agg.	1981	57	82	115	148	161	147	146

....continued

Table VI.2: Continued

Class	Year	Sales (thousands of 1981 dollars)						
		<25	25-49	50-99	100-149	150-199	200 249	250+
Census Division 15								
1	1971	31	45	53	-	-	-	-
1	1981	74	108	140	202	132	193	148
2	1971	29	45	55	64	-	-	-
2	1981	64	104	144	169	212	383	162
3	1971	29	42	47	47	-	-	-
3	1981	68	94	131	142	155	143	145
4	1971	32	33	53	55	53	-	31
4	1981	59	78	106	128	145	143	139
CD Agg.	1971	32	46	56	57	57	-	29
CD Agg.	1981	64	84	112	135	146	142	131

Figure VI.1: Machinery value per year of labour stratified by sales volume in CD 5, 1971.

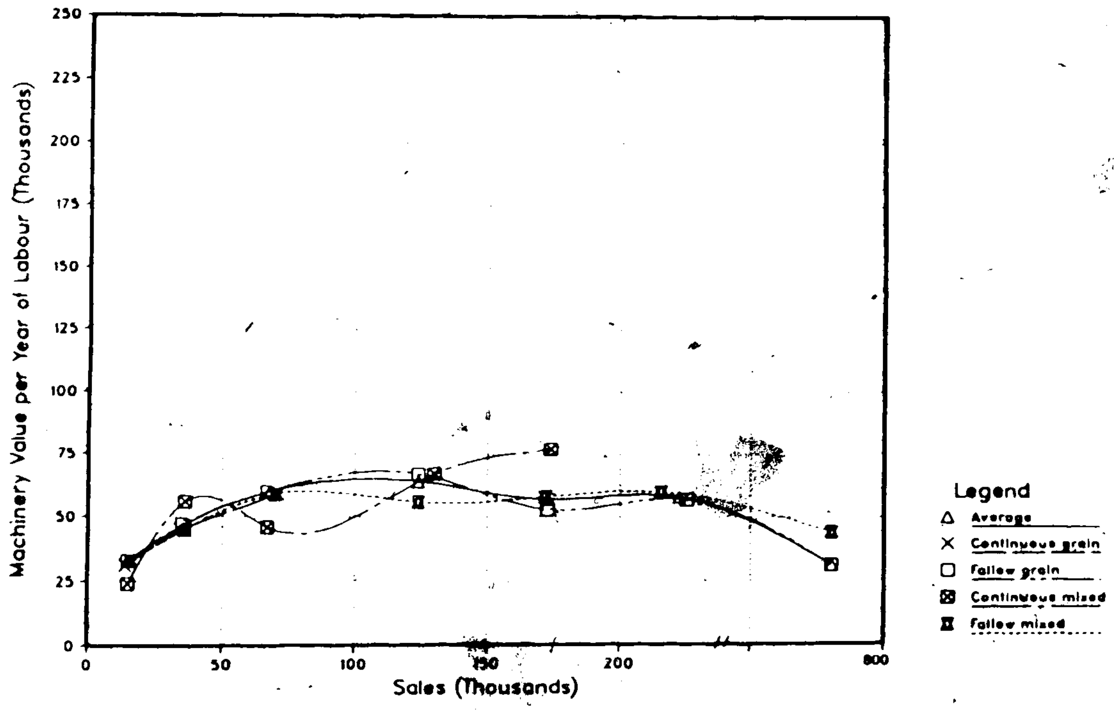

Figure VI.2: Machinery value per year of labour stratified by sales volume in CD 5, 1981.

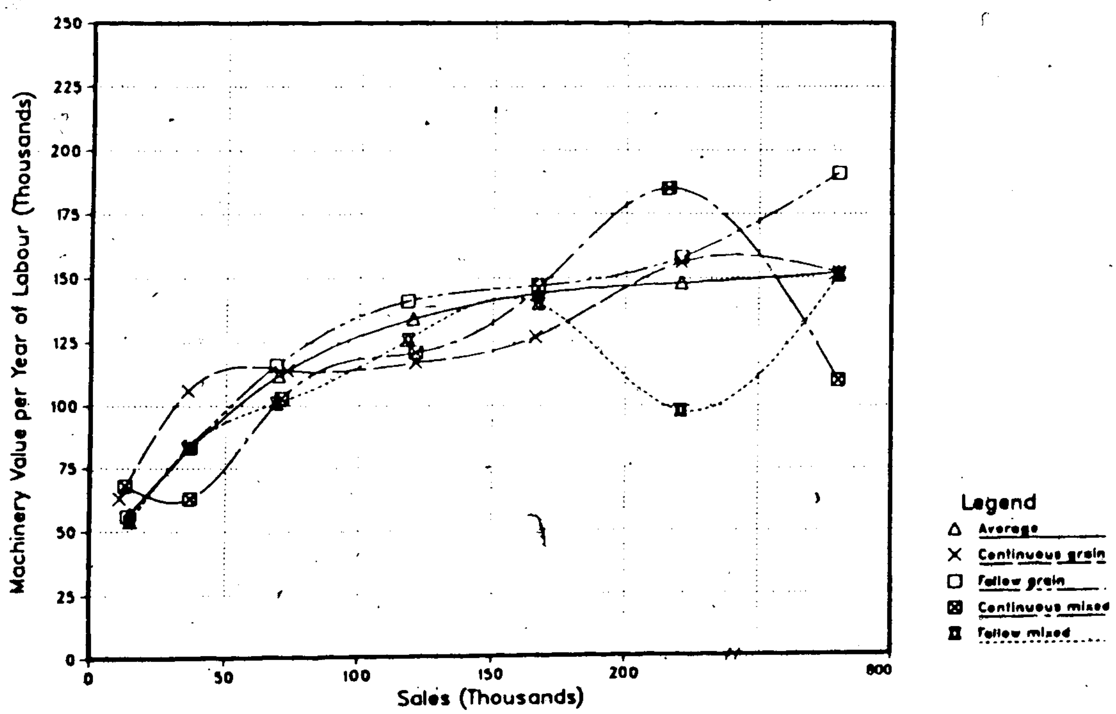

Figure VI.3: Machinery value per year of labour stratified by sales volume in CD 10, 1971.

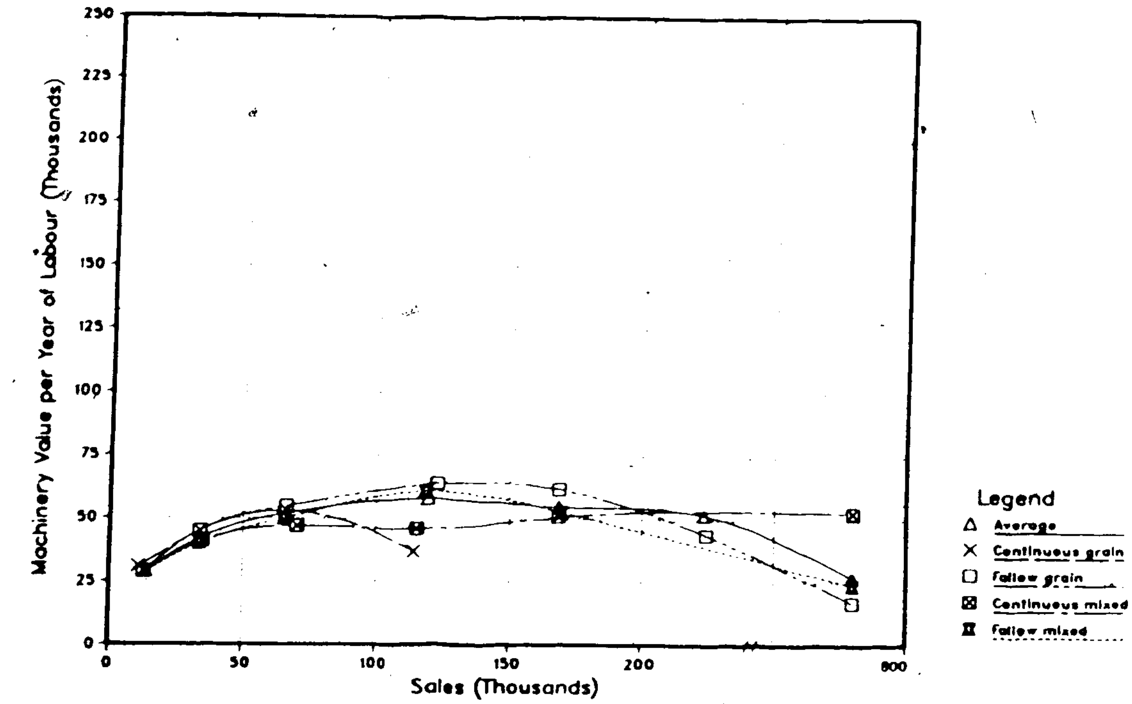

Figure VI.4: Machinery value per year of labour stratified by sales volume in CD 10, 1981.

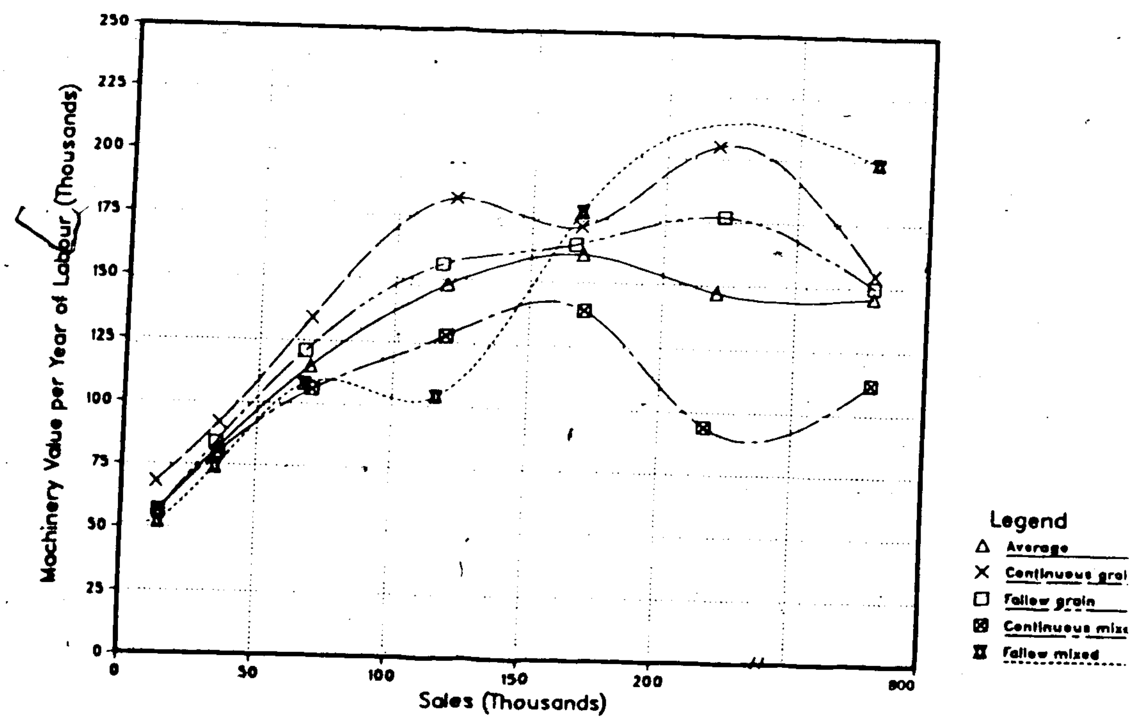

Figure VI.5: Machinery value per year of labour stratified by sales volume in CD 15, 1971.

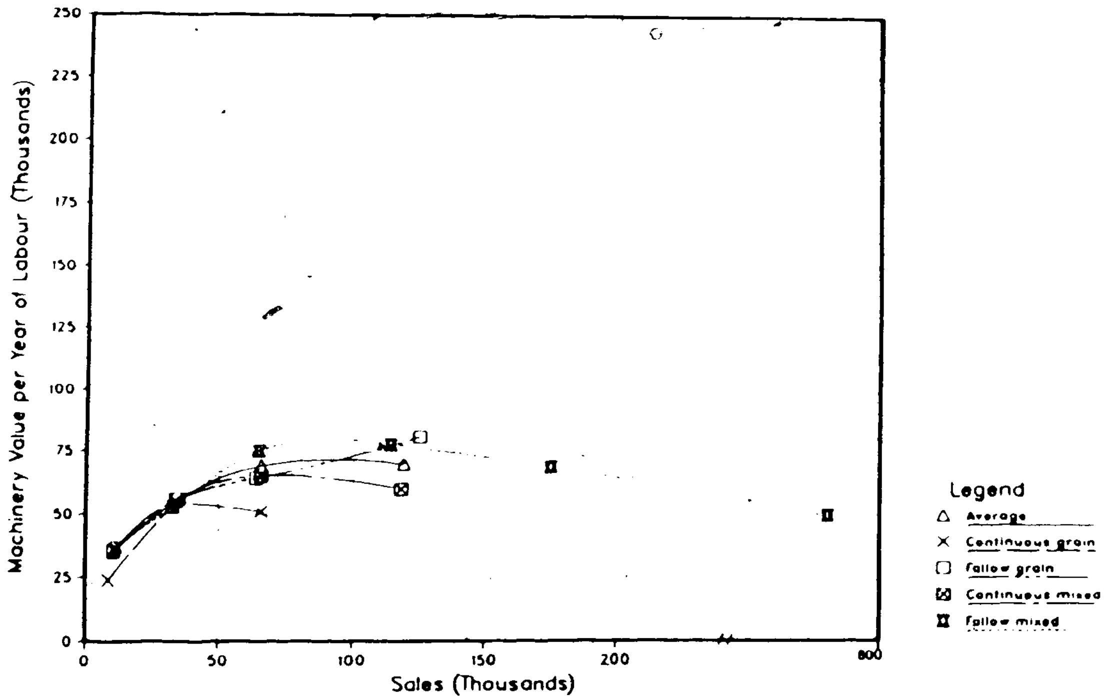

Figure VI.6: Machinery value per year of labour stratified by sales volume in CD 15, 1981.

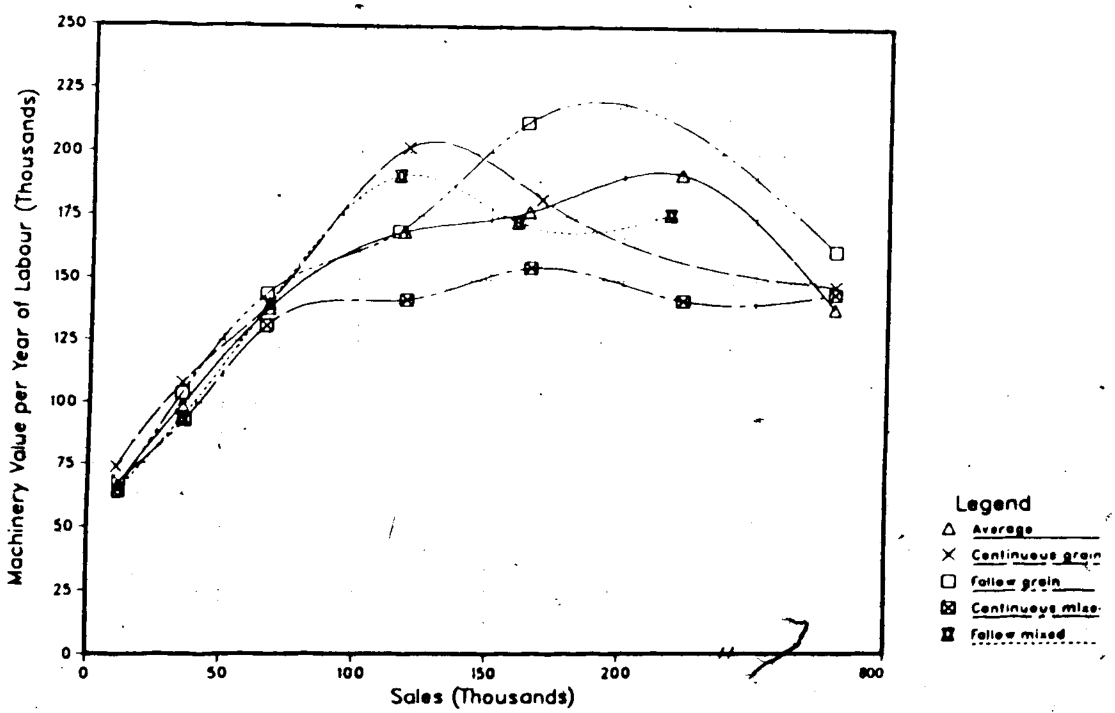

Table VI.3: Equations describing the relationship between the capital/labour ratio and volume of sales for the four commercial classes and the CD aggregates (Agg.) in CD 5 in 1971 and 1981.

Class	Form	Equation	R^2
		1971	
1	log linear	$\ln Y = 6.85 + 0.366 \ln X$	97
		(15)* (8)	
2	2nd poly	$Y = 30722 + 0.419X - 0.000,001\ X^2$	79
		(6) (6) (-4)	
3	log linear	$\ln Y = 6.14 + 0.429 \ln X$	66
		(3) (3)	
4	2nd Poly	$Y = 32703 + 0.341X - 0.764 \times 10^{-7}X^2$	74
		(6) (6) (-3)	
CD Agg.[1]	2nd poly	$Y = 31056 + 0.399X - 0.873 \times 10^{-7}X^2$	98
		(14) (8) (-7)	
		1981	
1	log linear	$\ln Y = 9.26 + 0.207 \ln X$	85
		(21) (5)	
2	log linear	$\ln Y = 7.16 + 0.398 \ln X$	96
		(19) (11)	
3	2nd poly	$Y = 45283 + 0.827X - 0.000,001\ X^2$	92
		(5) (7) (6)	
4	log linear	$\ln Y = 8.03 + 0.310 \ln X$	87
		(14) (6)	
CD Agg.	log linear	$\ln Y = 8.00 + 0.318 \ln X$	97
		(24) (10)	

*t-values are in parenthesis.

[1]The aggregate is estimated using the observations of the four farming systems. There are 28 observations in this regression normally (refer to Table VI.1 for missing cases).

Table VI.4: Equations describing the relationship between the capital/labour ratio and volume of sales for the four commercial classes and the CD aggregates (Agg.) in CD 10 in 1971 and 1981.

Class	Form	Equation	R^2
		1971	
1	2nd poly	$Y = 21625+0.926X-6.8 \times 10$ [illegible] X^2 (6)* (6) (3)	89
2	2nd poly	$Y = 21071+0.691X-2.43 \times 10$ [illegible] X^2 (6) (6) (7)	96
3	log linear	$\ln Y = \ln 7.83 + 0.261 \ln X$ (17) (6)	80
4	2nd poly	$Y = 24023+0.459X-1.21 \times 10$ [illegible] X^2 (6) (4) (3)	79
CD Agg.'	2nd poly	$Y = 24138+0.480X-1.31 \times 10$ [illegible] X^2 (15) (9) (7)	78
		1981	
1	2nd poly	$Y = 50277+1.34X-2.81 \times 10^{-}$ [illegible] X^2 (8) (11) (7)	97
2	2nd poly	$Y = 41908+1.23X-2.3 \times 10^{-}$ [illegible] X^2 (8) (11) (8)	97
3	log linear	$\ln Y = 8.37 + 0.280 \ln X$ (12) (4)	78
4	log linear	$\ln Y = 6.71 + 0.433 \ln X$ (.5) (10)	95
CD Agg.	log linear	$\ln Y = \ln 7.36 + 0.378 \ln X$ (21) (12)	84

*t-values are in parenthesis.
'The aggregate is estimated using the observations of the four farming systems. There are 28 observations in this regression normally (refer to Table VI.1 for missing cases).

Table VI.5: Equations describing the relationship between the capital/labour ratio and volume of sales for the four commercial classes and the CD aggregates (Agg.) in CD 15 in 1971 and 1981.

Class	Form	Equation	R^2
		1971	
1	2nd poly	$Y = 5354 + 2.29X - 2.42 \times 10^{-5}X^2$ (5) (21) (14)	99
2	log linear	$\ln Y = 6.92 + 0.381 \ln X$ (30)* (16)	99
3	2nd poly	$Y = 23230 + 1.22X - 7.8 \times 10^{-6}X^2$ (10) (8) (-5)	97
4	2nd poly	$Y = 29242 + 0.737X - 1.67 \times 10^{-6}X^2$ (12) (7) (-5)	94
CD Agg.'	2nd poly	$Y = 27285 + 0.773X - 1.79 \times 10^{-6}X^2$ (15) (9) (-6)	99
		1981	
1	2nd poly	$Y = 60925 + 1.34X - 2.44 \times 10^{-6}X^2$ (11) (10) (8)	97
2	2nd poly	$Y = 45336 + 1.070X - 3.63 \times 10^{-6}X^2$ (6) (8) (5)	95
3	log linear	$\ln Y = 8.16 + 3.18 \ln X$ (21) (8)	92
4	log linear	$\ln Y = 7.19 + 0.413 \ln X$ (14) (8)	93
CD Agg.	log linear	$\ln Y = 7.53 + 0.382 \ln X$ (32) (10)	91

*t-values are in parenthesis.
'The aggregate is estimated using the observations of the four farming systems. There are 28 observations in this regression normally (refer to Table VI.1 for missing cases).

The census division aggregate functions in CD's 5, 10 and 15 highlight the change in K/N that has taken place over time. In 1971, the relationship was represented by a second degree polynomial form in all CD aggregates. This form means that the K/N ratio increased from a value of about $30,000 at the smallest sales group to a peak of about $60,000 at the $100,000-$149,000 sales group. Thereafter, the K/N ratio declined rapidly as sales increased so that the largest producers actually had lower K/N ratios than the smallest producer in CD's 10 and 15. These functions are firm evidence that in 1971, beyond farm sizes of $149,000 in sales, it was not technically possible to continuously substitute capital for labour.

Between 1971 and 1981 the form of this relationship changed significantly. In 1981 a log function best represented the relationship for CD aggregates. The smallest producers had K/N ratios of about $60,000 in real terms, equalling the peak observed in 1971. The K/N ratio increased rapidly to about $150,000 for producers with sales between $150,000 and $200,000. Beyond this point, the ratio K/N is essentially flat in CD's 10 and 15; in CD 5 it continues to increase. The parabolic form has given way to a logarithmic relationship. The change in the K/N ratios was much greater at large sizes. Producers with sales below $100,000 experienced a doubling of the ratio. Those with sales above $100,000 but less than $250,000 expanded capital use relative to labour by 2.3 to 2.8 times. The largest producers with sales above $250,000 increased the use of capital relative to labour by 4.5 times in the decade. Thus, in addition to a general technical substitution in capital use relative to labour, the rate of substitution by the largest producers was so great as to change the form of the relationship.

An important factor in the change of the K/N ratio is labour use (see Table VI.6). The provincial aggregates indicate that all sales classes have reduced their labour use over the decade. This reduction is partly explained by producers moving to higher sales classes without increasing labour use. Nonetheless, the figures indicate a wide range of change from very small producers with a decline of only 10 percent to the largest producers with a decline of 57 percent in labour use per farm. The pattern of reduction in labour use is part of the explanation of why the K/N function has changed from a polynomial to a logarithmic form in the past decade.

These changes may be attributed to two forces. The first is relative factor prices. The increase in the cost of labour relative to the cost of capital and credit is probably responsible for the general upward shift in the K/N ratio. The second force behind the change in the form of the function may be needed technical innovations incorporated in capital goods. The development of technology in capital goods that allows continuous substitution of capital for

Table VI.6: Labour use per commercial grain farm, stratified by volume of sales, Alberta average, 1971 and 1981.

Year	Sales (thousands of 1981 dollars)						
	<25	25-49	50-99	100-149	150-199	200-249	250+
1981	0.79	0.94	1.09	1.31	1.50	1.80	2.88
1971	0.89	1.06	1.26	1.58	2.01	2.40	6.66
Change*	0.89	0.89	0.87	0.83	0.75	0.75	0.43

*1981 divided by 1971.

labour is consistent with the Hayami and Ruttan's[75] model of induced innovation. Innovations are being incorporated into capital goods to facilitate the use of greater amounts of the less costly input in the production process. A paramount cost for farmers was labour in the 1970s. Producers were motivated by cost saving opportunities to purchase machines that reduced labour use. The cost saving motivation for purchase was reflected in the design of machinery. The degree of labour reduction at large sizes suggests that the labour and cost savings associated with technical developments in machinery are particularly great for large sizes of farms.

The trends among the four classes of farming systems are too erratic to enable generalizations. Where the equations for continuous and fallow classes are of the same form in 1981, the continuous classes have higher intercepts

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[75] Hayami, Y. and Ruttan, V., op. cit., pp. 73-87.

but lower slope coefficients than fallow classes. The slopes of the K/N functions increase from CD 5 to CD 15 as does the observed level of substitution. The intercepts are not consistently different.

C. Sales per Acre

Literature on farm structure suggests a positive correlation between sales per acre, an aggregate productivity measure, and volume of production.[14] If this relationship has a continuous positive slope, it would indicate that no technical or management barriers to size exist. Data on sales per acre stratified by farm size are given in Table VI.7. The data are graphed in Figures VI.7 to IV.12. The most important feature of the relationships is the increase in sales per acre associated with volume increases. Sales per acre in 1981 ranged from about $25 per acre for producers with sales less than $25,000 to above $150 per acre for those with sales over $225,000.

The statistical estimates of these relationships are provided in Tables VI.10 to VI.12. The relationship between sales per acre and volume of sales is nearly always positive and either linear or logarithmic. Only the continuous mixed class in CD 5 (1971) and the fallow grain class in CD 10 (1981) exhibited a parabolic form. The fit of the function was generally satisfactory with a coefficient of determination above 0.90 in most cases. The t-values were

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[14] Edwards, C., op. cit., pp. 1-11.

Table VI.7: Sales per acre of improved land for commercial grain producers in each sales category for the four classes and the census division aggregates (Agg.) in CD's 5, 10 and 15 in 1971 and 1981.

Class	Year	Sales (thousands of 1981 dollars) <25	25-49	50-99	100-149	150-199	200-249	250+
Census Division 5								
1	1971	32	47	75	160	-	-	-
1	1981	18	66	74	117	124	163	285
2	1971	27	41	53	73	91	104	155
2	1981	27	51	64	73	80	93	128
3	1971	29	56	68	94	87	-	-
3	1981	22	64	79	111	122	141	264
4	1971	29	45	61	82	89	92	131
4	1981	27	46	64	81	83	90	218
CD Agg.	1971	27	42	55	76	91	99	142
CD Agg.	1981	25	51	67	81	89	103	187
Census Division 10								
1	1971	33	53	99	129	-	-	-
1	1981	37	75	98	100	131	145	151
2	1971	32	51	71	111	121	101	121
2	1981	37	65	85	98	110	141	128
3	1971	21	45	65	64	92	-	153
3	1981	34	70	91	111	146	151	332
4	1971	22	40	59	76	90	152	144
4	1981	35	61	79	96	98	142	129
CD Agg.	1971	33	54	78	101	118	134	170
CD Agg.	1981	35	67	87	103	121	145	193

....continued

Table VI.7: Continued

Class	Year	Sales (thousands of 1981 dollars) <25	25-49	50-99	100-149	150-199	200 249	250+
				Census Division 15				
1	1971	29	57	77	-	-	-	-
1	1981	28	54	75	92	107	119	211
2	1971	24	41	61	72	-	-	-
2	1981	27	49	63	67	87	75	125
3	1971	26	44	55	74	-	-	-
3	1981	26	53	69	87	102	96	151
4	1971	24	41	53	64	78	-	112
4	1981	25	47	62	76	76	89	150
CD Agg.	1971	24	42	56	71	83	-	112
CD Agg.	1981	26	50	66	79	90	91	143

significant at the 95 percent confidence level in most cases.

For the census division aggregate functions, the slope of the functions increased but the intercept term has decreased over the decade. CD 10 is an exception in that the slope decreased while the intercept increased. Generally speaking, the increased slope indicates a more rapid increase in sales of larger farms than of smaller farms. The positive slope may be accounted for by the quality of land, managerial skills, levels of inputs or market opportunities available to larger operators.

The change in sales per acre between 1971 and 1981 at any particular sales volume is small compared to the provincial aggregate increase in sales per acre for all farms. For example, in CD 5, census division aggregate sales per acre increased 56 percent in the decade 1971 to 1981 (see Table V.17). The greatest increase within any sales class for the census division aggregate was only 31 percent. In CD's 10 and 15, a similar situation existed. The aggregate increase in sales per acre is not explained by increasing the general level of sales at any given farm size. A large portion of the aggregate increase in sales per acre can only be accounted for by movement of producers to more intensive cropping systems and larger operational units.

The significance of change for the CD aggregates between 1971 and 1981 in each of CD's 5, 10 and 15 was tested using Chow's procedure:

CD 5 $F =$[77] $\dfrac{[92 - (13 + 61)/2]}{(31 + 61)/(51 - 4)} = \dfrac{9.00}{1.57} = 5.73$

CD 10 $F = \dfrac{[87.6 - (15 + 48)/2]}{(15 + 48)/(52 - 4)} = \dfrac{12.3}{1.31} = 9.38$

CD 15 $F = \dfrac{[93 - (41 + 32)/2]}{(41 + 32)/(45 - 4)} = \dfrac{10.00}{1.78} = 5.61$

The Chow tests indicate these periods are significantly different at the 99 percent level of confidence. The difference between farming systems was not distinctive except in CD 5 (1981) where the continuous systems had a

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[77]The critical F value at the 95 percent confidence level is 3.23; at the 99 percent confidence level it is 5.18.

Figure VI.7: Sales per acre of improved land stratified by sales volume in CD 5, 1971.

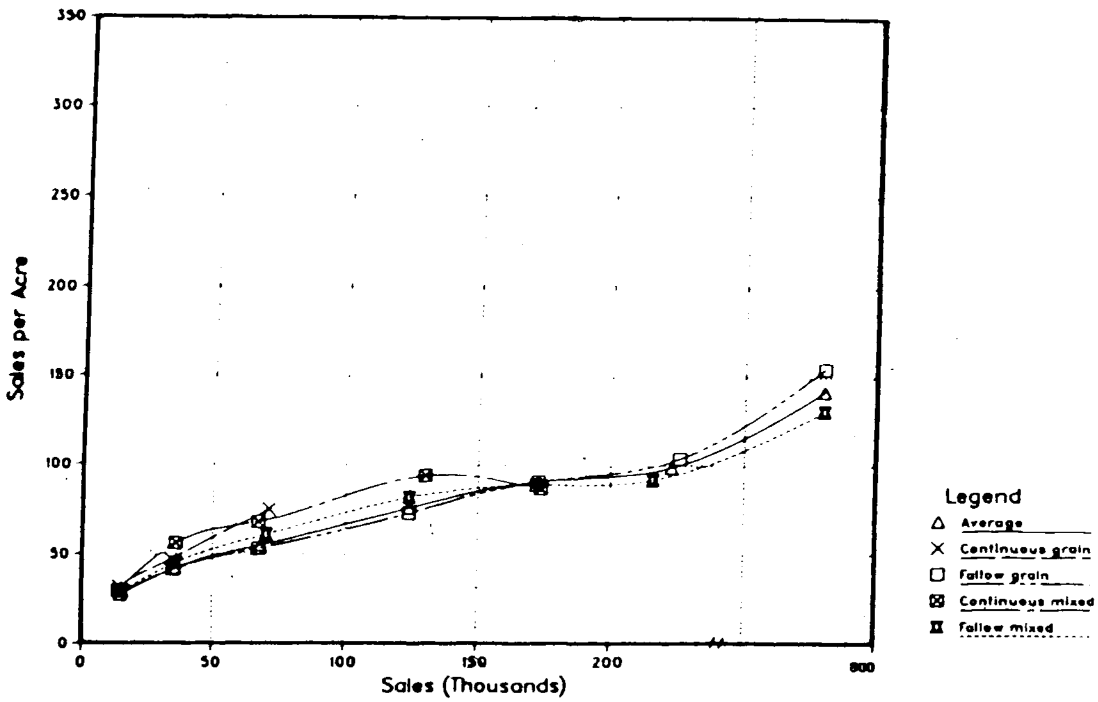

Figure VI.8: Sales per acre of improved land stratified by sales volume in CD 5, 1981.

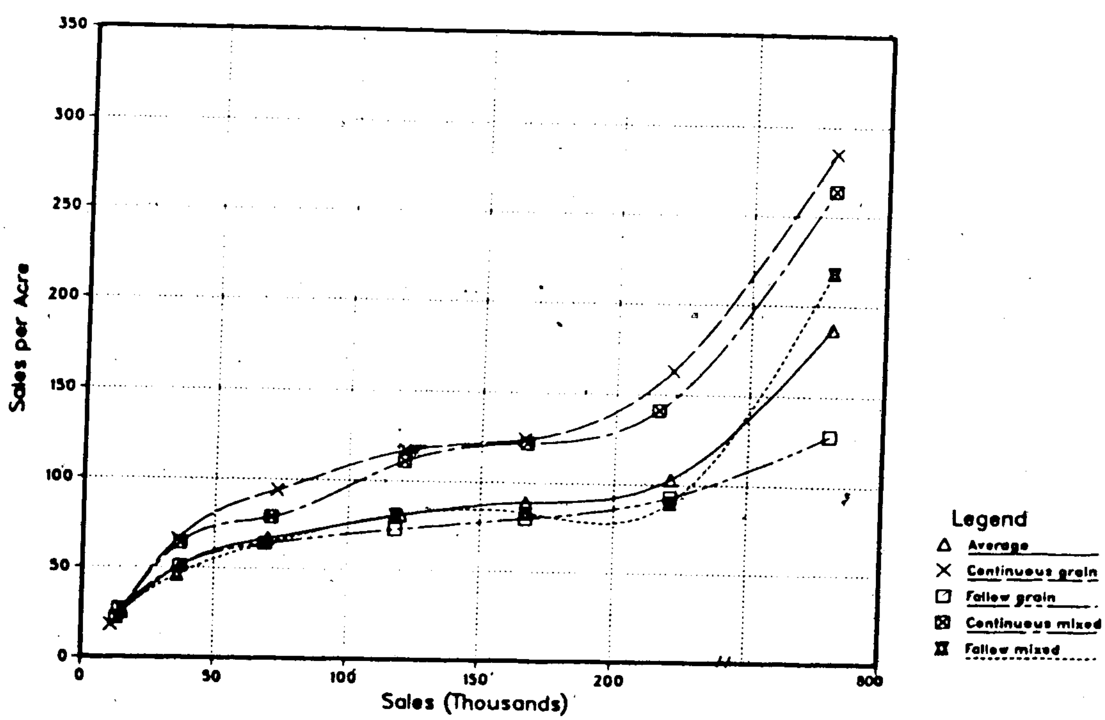

Figure VI.9: Sales per acre of improved land stratified by sales volume in CD 10, 1971.

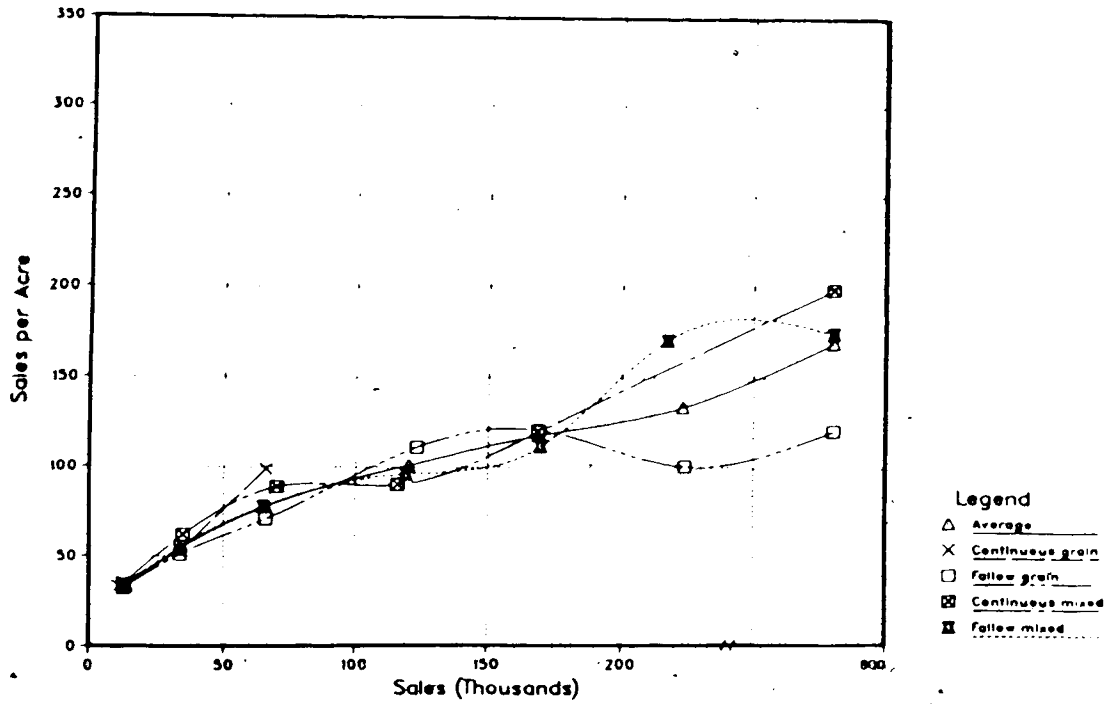

Figure VI.10: Sales per acre of improved land stratified by sales volume in CD 10, 1981.

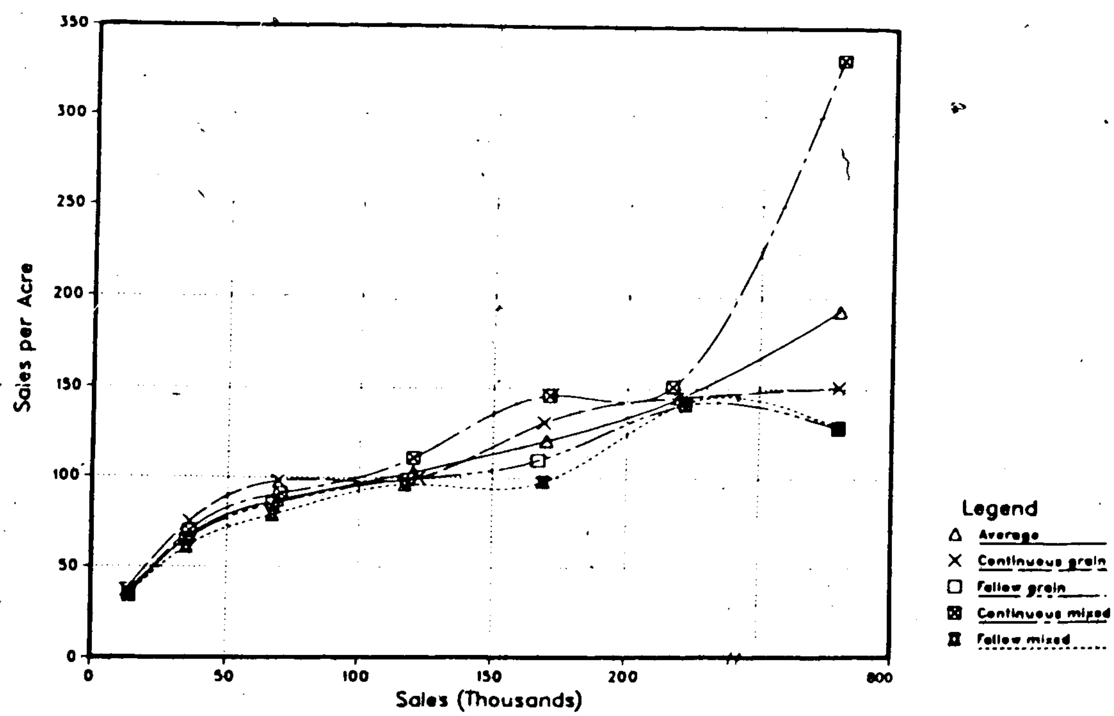

Figure VI.11: Sales per acre of improved land stratified by sales volume in CD 15, 1971.

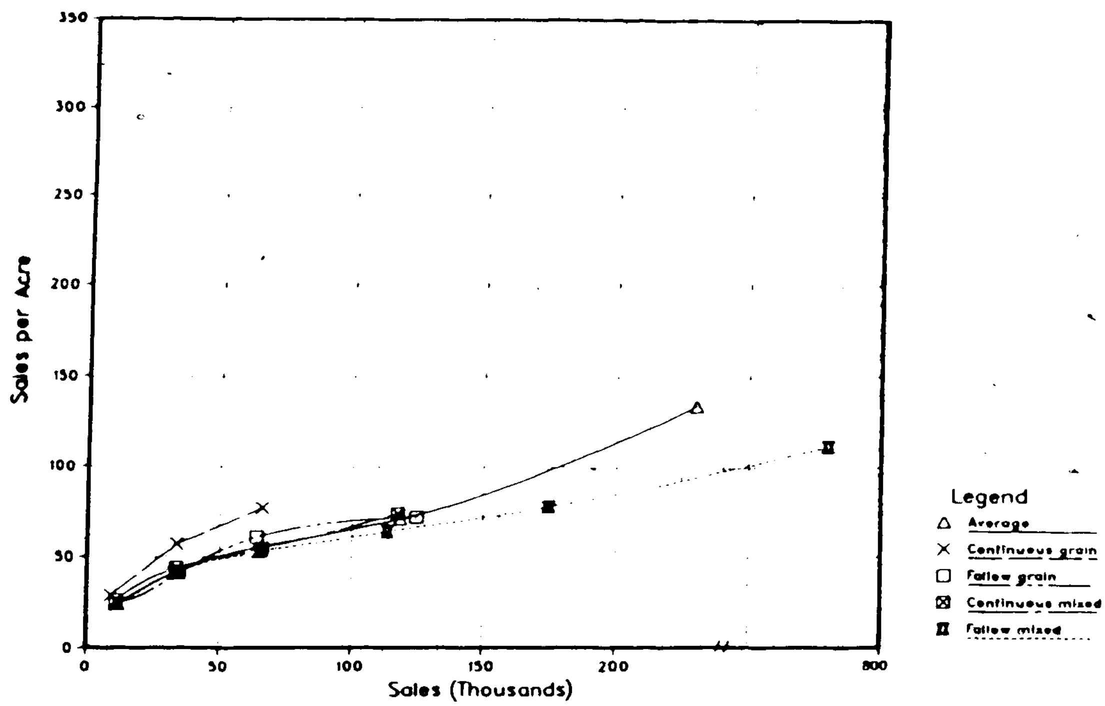

Figure VI.12: Sales per acre of improved land stratified by sales volume in CD 15, 1981.

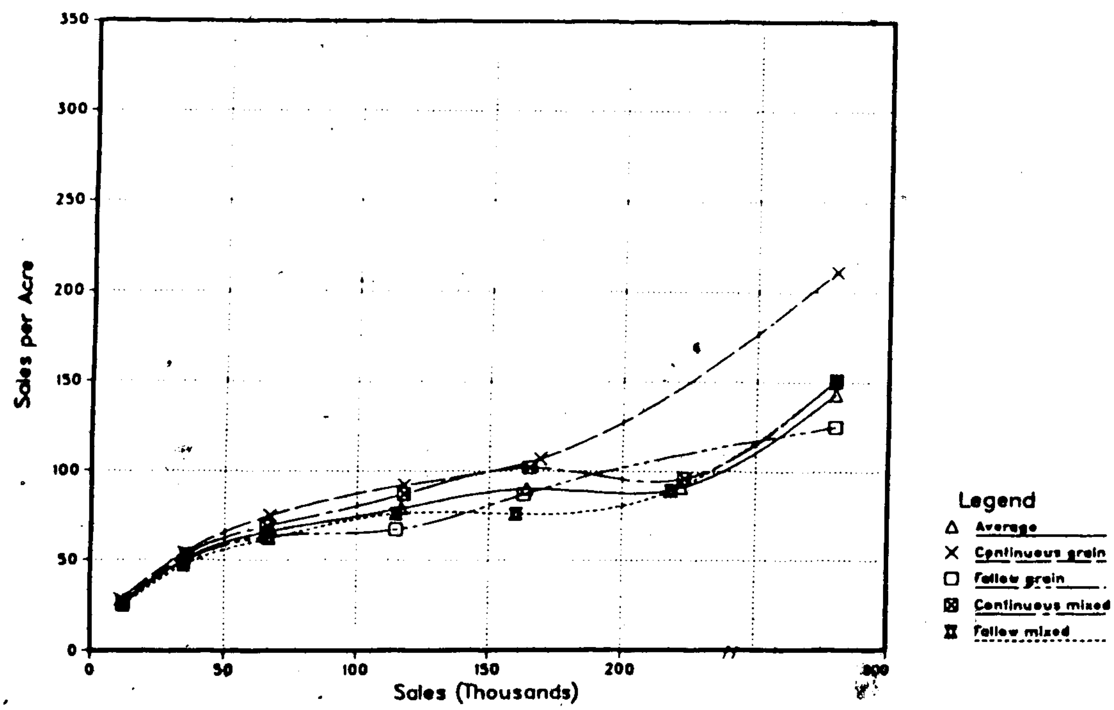

Table VI.8: Equations describing sales per acre related to farm sales for classes of commercial grain farms in CD 5 in 1971 and 1981.

Class	Form	Equation	R^2
		1971	
1	log linear	ln Y = -2.50 + 0.62 ln X (2)* (5)	92
2	log linear	ln Y = -1.30 + 0.477 ln X (9) (35)	[illegible]
3	2nd poly	Y = 14.2+.00115X-4.2 x $10^{[illegible]}X^2$ (2) (5) (3)	[illegible]
4	log linear	ln Y = -1.27 + 0.480 ln X (6) (26)	99
CD Agg.'	log linear	ln Y = -1.35 + 0.485 ln X (7) (26)	92
		1981	
1	log linear	ln Y = -2.79 + 0.641 ln X (3) (8)	94
2	linear	Y = 42.2 + .000719 X (7) (11)	82
3	linear	Y = 50.9 + .00037 X (7) (12)	96
4	log linear	ln Y = -1.75 + 0.528 ln X (-4) (14)	97
CD Agg.	log linear	ln Y = -1.68 + 0.525 ln X (4) (15)	90

*t-values are in parenthesis.
'The aggregate is estimated using the observations of the four farming systems. There are 28 observations in this regression normally (refer to Table VI.1 for missing cases).

Table VI.9: Equations describing sales per acre related to farm sales for classes of commercial grain farms in CD 10 in 1971 and 1981.

Class	Form	Equation	R^2
		1971	
1	linear	$Y = 17.2 + .00126\ X$ (6)* (13)	97
2	log linear	$\ln Y = -1.18 + 0.49 \ln X$ (6) (27)	99
3	linear	$Y = 35.8 + .000548\ X$ (6) (6)	88
4	log linear	$\ln Y = -1.20 + 0.544 \ln X$ (-9) (29)	99
CD Agg.'	log linear	$\ln Y = -1.53 + 0.528 \ln X$ (9) (32)	98
		1981	
1	linear	$Y = 56.6 + 0.000326$ (5) (3)	70
2	2nd poly	$Y = 31.5 + .000806 - 1.38 \times 10^{-9}\ X^2$ (5) (6) (4)	93
3	log linear	$\ln Y = -1.63 + 0.549 \ln X$ (4) (14)	98
4	log linear	$\ln Y = -0.767 + 0.478 \ln X$ (2) (10)	95
CD Agg.	log linear	$\ln Y = -1.14 + 0.500 \ln X$ (4) (21)	94

*t-values are in parenthesis.
'The aggregate is estimated using the observations of the four farming systems. There are 28 observations in this regression normally (refer to Table VI.1 for missing cases).

Table VI.10: Equations describing sales per acre related to farm sales for classes of commercial grain farms in CD 15 in 1971 and 1981.

Class	Form	Equation	R^2
		1971	
1	log linear	ln Y = -1.20 + 0.502 ln X (14)* (55)	100
2	log linear	ln Y = -1.31 + 0.482 ln X (6) (20)	100
3	log linear	ln Y = -1.62 + 0.458 ln X (5) (23)	100
4	log linear	ln Y = -1.48 + 0.495 ln X (7) (23)	99
CD Agg.'	log linear	ln Y = -1.01 + 0.452 ln X (3) (11)	90
		1981	
1	log linear	ln Y = -1.60 + 0.531 ln X (10) (34)	96
2	log linear	ln Y = -1.25 + 0.485 ln X (5) (4)	98
3	log linear	ln Y = -1.82 + 0.543 ln X (5) (10)	98
4	log linear	ln Y = -1.61 + 0.515 ln X (5) (16)	98
CD Agg.	log linear	ln Y = -1.34 + 0.515 ln X (8) (27)	95

*t-values are in parenthesis.
'The aggregate is estimated using the observations of the four farming systems. There are 28 observations in this regression normally (refer to Table VI.1 for missing cases).

much steeper slope than the fallow systems.

D. Economies of Size

Economies of size are a feature of mechanized production systems. The literature on agricultural systems in North America suggests economies of size increase rapidly at small and modest firm sizes, but diminish or disappear at large firm sizes. The evidence of worsening terms of trade reported by Veeman and Fantino[18] and the unequal reductions in labour use in different sales categories observed earlier suggests the unit cash cost curve has changed its position and perhaps its slope over time.

From the census it is possible to determine the cash cost per unit of sales.[19] These numbers are reported in Tables VI.11 to VI.13, representing CD's 5, 10 and 15 in 1971 and 1981 respectively. The data are graphed in Figures VI.13 to VI.18.

The curves graphed in Figures VI.13 to VI.18 indicate that a marked relationship between unit cash costs and sales does exist. The form of the relationship appears to be log linear. Unit cash costs decline sharply at small sales categories and level out as sales become greater. The L-shaped pattern, barely apparent in 1971, is well established in 1981.

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[18]Veeman, T.S. and Fantino, A., op. cit., p. 43.
[19]Cash costs include: Share and cash rent, wages paid, feed, seed, fertilizer, fuel, repair, electricity, chemicals and machinery rental. Note interest cost is not included as a cost.

Table VI.11: Cash costs as a proportion of sales for commercial grain producers in each sales category for the four classes and the census division aggregates (Agg.) in CD 5 in 1971 and 1981.

Class	Year	Sales (thousands of 1981 dollars)						
		<25	25-49	50-99	100-149	150-199	200-249	250+
1	1971	0.42	0.32	0.33	0.30	-		
1	1981	1.90	0.47	0.54	0.53	0.44	0.40	0.37
2	1971	0.40	0.29	0.27	0.27	0.25	0.24	0.27
2	1981	0.73	0.49	0.45	0.43	0.54	0.41	0.38
3	1971	0.56	0.35	0.27	0.23	0.28	-	-
3	1981	1.21	0.48	0.47	0.47	0.43	0.48	0.31
4	1971	0.39	0.29	0.26	0.28	0.31	0.32	0.22
4	1981	0.78	0.47	0.45	0.42	0.43	0.48	0.33
CD Agg.	1971	0.40	0.29	0.27	0.27	0.28	0.24	0.24
CD Agg.	1981	0.88	0.49	0.46	0.45	0.49	0.43	0.35

Table VI.12: Cash costs as a proportion of sales for commercial grain producers in each sales category for the four classes and the census division aggregates (Agg.) in CD 10 in 1971 and 1981.

Class	Year	Sales (thousands of 1981 dollars)						
		<25	25-49	50-99	100-149	150-199	200-249	250+
1	1971	0.43	0.32	0.24	-	-	-	-
1	1981	1.00	0.58	0.53	0.51	0.48	0.46	0.52
2	1971	0.37	0.28	0.28	0.26	0.21	0.28	0.24
2	1981	0.71	0.51	0.44	0.41	0.47	0.40	0.40
3	1971	0.40	0.27	0.23	0.27	0.23	-	0.23
3	1981	0.90	0.57	0.47	0.48	0.47	0.50	0.30
4	1971	0.36	0.27	0.24	0.20	0.19	0.11	0.18
4	1981	0.81	0.48	0.42	0.45	0.45	0.29	0.40
CD Agg.	1971	0.37	0.27	0.26	0.24	0.21	0.22	0.21
CD Agg.	1981	0.82	0.53	0.46	0.47	0.47	0.44	0.38

Table VI.13: Cash costs as a proportion of sales for commercial grain producers in each sales category for the four classes and the census division aggregates (Agg.) in CD 15 in 1971 and 1981.

Class	Year	Sales (thousands of 1981 dollars)						
		<25	25-49	50-99	100-149	150-199	200 249	250+
1	1971	0.42	0.30	0.28	-	-	-	-
1	1981	1.09	0.68	0.52	0.51	0.58	0.50	27
2	1971	0.39	0.30	0.29	0.32	-	-	-
2	1981	0.91	0.54	0.50	0.52	0.43	0.55	0.38
3	1971	0.38	0.30	0.34	0.31	-	-	-
3	1981	0.92	0.57	0.52	0.50	0.48	0.59	0.46
4	1971	0.39	0.28	0.28	0.25	0.25	-	0.28
4	1981	0.94	0.55	0.48	0.42	0.47	0.46	0.67
CD Agg.	1971	0.39	0.30	0.27	0.28	0.33	-	0.19
CD Agg.	1981	0.95	0.57	0.50	0.49	0.49	0.52	0.44

Several of the curves display an upturn of the unit cash costs at the largest sizes, particularly in 1971. In CD 5, classes 1 and 3 turn up and in CD 15 classes 2 and 3 turn up. The significance of these diseconomies of size can be tested by estimating the relationship using (WLS). Tables VI.11 to VI.13 report the equations that best represent the relationships graphed in Figures VI.13 to VI.18.

The statistical estimates of the cash cost curve indicate that the functional form that provides the best fit is log linear, indicating economies of size in most cases. Typically the cost per dollar of output dropped 8 to 10 cents between $25,000 and $100,000 in 1971 and 16 to 20 cents in 1981 (see Table VI.17). The correlation coefficients for these relationships were the lowest of the four structural variables tested. Even so, all the t-statistics exceeded 2.00 except for CD 5 (1971), classes 1 and 4. Census division aggregate correlation coefficients ranged from 0.75 to 0.89 in 1971 and from 0.55 to 0.86 in 1981.

The results of a Chow test comparing the 1971 and 1981 functions indicates significant change between 1971 and 1981. The calculations for census division aggregates are as follows:

$$\text{CD 5} \quad F = \frac{[502 - (76 + 25)/2]}{(76 + 25)/(51 - 4)} = \frac{200.5}{2.14} = 93$$

$$\text{CD 10} \quad F = \frac{[287 - (22 + 92)/2]}{(22 + 92)/(52 - 4)} = \frac{86.00}{2.37} = 36$$

$$\text{CD 15} \quad F = \frac{[1618 - (9 + 63)/2]}{(9 + 63)/(45 - 4)} = \frac{773.0}{1.75} = 441$$

The Chow test indicates a significant change between 1971 and 1981 for census division aggregates.

Between 1971 and 1981, the intercept and slope terms increased for census division aggregate functions in each census division. The cost per unit of output for all sales classes in a particular census division increased by a constant factor. The factor was not the same for all regions, increasing from south to north; in CD 5 it was 75 percent in CD 10 it was 100 percent and in CD 15 it was 120 percent. The effects of the cost price squeeze do not appear

Figure VI.13: Cash costs per dollar of sales stratified by sales volume in CD 5, 1971.

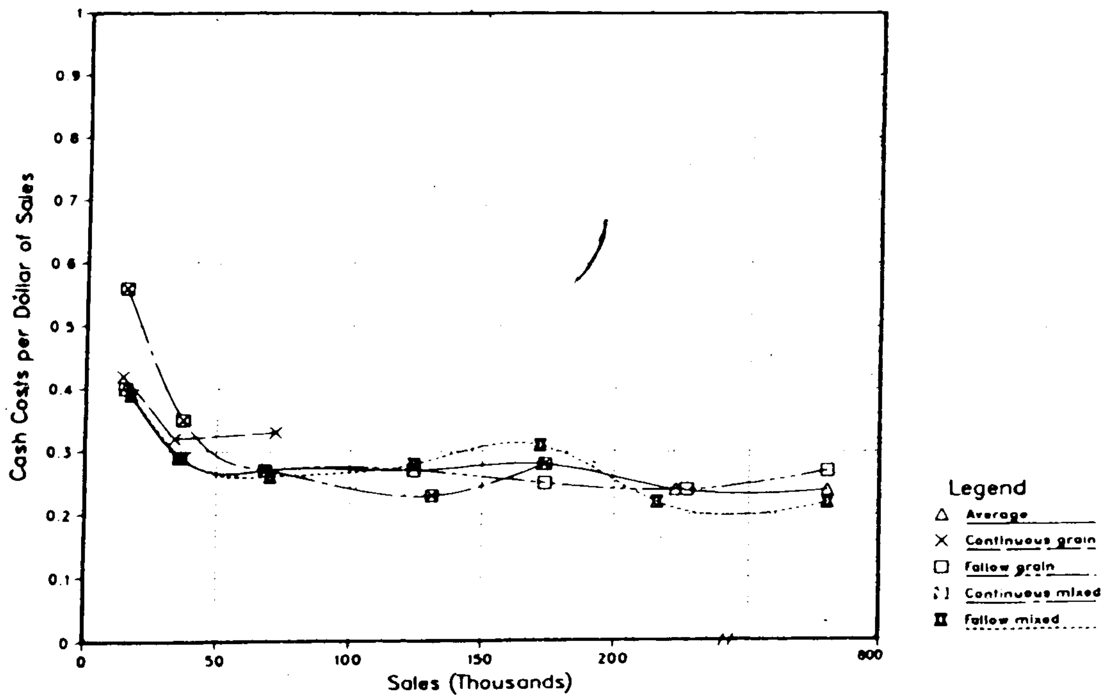

Figure VI.14: Cash costs per dollar of sales stratified by sales volume in CD 5, 1981.

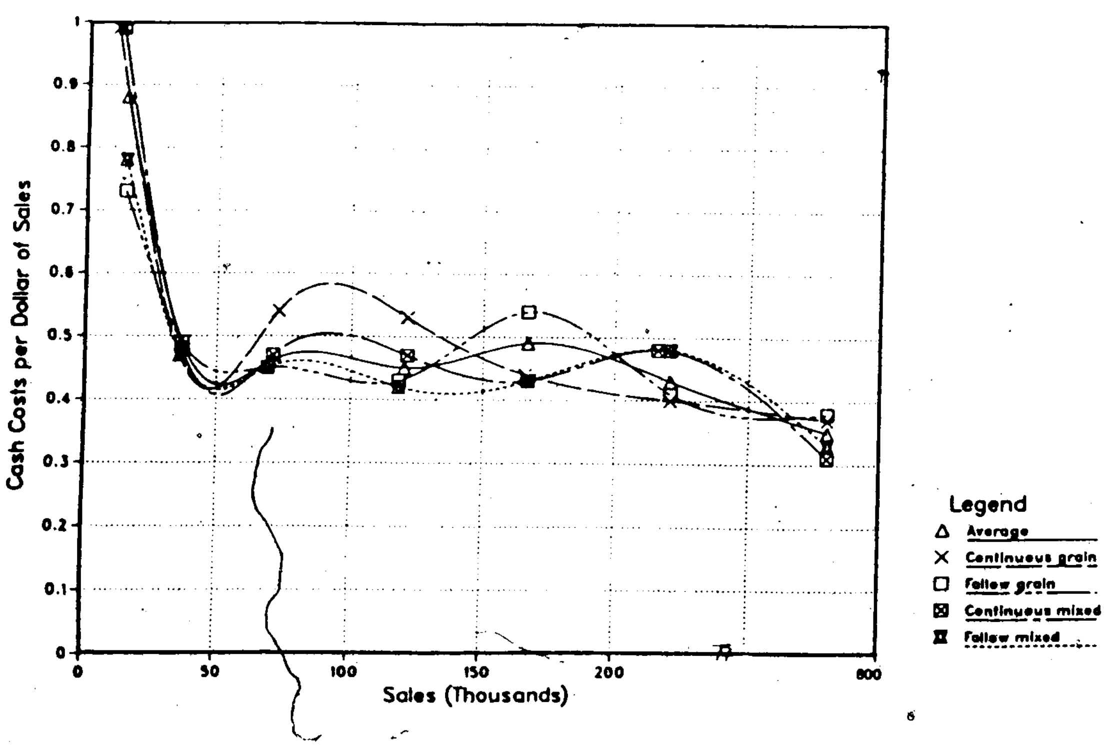

Figure VI.15: Cash costs per dollar of sales stratified by sales volume in CD 10, 1971.

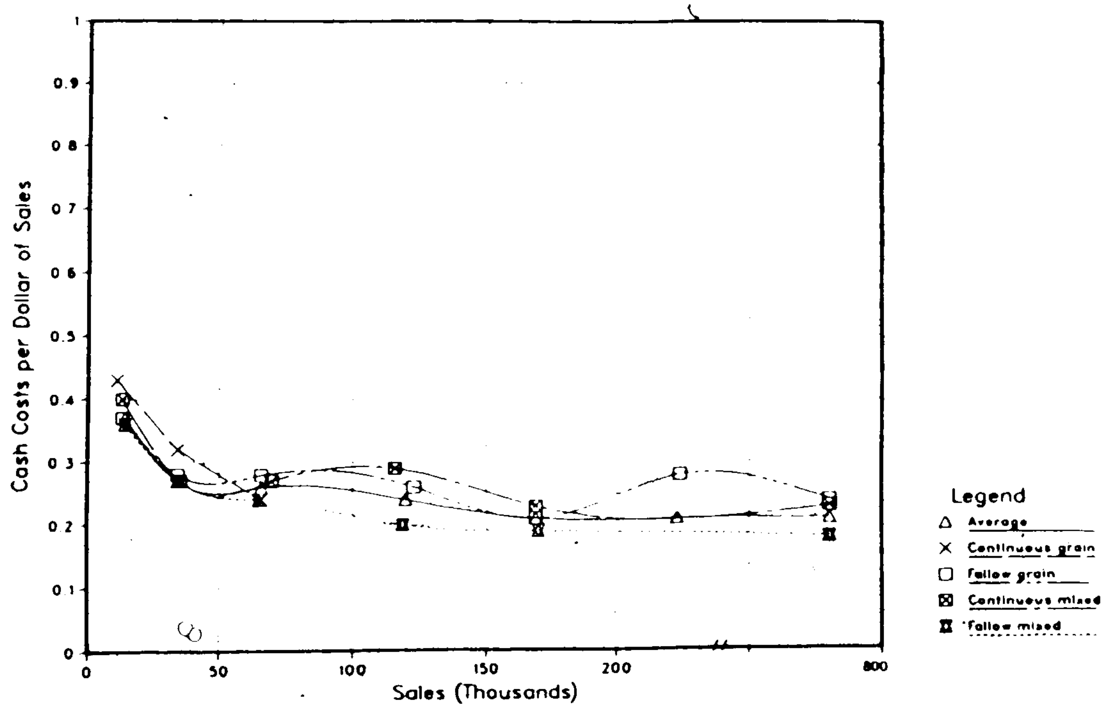

Figure VI.16: Cash costs per dollar of sales stratified by sales volume in CD 10, 1981.

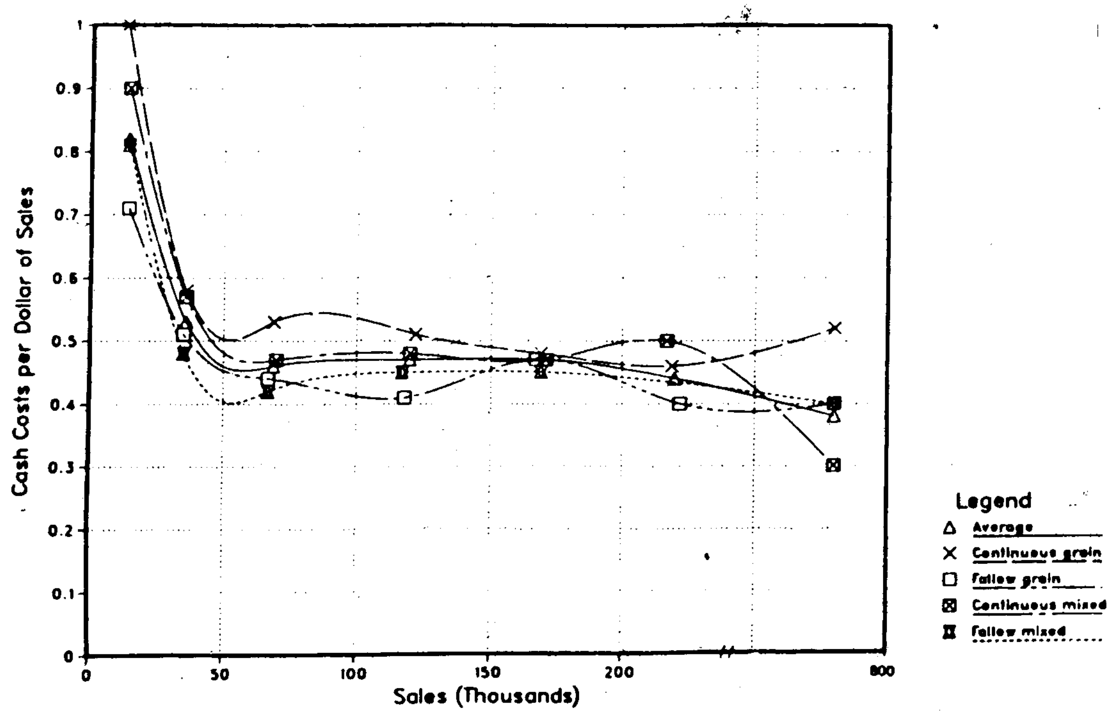

Figure VI.17: Cash costs per dollar of sales stratified by sales volume in CD 15, 1971.

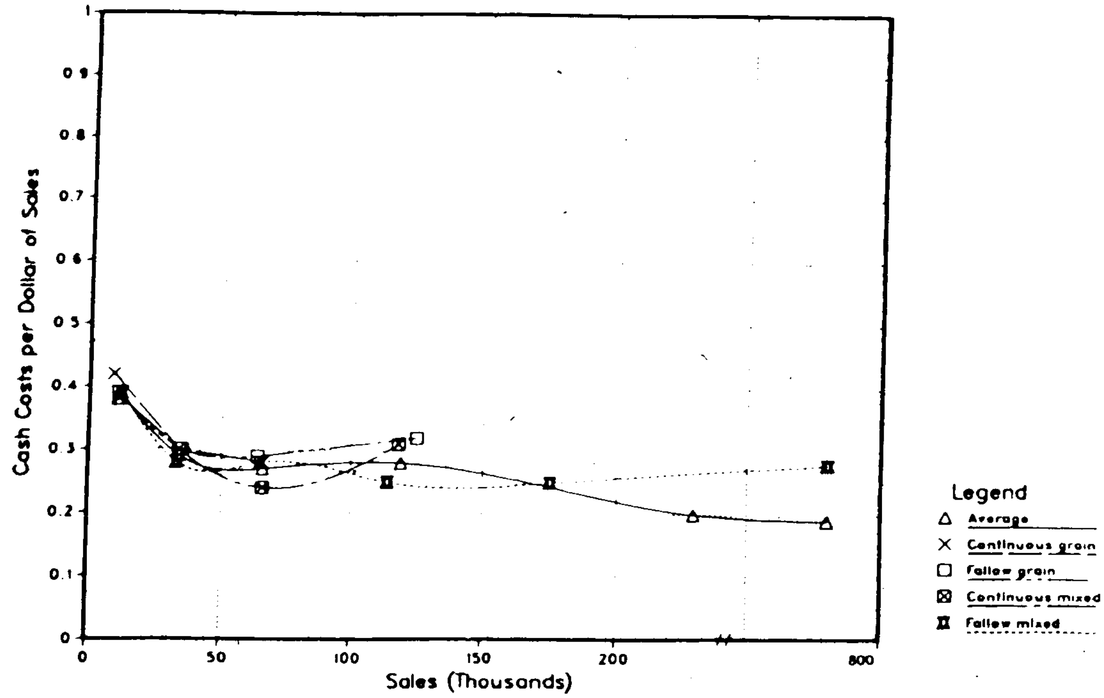

Figure VI.18: Cash costs per dollar of sales stratified by sales volume in CD 15, 1981.

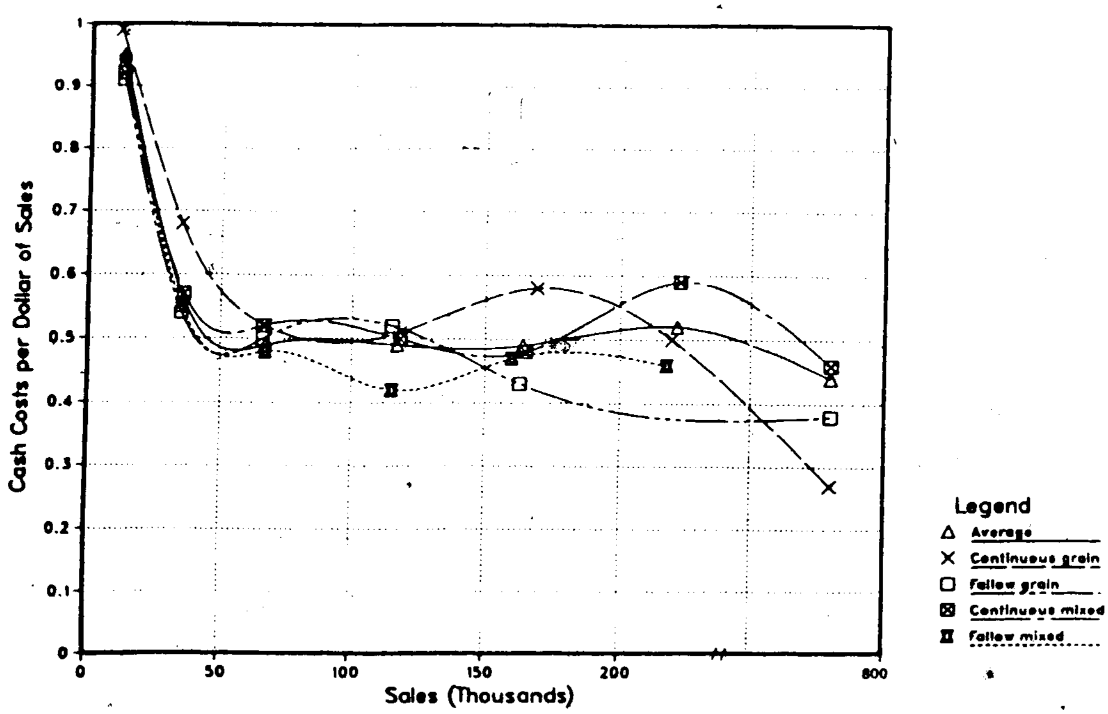

Table VI.14: Equations describing the relationship between the unit cash costs and volume of sales for the four commercial classes and the CD aggregates (Agg.) in CD 5 in 1971 and 1981.

Class	Form	Equation	R^2
		1971	
1	log linear	ln Y = 0.829 - 0.179 ln X (1)* (-3)	84
2	log linear	ln Y = 1.04 - 0.209 ln X (2) (4)	79
3	log linear	ln Y = 2.97 - 0.377 ln X (3) (5)	90
4	log linear	ln Y = 0.661 - 0.174 ln X (1) (4)	72
CD Agg.'	log linear	ln Y = 1.01 - 0.206 ln X (4) (8)	75
		1981	
1	log linear	ln Y = 3.52 - 0.207 ln X (21) (5)	66
2	log linear	ln Y = 1.26 - 0.180 ln X (2) (3)	67
3	log linear	ln Y = 2.30 - 0.266 ln X (2) (3)	68
4	log linear	ln Y = 1.56 - 0.208 ln X (2) (-4)	75
CD Agg.	log linear	ln Y = 1.68 - 0.215 ln X (4) (6)	55

*t-values are in parenthesis.
'The aggregate is estimated using the observations of the four farming systems. There are 28 observations in this regression normally (refer to Table VI.1 for missing cases).

Table VI.15: Equations describing the relationship between the unit cash costs and volume of sales for the four commercial classes and the CD aggregates in CD 10 in 1971 and 1981.

Class	Form	Equation	R^2
		1971	
1	log linear	ln Y = 1.87 - 0.292 ln X (6)* (9)	97
2	log linear	ln Y = 0.883 - 0.199 ln X (3) (6)	88
3	log linear	ln Y = 1.24 - 0.231 ln X (2) (4)	80
4	log linear	ln Y = 1.74 - 0.289 ln X (6.5) (11)	99
CD Agg.'	log linear	ln Y = 1.32 - 0.244 ln X (6) (12)	86
		1981	
1	log linear	ln Y = 2.28 - 0.255 ln X (3) (4)	74
2	log linear	ln Y = 1.97 - 0.243 ln X (4) (6)	82
3	log linear	ln Y = 2.38 - 0.273 ln X (4) (5)	83
4	log linear	ln Y = 2.78 - 0.323 ln X (3) (-4)	77
CD Agg.	log linear	ln Y = 2.11 - 0.253 ln X (6) (8)	70

*t-values are in parenthesis.
'The aggregate is estimated using the observations of the four farming systems. There are 28 observations in this regression normally (refer to Table VI.1 for missing cases).

Table VI.16: Equations describing the relationship between the unit cash costs and volume of sales for the four commercial classes and the CD aggregates in CD 15 in 1971 and 1981.

Class	Form	Equation	R^2
		1971	
1	log linear	$\ln Y = 1.28 - 0.236 \ln X$ (5) (9)	96
2	2nd poly	$Y = 0.439 - .000005X + 3.36 \times 10^{[illegible]} X^{2}$ (30) (4) (3)	99
3	log linear	$\ln Y = 1.03 - 0.214 \ln X$ (3) (5)	90
4	log linear	$\ln Y = 1.38 - 0.247 \ln X$ (3) (5)	88
CD Agg.'	log linear	$\ln Y = 1.16 - 0.226 \ln X$ (6) (12)	89
		1981	
1	log linear	$\ln Y = 3.44 - 0.362 \ln X$ (11) (10)	97
2	log linear	$\ln Y = 3.10 - 0.343 \ln X$ (6) (6)	98
3	log linear	$\ln Y = 2.55 - 0.286 \ln X$ (5) (6)	86
4	log linear	$\ln Y = 3.24 - 0.355 \ln X$ (5) (6)	90
CD Agg.	log linear	$\ln Y = 3.04 - 0.332 \ln X$ (11) (13)	86

*t-values are in parenthesis.
'The aggregate is estimated using the observations of the four farming systems. There are 28 observations in this regression normally (refer to Table VI.1 for missing cases).

Table VI.17: Unit cash costs per dollar of sales for census division aggregates as estimated from equations for CD's 5, 10 and 15 for various sales levels in 1971 and 1981 and the relative and absolute change in cost per dollar of sales.

	Sales (thousands of 1981 dollars)				
Year	13	25	50	100	500
	Census Division 5				
	$	$	$	$	$
1971	0.39	0.34	0.30	0.26	0.18
1981	0.69	0.61	0.52	0.45	0.32
relative chg.	1.76	1.71	1.76	1.76	1.63
absolute chg.	0.30	0.27	0.22	0.19	0.14
	Census Division 10				
	$	$	$	$	$
1971	0.37	0.33	0.27	0.23	0.15
1981	0.75	0.63	0.53	0.45	0.30
relative chg.	2.02	1.98	2.00	1.98	2.00
absolute chg.	0.38	0.31	0.21	0.22	0.15
	Census Division 15				
	$	$	$	$	$
1971	0.38	0.32	0.28	0.24	0.16
1981	0.90	0.72	0.58	0.46	0.27
relative chg.	2.40	2.25	2.08	1.93	1.62
absolute chg.	0.52	0.40	0.30	0.22	0.11

to have been equal in all regions of the province.

The effect of a proportionate increase in cost per dollar of sales is not scale neutral. Table VI.17 gives examples of the relative and absolute changes in cost per unit of sales between 1971 and 1981. In absolute terms the increase in cost for small producers with less than $25,000 sales was between 30¢ and 40¢ compared with 15¢ and 20¢ for producers with sales of $150,000. Though the producers are in the same relative positions, i.e., it costs twice as much for the small producer to generate a dollar of sales in both years, the absolute difference between costs per dollar of sales for small and large producers has doubled.

Between farming systems it can be noted that the continuous grain system (class 1) had a higher intercept and steeper slope than the fallow grain system (class 2) in CD's 5, 10 and 15 in 1981. The continuous mixed system (class 3) had lower intercept and slope than the fallow mixed system (class 4) in CD's 10 and 15. At smaller sizes, the continuous grain systems operated at cost disadvantage to fallow grain systems. This was generally not the case for continuous mixed systems.

There are some regional differences in the 1981 cash cost function. The CD aggregate curve has the lowest intercept term in CD 5 and the highest intercept in CD 15. The slope of the function increases correspondingly. This suggests the Peace region has the greatest economies of size. As noted earlier, small sizes are dominant in the Peace region. In CD 5 (1981), 38 percent of farms had sales below $50,000; in CD 15, 75 percent of farms had sales below $50,000.

The implication of economies of size is a tendency for farm sizes to increase and efficiency to improve with size expansion. Since there is no upturn of the cash cost curve within the observed range of sales in 1981, no maximum farm size is suggested. A continued cost price squeeze will encourage expansion to gain greater economies of size. Smaller producers in many cases are already non-viable organizations. If the process of cost increase continues, the conditions for this group can be expected to deteriorate.

E. Gross Margins per Acre

Gross margins are calculated as sales less average variable costs. The combined influence of higher sales per acre and lower unit cash costs at larger sizes should cause the relationship between gross margins and sales volume to be positive. The large magnitude in the shift of cost relative to the small shift in sales per acre is anticipated to have had negative effects on margins for farms of all sizes and in all farming systems. The margins per acre are reported in Table VI.18 and Figures VI.19 to VI.24.

The table and figures indicate that a general decline in gross margins per acre occurred over the past decade for most classes and sizes and in all regions. The greatest decline in margins was in the under $25,000 sales category of farm where they declined by 50 percent or about $10-$15 per acre. The $25,000-$99,000 sales group showed only slight declines in margins per acre in the range of 15 to 20 percent or $3-$10 per acre. Between $100,000 and $199,000, the decline in margin ranged from 20-30 percent or $10-$30 per acre. Above $250,000 some CD aggregates showed increased

Table VI.18: Gross margin in dollars per acre for commercial grain producers in each sales category for the four classes and the census division aggregates (Agg.) in CD's 5, 10 and 15 in 1971 and 1981.

Class	Year	Sales (thousands of 1981 dollars) <25	25-49	50-99	100-149	150-199	200-249	250+
Census Division 5								
1	1971	18	32	50	112	-	-	
1	1981	-17	35	43	55	70	98	180
2	1971	16	29	39	53	68	79	113
2	1981	7	26	36	42	37	55	79
3	1971	13	36	50	72	63	-	-
3	1981	-5	33	42	58	70	74	182
4	1971	18	32	45	59	61	71	103
4	1981	6	24	35	47	47	44	123
CD Agg.	1971	18	30	41	56	66	81	104
CD Agg.	1981	7	28	38	46	46	60	123
Census Division 10								
1	1971	19	36	75	134	-	-	-
1	1981	3	32	46	49	68	78	73
2	1971	28	37	51	82	95	72	92
2	1981	11	32	48	58	59	85	77
3	1971	21	45	65	65	92	-	153
3	1981	3	28	46	56	73	73	222
4	1971	22	40	59	77	91	152	144
4	1981	7	32	46	53	54	100	80
CD Agg.	1971	22	39	57	77	93	105	135
CD Agg.	1981	10	34	49	57	65	82	122

....continued

Table VI.18: Continued

Class	Year	Sales (thousands of 1981 dollars) <25	25-49	50-99	100-149	150-199	200 249	250+
		Census Division 15						
1	1971	17	40	55	-	-	-	-
1	1981	-3	17	36	45	45	68	154
2	1971	15	29	43	50	-	-	-
2	1981	3	23	32	32	50	34	77
3	1971	16	31	42	51	-	-	-
3	1981	2	22	33	43	52	39	76
4	1971	15	30	38	48	58	-	81
4	1981	2	21	32	44	38	48	41
CD Agg.	1971	16	30	41	51	56		-
CD Agg.	1981	3	23	35	41	48	44	82

margin. The different rates of change reinforced the pattern of consistently higher margins for higher sales volumes.

The equations describing the relationship between margins and value of sales are given in Tables VI.19 to VI.21. The best fitting form is generally log linear. In no circumstances does the function have a negative slope. The coefficient of determination is high, in most cases above 0.90. The t-values exceed 2 in all cases except that of continuous grain in CD 10 (1981). Over time, the intercepts of all functions have declined and the slopes have increased in CD's 5, 10 and 15.

The significance of change in the CD aggregate gross margin per acre function between 1971 and 1981 was tested using the Chow test. The results are as follows:

$$\text{CD 5} \quad F = \frac{[46 - (3 + 28)/2]}{(3 + 28)/(51 - 4)} = \frac{7.50}{0.65} = 11$$

$$\text{CD 10} \quad F = \frac{[86 - (5 + 22)/2]}{(5 + 22)/(52 - 4)} = \frac{29.5}{0.56} = 52$$

$$\text{CD 15} \quad F = \frac{[118 - (3 + 10)/2]}{(3 + 10)/(45 - 4)} = \frac{52.50}{0.317} = 166$$

The change in the slope and intercept of the census division total gross margin curves was significant at the 99 percent confidence level.

The reduced intercept and increased slope of CD aggregate gross margin equations indicate that only those producers with very high volumes obtained margins per acre in 1981 equal to or greater than 1971 values. The CD aggregate sales volumes with equal per acre margins in 1971 and 1981 were $290,000 in CD 5 and $219,000 in CD 15. In CD 10 the curves did not converge in the observed range. Only in the top sales group did sales per acre increase sufficiently to compensate for higher costs.

The indications from the equation describing gross margin are that the continuous classes have lower intercept terms and steeper slopes than their fallow counterparts. The lower intercept of continuous systems suggests that small volume continuous producers experience a margin disadvantage relative to small fallow producers. To determine if there were economic benefits from intensification at small farm sizes, a simple single equation model was developed for 1981. Equations relating volume of sales to improved area,

Figure VI.19: Gross margin in dollars per acre of improved land stratified by sales volume in CD 5, 1971.

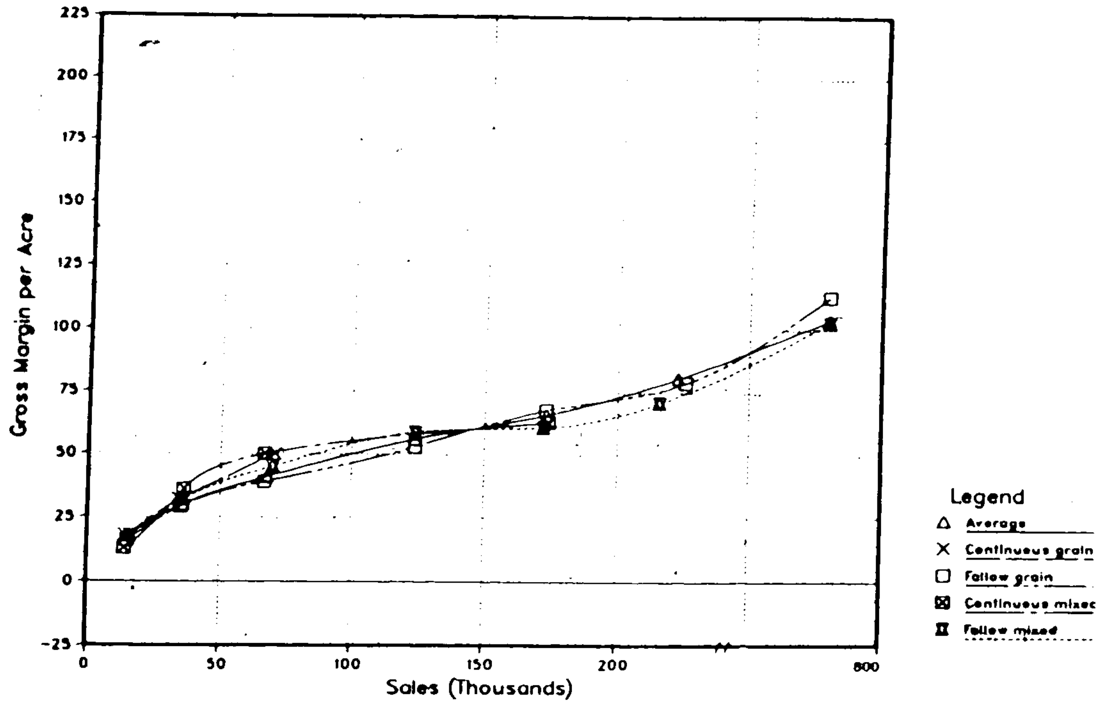

Figure VI.20: Gross margin in dollars per acre of improved land stratified by sales volume in CD 5, 1981.

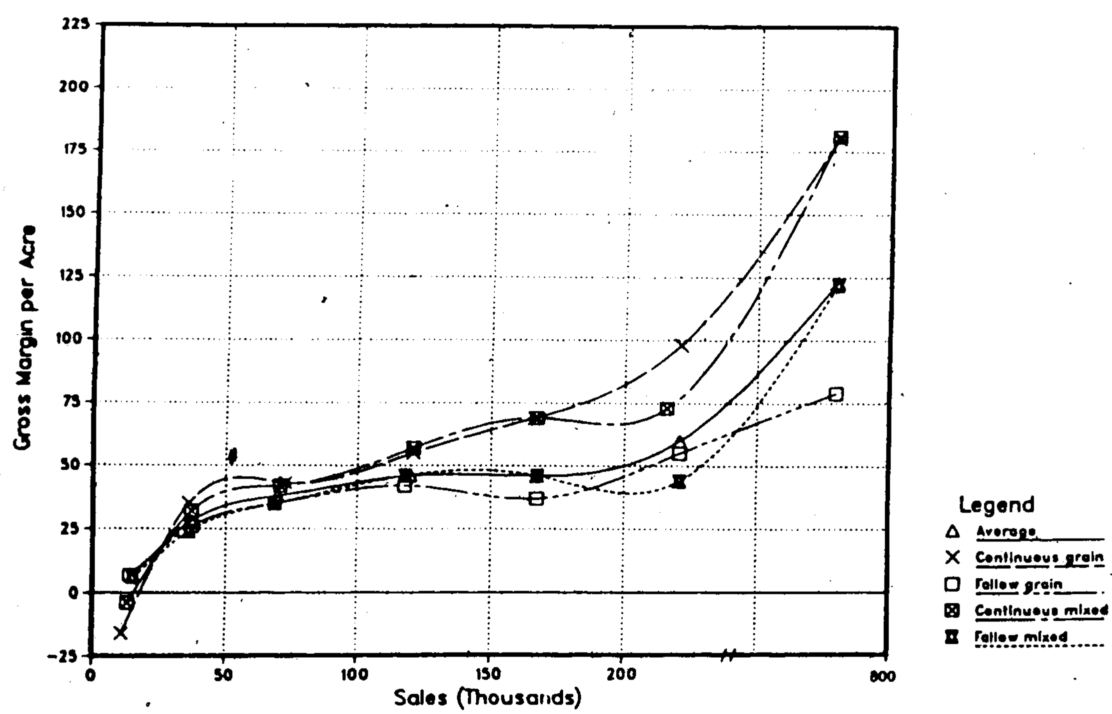

Figure VI.21: Gross margin in dollars per acre of improved land stratified by sales volume in CD 10, 1971.

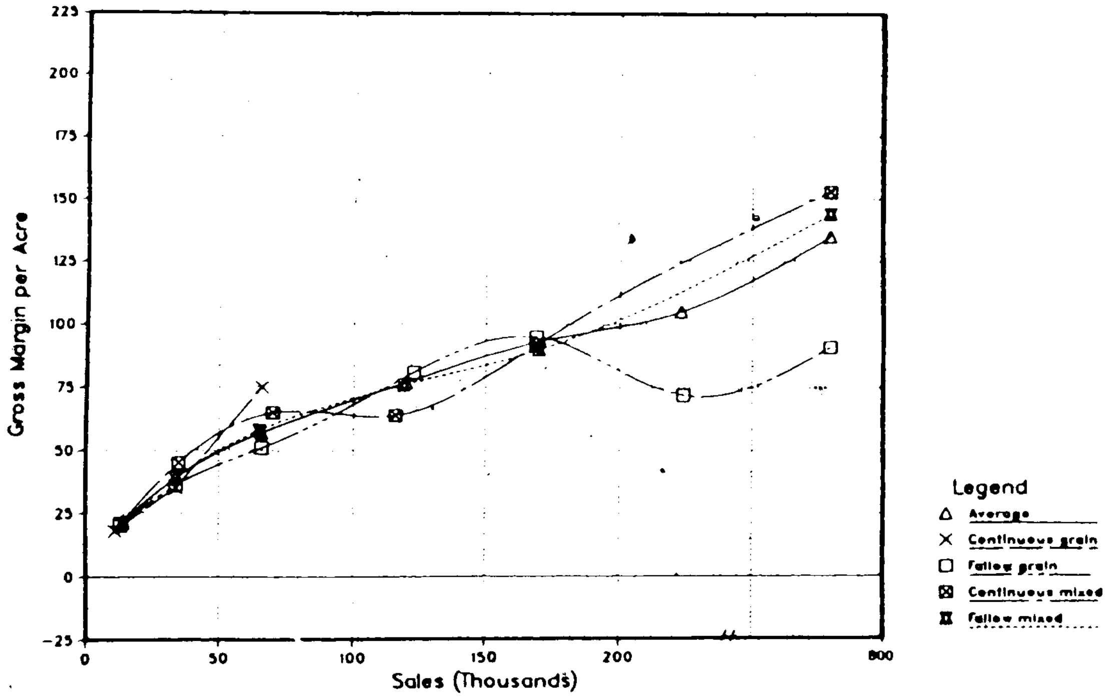

Figure VI.22: Gross margin in dollars per acre of improved land stratified by sales volume in CD 10, 1981.

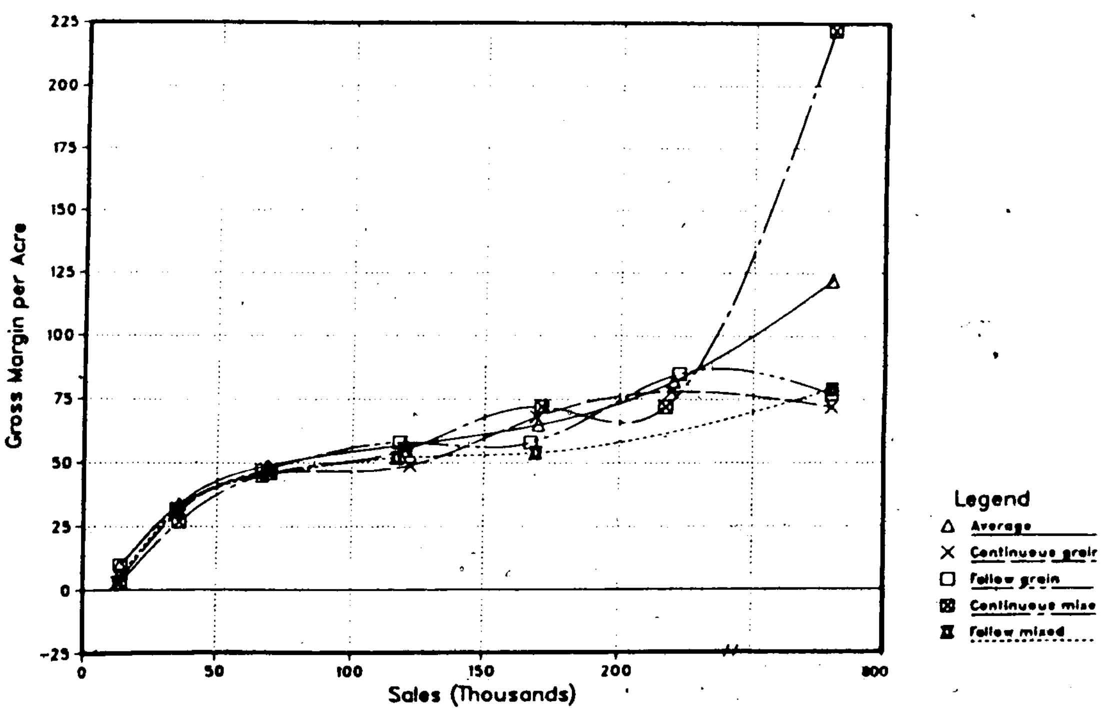

Figure VI.23: Gross margin in dollars per acre of improved land stratified by sales volume in CD 15, 1971.

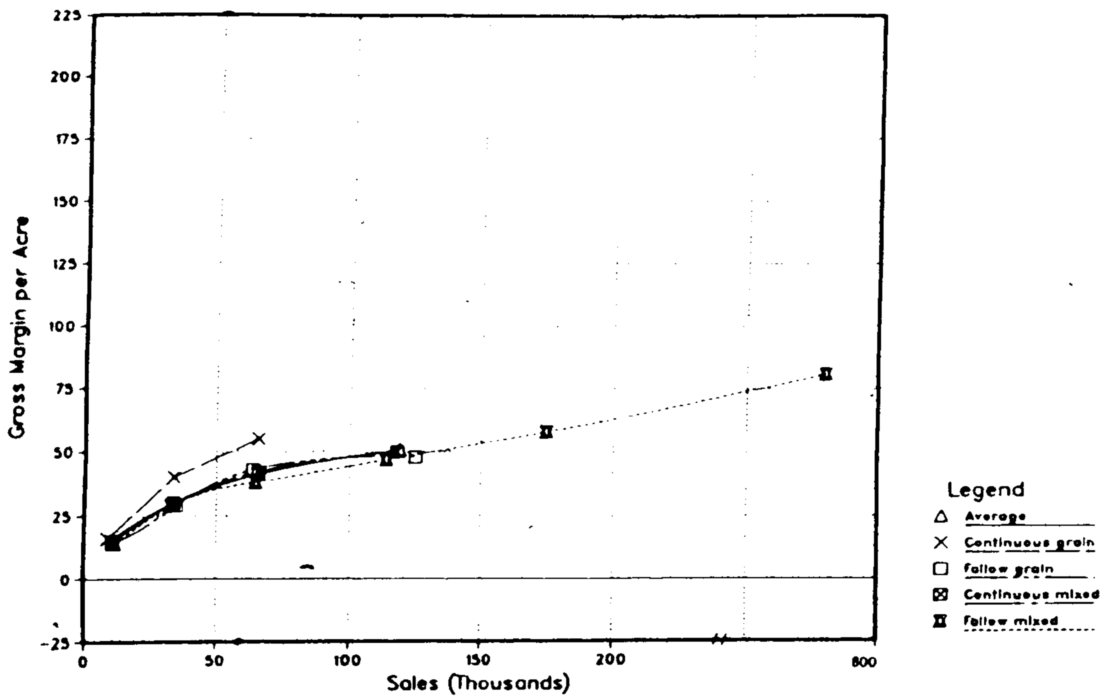

Figure VI.24: Gross margin in dollars per acre of improved land stratified by sales volume in CD 15, 1981.

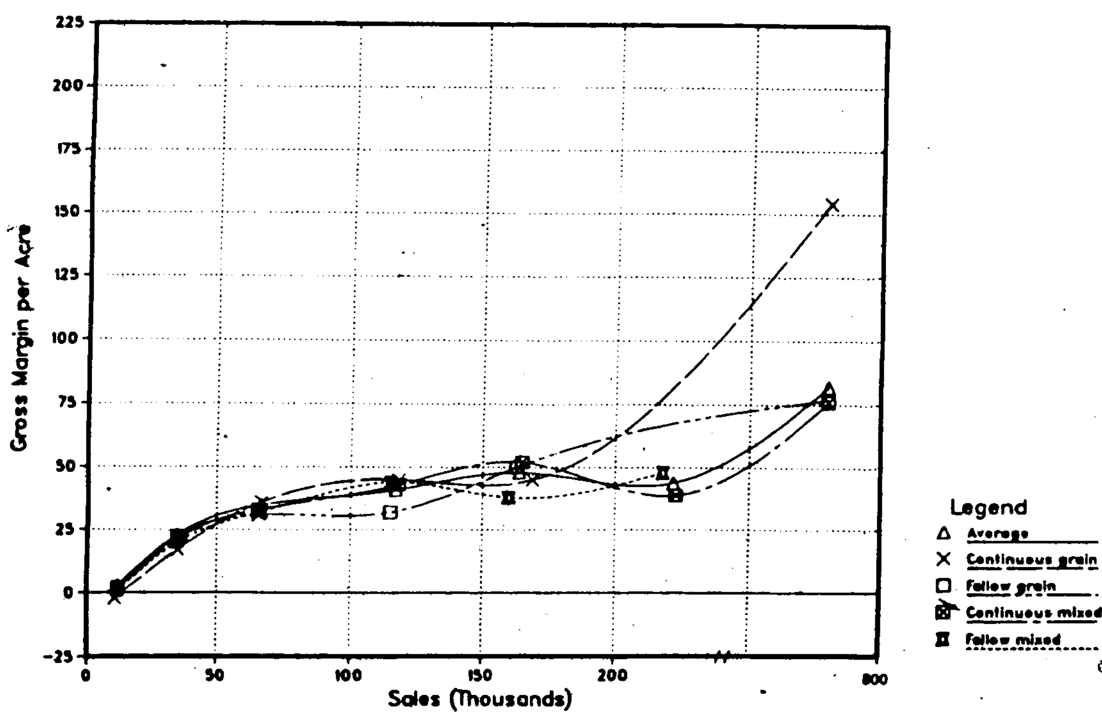

Table VI.19: Equations describing the relationship between gross margin in dollars per acre for commercial grain producers in each sales category for the four classes and the CD aggregates (Agg.) in CD 5 in 1971 and 1981.[1]

Class	Form	Equation	R^2
1971			
1	linear	Y = 54.6 + .000817 X (12)* (8)	94
2	log linear	ln Y = 2.04 + 0.222 ln X (15) (17)	99
3	log linear	ln Y = 1.55 + 2.74 ln X (4) (8)	95
4	log linear	ln Y = 1.97 + 0.236 ln X (21) (28)	99
CD Agg.[2]	log linear	ln Y = 1.96 + 0.231 ln X (21) (26)	96
1981			
1	log linear	ln Y = 69.1 + .000220 X (6) (6)	94
2	log linear	ln Y = 2.04 + 0.215 ln X (7) (8)	94
3	log linear	ln Y = 68.9 + .000278 ln X (13) (12)	97
4	log linear	ln Y = 1.45 + 0.268 ln X (4) (9)	94
CD Agg.	log linear	ln Y = 1.23 + 0.289 ln X (5) (12)	85

*t-values are in parenthesis.
[1]$50 was added to gross margin per acre to eliminate negative values for estimation purposes.
[2]The aggregate is estimated using the observations of the four farming systems. There are 28 observations in this regression normally (refer to Table VI.1 for missing cases).

Table VI.20: Equations describing the relationship between gross margin in dollars per acre for commercial grain producers in each sales category for the four classes and the CD aggregates (Agg.) in CD 10 in 1971 and 1981.

Class	Form	Equation	R^2
		1971	
1	linear	$Y = 56.2 + .00104\ X$ (31)* (17)	98
2	log linear	$\ln Y = 2.04 + 0.233 \ln X$ (16) (18)	98
3	log linear	$Y = 1.41 + 0.299\ X \ln X$ (6) (13)	97
4	log linear	$\ln Y = 1.53 + 2.85 \ln X$ (14) (26)	99
CD Agg.[1]	log linear	$\ln Y = 1.71 + 0.267 \ln X$ (17) (27)	97
		1981	
1	log linear	$\ln Y = 1.10 + 0.305 \ln X$ (2) (7)	90
2	log linear	$\ln Y = 1.53 + 0.272 \ln X$ (6) (12)	96
3	linear linear	$Y = 68.4 + .000254\ X$ (12) (7)	98
4	log linear	$\ln Y = 1.20 + 0.300 \ln X$ (3) (8)	93
CD Agg.	log linear	$\ln Y = 1.18 + 0.302 \ln X$ (7) (19)	93

*t-values are in parenthesis.
[1]The aggregate is estimated using the observations of the four farming systems. There are 28 observations in this regression normally (refer to Table VI.1 for missing cases).

Table VI.21: Equations describing the relationship between gross margin in dollars per acre for commercial grain producers in each sales category for the four classes and the CD aggregates (Agg.) in CD 15 in 1971 and 1981.

Class	Form	Equation	R^2
		1971	
1	log linear	$\ln Y = 2.12 + 0.228 \ln X$ (100)* (100)	99
2	log linear	$\ln Y = 2.49 + 1.81 \ln X$ (21) (15)	98
3	log linear	$\ln Y = 2.45 + 1.85 \ln X$ (106) (77)	100
4	log linear	$\ln Y = 2.34 + 0.195 \ln X$ (47) (38)	99
CD Agg.'	log linear	$\ln Y = 2.48 + 1.81 \ln X$ (23) (16)	95
		1981	
1	log linear	$\ln Y = 0.902 + 0.317 \ln X$ (4) (17)	98
2	log linear	$\ln Y = 1.55 + 0.257 \ln X$ (7) (12)	96
3	log linear	$\ln Y = 1.51 + 0.261 \ln X$ (9) (17)	95
4	log linear	$\ln Y = 1.52 + 0.259 \ln X$ (6) (11)	95
CD Agg.	log linear	$\ln Y = 1.41 + 0.270 \ln X$ (13) (26)	96

*t-values are in parenthesis.
'The aggregate is estimated using the observations of the four farming systems. There are 28 observations in this regression normally (refer to Table VI.1 for missing cases).

and to gross margin per acre, were estimated for each farming system in CD's 5, 10 and 15, using WLS. It is possible to predict the sales and margin per acre and total margin of farms with 500 and 1,500 acres using inverse regression.•° In CD 5, 700 acres was used because 500 acres was below the observed range of acreage. The results are given in Table VI.22.

The results indicate that for farms with small improved acreage bases (below 700 acres), the continuous grain class had sales of $5,000 to $10,000 more than similar sized fallow grain farms in 1981. The higher costs of production for continuous producers which were reflected in the low intercept of the gross margin function ensures that the difference in margin is much smaller than the difference in sales. Generally speaking, the margins per farm are nearly indentical. The added risk exposure makes the continuous grain option non-viable for small producers in all regions of the province. This may help explain why intensification is progressing very slowly in the north. For the continuous and fallow mixed systems, the results are different. In CD's 10 and 15, the sales of the two mixed systems are nearly identical, yet the continuous mixed system generates higher total gross margins in all census divisions.

In the 1,500 acre size range, the sales of continuous grain systems exceeded those for fallow grain systems by a minimum of $28,000. In CD 5, this translates into a $70,000

••See Chapter VII.

Table VI.22: A comparison of sales per acre, gross margin per acre and total gross margin per farm (in dollars) for farms of 500, 700 and 1,500 acres using the four cropping systems in CD's 5, 10 and 15, 1981.

CD	Class	Area (Acres)	Sales Per Farm	Gross Margin Per Acre	Total Gross Margin Per Farm
Small Farms (500-700 acres)					
CD 5	1	700	33,453	26.4	18,521
CD 5	2	700	22,714	24.1	16,867
CD 5	3	700	35,774	28.8	20,191
CD 5	4	700	26,417	15.2	10,697
CD 10	1	500	34,166	22.5	11,250
CD 10	2	500	29,142	25.0	12,826
CD 10	3	500	23,250	24.3	12,150
CD 10	4	500	22,959	17.5	8,778
CD 15	1	500	19,176	6.8	3,400
CD 15	2	500	15,319	6.1	3,035
CD 15	3	500	14,942	5.6	2,815
CD 15	4	500	13,009	3.1	1,588
Large Farms (1,500 acres and up)					
CD 5	1	1,500	321,250	89.7	134,656
CD 5	2	1,500	137,000	47.8	71,694
CD 5	3	1,500	247,543	87.7	131,575
CD 5	4	1,500	121,000	48.1	72,232
CD 10	1	1,500	200,835	74.4	112,000
CD 10	2	1,500	172,000	72.6	108,000
CD 10	3	1,500	260,046	84.4	126,660
CD 10	4	1,500	189,196	77.0	115,626
CD 15	1	1,500	204,000	68.0	103,000
CD 15	2	1,500	133,000	59.0	88,500
CD 15	3	1,500	169,824	54.9	82,406
CD 15	4	1,500	125,316	45.6	68,417

advantage in margin followed by CD 15 at $15,000 and CD 10 at only $4,000. The volume of sales advantage at 1,500 acres for continuous mixed producers over fallow producers was in the range of $40,000 to $100,000. This translated into a margin advantage of $60,000 in CD 5, $14,000 in CD 15 and only $10,000 in CD 10. At large sizes, the continuous systems have a consistent advantage over the fallow systems in terms of margin. The advantage in margin is relatively small compared to sales volume increases, indicating higher costs associated with intensive cropping. At small farm sizes, there is no advantage to intensification in grain systems, but obvious advantages in mixed systems. CD 5 displayed the greatest advantage from intensification and CD 10 displayed the smallest.

The values of margins per acre for all farming systems and at most sizes declined over the decade, yet the provincial average margin per acre increased over the decade from $45 to $59 per acre. The discrepancy can only be explained by the adjustment of producers to larger farms and toward more intensive farming systems.

F. Summary of Relationships and Changes Over Time

The K/N function changed from a parabolic form indicating diminishing substitution of capital for labour to a logarithmic form, suggesting continuous substitutability. The general level of the curve shifted upward consistent with changes over the decade in relative factor prices which motivated the use of less labour and more capital. The technology embodied in capital goods was particularly effective in reducing labour use for the largest farm sizes.

The general level of the K/N ratio was variable among regions. Southern Alberta (CD 5) had the lowest levels and the Peace region (CD 15) had the highest levels. The Peace region required much higher levels of capital per year and had the steepest slope for the K/N function. CD 15 also displayed the most resistence to the continuous substitution of capital for labour at large sizes. Peace grain producers may be reaching the technical and financial limits of capital/labour substitutability at large sizes.

The sales per acre function was positively sloping in both census years. There was no drop in production at large sizes as the function was represented by either a linear or log linear form. The positive slope can be related to the quality of land, agroclimatic conditions, soils, topology, the management capability of the operator, levels of capital available, or marketing opportunities open to larger producers.

The regional differences appeared to be minor. CD's 5 and 15 had functions with similar intercepts and slopes. CD 10 had a higher intercept and lower slope than CD's 5 and 15. The CD 15 aggregate function revealed higher sales per acre than did the CD 5 aggregate function at many sizes. The similarity of sales per acre functions in the two regions suggest the very low levels of sales per acre in the Peace may be a function of average farm size rather than the inherent productivity of resources and inputs.

There are differences among farming systems and this varies on a regional basis. In CD 5, the continuous producers had a much greater sales per acre than did their fallow counterparts. In CD 15, there was a small advantage for continuous producers over much of the range. These results suggest the benefits of intensification are greatest in southern and central Alberta. On the other hand, the Peace region could benefit in terms of sales per acre from expansion of average farm size.

The cash cost function was negative and log linear in form in 1971 and 1981 in most cases. The logarithmic form indicates that economies of size exist over the entire observed range. Over the decade, the curves shifted upward. The upward shift in the cash cost function was not equal in all regions. The magnitude of increase ranged from 1.75 in CD 5 to 2.20 times in CD 15. The reason for the regional difference in cost increase is not obvious. The greater intercept and slope of the cash cost function in the Peace region indicate the greatest benefit from increased size compared to CD's 5 and 10. The cost squeeze had particularly adverse effects on small scale producers. The smaller producers did not reduce labour use, nor have they increased sales per acre. As a result, unit cash costs increased more rapidly for smaller farms.

The continuous grain farms tend to have higher intercept and steeper slopes for cash cost functions than the fallow grain farms. As a result, continuous grain producers had higher costs than fallow grain producers of small size. The higher cost of continuous grain systems at small sizes may make intensification in grain systems non-economic. On the other hand, the continuous mixed system tended to have lower intercepts and slopes than the fallow mixed class. No barrier impedes intensification in mixed systems in CD's 5, 10 and 15 at small sizes.

The potential benefits of increased size from extensification appear to lie in northern Alberta where the cash cost function is steepest for small farms. Potential for intensification appears to exist in the South, where farm size is large enough to allow continuous grain cropping to be viable and there is also an outlet for livestock required for the continuous mixed systems.

The gross margin function is monotonically positive. The intercept has declined while the slope has increased over time. As a result, all but the largest sales categories showed a decline in gross margin per acre. There was an incentive to increase size in all regions as the gross margin function was monotonically positive. The methods of size expansion include intensification and area expansion. The lower intercept and steeper positive slopes of the continuous systems provide little incentive for small producers to intensify, particularly to continuous grain cropping systems. At larger size, benefits of intensification are greater. The downward shift in the gross margin function represents a very negative impact on the smallest producers. Over 25 percent of producers provincially had sales below $25,000. This group has virtually no after-cost margin. The on-farm adjustments open to this group are non-existent or severely limited by their income position.

VII. DISTRIBUTION OF SALES, GROSS MARGIN AND RATES OF STRUCTURAL ADJUSTMENT

A. Introduction

Chapter VII reports on two results. The first is the relationship between sales ranked by percentile and rates of change in area, cropping intensity and sales per acre. The second is a simulation of adjustments required to maintain current levels of margins per acre in a changing economic environment. Cost increases representing the cost squeeze and lower output prices representing the long-term effect of the WGTA were simulated.

B. The Distribution of Sales and Gross Margin

The downward slope of the cash cost curve and the higher levels of sales per acre associated with greater volumes of production suggest that the distribution of income and margin among farm sizes represented by sales groups is not even. The census retabulations provide the proportion of provincial sales and margin accounted for by sales percentiles. The results are given in Table VII.1.

The table indicates major concentration in terms of sales and margin among the top 5 percent of producers. The top 1,500 producers develop over twice the volume of sales of the bottom 15,000 producers and four times the gross margin.[1] In 1981 the top 5 percent generated 34.5 percent

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[1] It is possible that smaller producers systematically under-reported sales.

Table VII.1: The proportion of total sales and gross margin generated by each sales percentile grouping for commercial grain farms in Alberta in 1971 and 1981 expressed as a percentage and accumulated percentages.

Sales Percentile Grouping of Producers	Total Sales		Gross Margin	
	%	Cum.%	%	Cum.%
1971				
99	14.4	14.4	15.3	15.3
95-98	17.5	31.9	18.0	33.3
80-94	27.0	58.9	27.4	60.7
50-79	25.3	84.2	25.1	85.8
30-49	9.4	93.6	8.9	94.7
1-29	6.4	100.0	5.2	100.0
1981				
99	18.0	18.0	22.2	22.2
95-98	16.5	34.5	16.9	39.1
80-94	26.4	60.9	26.2	65.3
50-79	24.6	85.5	24.3	89.6
30-49	9.0	94.5	8.0	97.6
1-29	5.5	100.0	2.3	100.0

of sales and 39 percent of margin up from 32 percent of sales and 33 percent of margin in 1971. By comparison, the lower 50 percent of producers generated 14.5 percent of sales and only 10 percent of the margin in 1981 down from 16 percent of the sales and 14 percent of the margin in 1971. A concentration of sales and gross margin has occurred in the past decade.

The phenomenon of the disappearing middle is not apparent. The middle percentiles between 50 and 95 have maintained nearly a constant proportion of sales and margin. In 1971 and 1981, they accounted for about 50 percent of sales and 50 percent of margin. This group represents the typical commercial cereal agriculture sector. Its position has not weakened substantially in terms of the proportion of sales and margin for which it accounts. The 50th percentile has real sales of $50,000 per year, up from $27,000 in 1971.

To compensate for changes in the cost and price structures and to benefit from apparent economies of size, structural adjustments have occurred. The most obvious adjustment is an increase in the volume of production per farm. Two methods of obtaining larger size are to physically expand the farm by acquiring more land or secondly, to increase the productivity of the existing land base by cropping more frequently and using more inputs. Table VII.2 was developed to determine if the adjustments in cropping intensity, farm area, and sales per acre were constant among sales percentiles.

The increases in improved farm area range from 45 percent in the 95-98 percentile to a low of 15 percent in the bottom 1-29. Intensification of cropping was distributed in the same fashion. The 95-98 percentiles of producers increased cropping intensity by 20 percent while the 1-29 percentiles increased cropping intensity by only 3 percent. As a result, the effective increase in cropped area for the 95-98 percentiles was 75 percent, while the increase was only 18 percent in the 1-29 percentiles.

Table VII.2: The area, cropping intensity and sales per acre for producers in each percentile, based on provincial average data in 1971 and 1981.

Area (Acres)			
Percentile	1971	1981	Change
99	2,928	4,150	1.42
95-98	1,514	2,211	1.46
80-94	1,038	1,366	1.31
50-79	709	873	1.23
30-49	534	631	1.18
1-29	402	463	1.15
Intensity (R')			
Percentile	1971	1981	Change
99	0.54	0.63	1.17
95-98	0.55	0.66	1.20
80-94	0.54	0.62	1.15
50-79	0.54	0.60	1.11
30-49	0.56	0.59	1.05
1-29	0.58	0.60	1.03
Sales per Acre ($)			
Percentile	**1971**	**1981**	**Absolute Change ($)**
99	204	354	150
95-98	119	151	32
80-94	71	104	33
50-79	49	77	28
30-49	36	58	22
1-29	21	32	11

'R = Area cropped per improved acre.

The possibility that small producers have expanded and moved to high percentiles appears to be remote. The work of Ehrensaft, et. al.[82] on the microdynamics of structural change indicates that movement from small to larger percentiles over time is minimal. Farms that start small tend to stay small. The increase in sales required simply to maintain a percentile ranking between 1971 and 1981 was significant. Table VII.3 indicates that the 1971 and 1981 value of sales required to maintain a percentile ranking. The increase in sales required is in the range of 100 percent for most percentiles. While this evidence supports Ehrensaft's argument, matching of census respondents would be required to test conclusively for movement between percentiles and among farming systems.

The slow adjustment in structure at the lower percentiles suggests that a large portion of Alberta's "commercial producers" are not really commercial. Indeed, the bottom 50 percent of producers included in this study account for a very small proportion of sales and income. This group lacks means and/or desire to acquire resources needed to obtain viable size and requires substantial sources of outside income to survive. For commercial agricultural policy purposes, this group could be separated from the remaining 15,000 commercial producers as has been argued by Tweeten for the U.S.A.[83]

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[82] Ehrensaft, P., et. al., op. cit., pp. 823-835.
[83] Tweeten, L., op. cit., pp. 19-47.

Table VII.3: Value of sales required for a commercial grain farm to be in selected sales percentiles in 1971 and 1981 in Alberta.

	Sales ($'000)		
Percentile	1971	1981	percent change
15	9	13	44
40	19	37	95
65	35	68	94
87	74	141	91
97	180	316	76
99	598	1472	246

The slow rates of change for the bottom 50 percentiles indicates the existence of a polarized structure. A large number of producers are essentially static in structure and could be described as having been trapped by cost increases over the decade. Another smaller group is adjusting rapidly and has managed to more than compensate for cost increases by increasing their effective size of operation through expansion and intensification.

C. Adjustments to Price Decreases and Cost Increases in 1971 and 1981

The structural change of the past decade has been hypothesized to originate in the attempt by producers to overcome adverse trade movements.[44] Since 1984, the WGTA has represented higher freight rates which are projected to increase in the future. Lewis has suggested that regardless of method of payment, the cost per tonne of grain shipped

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[44] Cochrane, W.W., op. cit., pp. 85-107.

will increase from $14 in 1985 to $26 by 1995.[15] This represents a 6 percent reduction in the value of wheat and 10 percent reduction in the value of barley at current prices of $220 and $125 a tonne respectively.

The adjustments required to maintain constant gross margins per acre in the face of a 20 percent cost increase are determined in 1981 for two levels of sales volume, $50,000 and $150,000. The 20 percent figure is totally arbitrary and is a small increase compared to the 100 percent increase in cost per unit of sale that was evident between 1971 and 1981. Only the results from CD aggregates are given in Tables VII.4 and VII.5.

The procedure involves estimating the equations describing the relationship of sales volume to capital per farm, improved area, sales per acre, and gross margin per acre respectively. The gross margin per acre can then be derived for any sales volume such as the $50,000 and $150,000 of sales used here. The gross margin per acre function is re-estimated with a 20 percent cost increase. The original gross margins corresponding to each of the $50,000 and $150,000 sales volumes are then substituted back into the re-estimated equation enabling derivation of revised sales volumes from the inverse function. The new sales volume, or X, is substituted into the original area, and capital equations to determine the changes required to enable the increased sales. An example of this procedure may

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[15]Lewis, A., op. cit., p.8.

Table VII.4: The sales, margins per acre, capital, area, sales per acre, for CD aggregates in CD's 5, 10 and 15 at the $50,000 sales volume, before and after adjustments to a 20 percent cost increase, 1971 and 1981.[1]

Year	Sales	Margin/ Acre	Capital ($'000)	Area (Acres)	Sales Per Acre ($)
Census Division 5					
1971a[2]	50,000	36	60	1,020	49
1971b[3]	56,117	36	65	1,082	52
Change	1.12	--	1.07	1.06	1.06
1981a[2]	50,000	28	108	919	55
1981b[3]	63,000	28	124	1,023	62
Change	1.26	--	1.15	1.12	1.13
Census Division 10					
1971a	50,000	49	54	765	67
1971b	55,300	49	58	802	70
Change	1.10	--	1.05	1.05	1.05
1981a	50,000	35	103	701	72
1981b	67,000	35	122	813	83
Change	1.34	--	1.18	1.16	1.15
Census Division 15					
1971a	50,000	34	70	1,022	48
1971b	54,440	34	74	1,070	50
Change	1.08	--	1.05	1.05	1.14
1981a	50,000	26	118	988	55
1981b	70,000	26	144	1,162	66
Change	1.40	--	1.22	1.18	1.20

[1]For all equations: minimum R^2 = 0.80
minimum t = 4
minimum N = 23
(except CD 15 (1971), where N = 17)

[2]a signifies original condition.

[3]b signifies condition after adjustment.

Table VII.5: The sales, margins per acre, capital, area, sales per acre, for CD aggregates in CD's 5, 10 and 15 at the $150,000 sales volume, before and after adjustments to a 20 percent cost increase, 1971 and 1981.[1]

Year	Sales	Margin/ Acre	Capital ($'000)	Area (Acres)	Sales Per Acre ($)
		Census Division 5			
1971a[2]	150,000	61	113	1,788	84
1971b[3]	171,000	61	122	1,912	89
Change	1.14	--	1.08	1.07	1.06
1981a[2]	150,000	57	202	1,556	97
1981b[3]	188,000	57	229	1,734	109
Change	1.25	--	1.13	1.11	1.13
		Census Division 10			
1971a	150,000	83	97	1,287	119
1971b	168,300	83	103	1,357	126
Change	1.12	--	1.06	1.05	1.06
1981a	150,000	69	194	1,221	124
1981b	200,000	69	230	1,414	143
Change	1.33	--	1.18	1.16	1.16
		Census Division [illegible]			
1971a	150,000	53	135	1,869	79
1971b	169,000	53	169	1,995	88
Change	1.13	--	1.07	1.07	1.05
1981a	150,000	52	226	1,679	97
1981b	200,000	52	269	1,937	113
Change	1.33	--	1.19	1.15	1.17

[1]For all equations: minimum R [illegible] 0.80
minimum t = 4
minimum N = 23
(except CD 15 (1971), where N = 17)

[2]a signifies original condition.

[3]b signifies condition after adjustment.

be useful. The structural equations in Table VII.6 were estimated in CD 5 (1971) for the CD aggregate. At $50,000 of sales, equation No.'s 1 through 4 will yield the results reported in the first row of Tables VII.4 and VII.7.

In a similar manner, the variable costs per acre can be adjusted upward to simulate the cost squeeze. If unit cash costs are increased 20 percent, a new gross margin per acre function can be estimated (equation No. 5 in Table VII.6). When equation No. 5 is forced to generate a gross margin per acre equivalent to that of equation No. 4, a new value for X (sales) is determined. Substituting the new value for X into equations 1 through 3, leads to the results in line 2 of Table VII.4.

The value of output per acre can also be adjusted downward to simulate a price squeeze or the likely impact of the WGTA. If the value of sales per acre drops 20 percent, another gross margin per acre function can be estimated (equation No. 6). When equation No. 6 is used to generate a gross margin per acre equivalent to equation No. 4, another value for X (sales) is determined. The new X value was substituted into equations 1 through 3, the results in line 2 of Table VII.7 are obtained.

Attempting to determine the predicted X_0 value given a specific value of Y is known as inverse regression.[44] In a straight line case, it is possible to take $Y_0 = b_0 + b_1X_0$ and solve for X_0

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[44] Draper, N. and Smith, H., **Applied Regression Analysis** (2nd ed.). New York: John Wiley & Sons Inc., 1981: p. 47

Table VII.6: Equations describing the relationship between volume of sales and structural variables for the Census division aggregate in CD 5, 1971.

No.	Variable	Estimated Equation	R^2
1	Capital	$\ln K = 4.83 + 0.571 \ln X^2$ (25)* (32)	98
2	Area	$\ln Ac = 1.40 + 0.511 \ln X$ (7) (28)	97
3	Sales/Ac	$\ln S/Ac = -1.35 + 0.485 \ln X$ (7) (26)	97
4	GM/Ac_1 [3]	$\ln GM/Ac_1 = 1.96 + 0.231 \ln X$ (21) (26)	96
5	GM/Ac_2 [4]	$\ln GM/Ac_2 = 1.95 + 0.229 \ln X$ (22) (27)	[illegible]7
6	GM/Ac_3 [5]	$\ln GM/Ac_3 = 2.19 + 0.198 \ln X$ (22) (27)	95

*t-values are in parenthesis.
[1] $50 was added to gross margin per acre to eliminate negative values for estimation purposes.
[2] X = volume of sales.
[3] GM/Ac_1 = (total sales - unit cash costs) + improved area;
[4] $GM/Ac_2 = GM/ac_1$ - ({AVC/sales • sales/ac} • .2);
[5] $GM/ac_3 = GM/ac_1$ - (sales/ac • .2);

$$X_0 = \frac{(Y_0 - b_0)}{b_1}$$

This procedure was followed in this simulation but is only valid for simple linear cases according to Draper and Smith.[87]

In the last chapter it was demonstrated that the components of gross margin, unit cash costs, and sales per acre vary with farm size. As a result, it is not possible to

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[87] Ibid.

simply shift the gross margin per acre curve up or down. The slope must be adjusted to simulate a cost increase and price declines.

The results in Table VII.4 indicate that in 1971, a 20 percent cost increase would require an increase in total sales of about 8 to 12 percent to regain the margin lost to cost increases at the sales volume of $50,000. At the $150,000 sales volume, the upward adjustment required in sales was 12 to 14 percent, slightly higher than at the $50,000 size of operation. Smaller increases were required for the value of machinery, area, and sales per acre; each factor increased by 5-8 percent.

In Tables VII.4 and VII.5, the increased volume required to compensate for lost margin has increased to 25-35 percent from the 1971 value of 8 to 12 percent. The $50,000 sales group tend to require slightly larger relative adjustments than the $150,000 sales group. Concomitant changes are again required for the value of machinery, capital, area, and sales per acre. However, the adjustments required for farm sizes (land) tend to be slightly lower than for machinery and sales per acre in 1981.

Using a similar simulation it is possible to test the impact of price decreases on gross margins. Again, the arbitrary 20 percent drop in revenue from sales was selected. The impact of the WGTA on prices will be negative in the long run as producers assume a greater portion of costs of grain shipment, **ceteris paribus**. This impact will

Table VII.7: The sales, margins per acre, capital, area, sales per acre, for CD aggregates in CD's 5, 10 and 15 at the $50,000 sales volume, before and after adjustments to a 20 percent price decrease, 1971 and 1981.[1]

Year	Sales	Margin/ Acre	Capital ($'000)	Area (Acres)	Sales Per Acre ($)
			Census Division 5		
1971a[2]	50,000	36	60	1,020	49
1971b[3]	93,000	36	86	1,400	66.5
Change	1.86	--	1.42	1.37	1.36
1981a[2]	50,000	28	108	919	55
1981b[3]	89,000	28	150	1,212	74
Change	1.78	--	1.39	1.32	1.34
			Census Division 10		
1971a	50,000	49	54	765	67
1971b	89,400	49	74	1,007	90
Change	1.78	--	1.35	1.32	1.35
1981a	50,000	35	103	701	72
1981b	101,000	35	154	1,000	102
Change	2.00	--	1.50	1.43	1.42
			Census Division 15		
1971a	50,000	34	70	1,022	48
1971b	161,000	34	107	1,507	66
Change	2.02	--	1.53	1.47	1.37
1981a	50,000	26	118	988	55
1981b	101,000	26	179	1,387	79
Change	2.00	--	1.52	1.40	1.44

[1]For all equations: minimum R^2 = 0.80
minimum t = 4
minimum N = 23
(except CD 15 (1971), where N = 17)

[2]a signifies original condition.

[3]b signifies condition after adjustment.

Table VII.8: The sales, margins per acre, capital, area, sales per acre, for CD aggregates in CD's 5, 10 and 15 at the $150,000 sales volume, before and after adjustments to a 20 percent price decrease, 1971 and 1981.[1]

Year	Sales	Margin/ Acre	Capital ($'000)	Area (Acres)	Sales Per Acre ($)
		Census Division 5			
1971a[2]	150,000	61	113	1,788	84
1971b[3]	337,000	61	179	2,704	124
Change	2.24	--	1.59	1.51	1.48
1981a[2]	150,000	57	202	1,556	97
1981b[3]	318,000	57	309	2,231	144
Change	2.12	--	1.53	1.43	1.49
		Census Division 10			
1971a	150,000	83	97	1,287	119
1971b	319,300	83	144	1,840	177
Change	2.12	--	1.48	1.43	1.49
1981a	150,000	69	194	1,221	124
1981b	371,000	69	330	1,930	195
Change	2.47	--	1.70	1.58	1.57
		Census Division 15			
1971a	150,000	53	135	1,869	79
1971b	384,400	53	237	3,137	120
Change	2.56	--	1.75	1.68	1.52
1981a	150,000	52	226	1,679	97
1981b	360,000	52	380	2,563	153
Change	2.40	--	1.58	1.53	1.57

[1]For all equations: minimum $R^2 = 0.80$
minimum t = 4
minimum N = 23
(except CD 15 (1971), where N = 17)

[2]a signifies original condition.

[3]b signifies condition after adjustment.

hold in the long-run regardless of method of payment.

The impact of this change relative to 1971 and 1981 is reported in Tables VII.7 and VII.8. In 1971 the adjustments in sales which would have been required to compensate for a 20 percent price decline are in the range of 1.78-2.02 times for $50,000 producers and between 2.12 and 2.56 times for the $150,000 producers. The magnitude of required adjustment was roughly 5 times greater for the price drop than for the comparable cost increase in 1971. In 1981, the situation was not substantially different. Adjustments of 1.78 to 2.00 times in total sales were required to compensate for a 20 percent price drop at the $50,000 sales level. Adjustment of between 2.12 and 2.47 times in sales were required for the $150,000 sales producers. In both years, adjustments of machinery, area and sales per acre ranging between 30 and 70 percent are required to compensate for the price drop.

The impact of a permanent structural price decline which the WGTA represents is substantial. A 20 percent drop in commodity prices would require about a doubling in farm sales volume to regain lost margins. The WGTA has the potential to become a substantial force motivating structural adjustment to compensate for net farm income lost to higher transportation costs. Even if price declines are in the 5 to 10 percent range as predicted by Lewis,** they will be sufficient to exert a strong force on the industry.

**Lewis, A., op. cit., p. 8.

D. Summary

The results of this chapter indicate that on an industry-wide basis, there has been an increase in the concentration of sales and gross margin in the top 5 percentiles of producers. The concentration has come almost exclusively at the expense of the bottom 50 percentiles of producers who generate less than 15 percent of the industry's sales and gross margin. The low income available to the bottom 50 percentiles of producers has been a factor in the very slow rates of structural adjustment for that group.

A polarized industry structure is developing with three distinct groups emerging. The top 5 percentiles of producers are showing extremely rapid adjustment in sales per acre, cropping intensity and farm area. The middle producers, between the 50th and 95th percentiles, displayed structural adjustments adequate to maintain their share of industry income and gross margin. The bottom 50 percentiles have shown very little structural change compared to the other groups and are losing their share of sales and gross margin.

The commercial cereal production industry is in a situation where a large number of producers have a non-flexible structure and a relatively few producers have very dynamic organizations. Environmental conditions, including the WGTA and cost squeeze, herald continued structural change if gross margins are to be maintained. If current forces continue, the result will be an increasingly polarized industry in terms of income and an increasingly large non-adjusting low income sector.

VIII. SUMMARY WITH IMPLICATIONS

A. Purpose, Objectives and Hypotheses

Commercial cereal agriculture generates half the total value of agricultural production in Alberta. The viability of this industry in a changing environment is largely dependent on its ability to achieve structural change in response to outside pressures. This research attempted to determine the forces motivating the structural adjustments that occurred between 1971 and 1981. Since these structural adjustments represent a source of continued viability for agriculture, it is important to understand the direction, magnitude and factors affecting structural change so that future potential public policies and social implications can be evaluated.

To gain an understanding of structural change, several objectives for this research were established. Initially, a classification system was needed to allow some measure of disaggregation. A classification based on cropping intensity was developed to distinguish producers with over 320 acres of land and 100 acres of grain according to four different farming systems.

The second objective was to evaluate the farming systems and changes that took place within each one at the census division level. Retabulated census data were expected to provide information on area, organization, age, labour use, machinery values, sales, margins, and a number of partial productivity measures.

The third objective was to identify relationships between volume of sales, and; unit cash costs, capital/labour ratio, sales per acre, and gross margin per acre respectively. The relationships could indicate economies of size, a cost price squeeze, relative factor prices favouring capital substitution, induced innovation, and a financial motivation for size expansion.

The fourth objective was to simulate structural adjustments required to offset a cost increase or a price decrease for cereal. The results provide an indication of the impacts of the WGTA and a cost squeeze on grain producers.

The fifth and last objective was to determine the change in concentration of sales and income over time in cereal farming. This objective addressed the question of polarization or the case of the 'disappearing middle' in agriculture.

General systems theory suggests problems exist in attempting to understand complex open systems through reductionist methods. The analytic problem lies in disaggregating farming systems so the changes in the whole can be perceived clearly without jeopardizing holism. The individual farm is too small and the census division aggregate is too great. The work of farming systems authors suggests land use intensity can be used as a feature for classifying farms into systems. Intensity of land use is hypothesized to be a type-defining feature.

Economic theory also provides a basis for formulating hypotheses. Economic theory suggests that economic growth leads to a change in relative factor prices between capital and labour. It is hypothesized that the use of capital has increased, and that technical changes to facilitate the substitution of capital for labour will be evident.

Associated with the increased use of machinery are economies of size. Reduced fixed costs per unit of output results in a cost advantage for larger producers. The advantage may be due to technical, pecuniary, or other external economies. In any case, large farms are hypothesized to produce more cheaply on average than small farms.

The combined effects of capital/labour substitution, technical changes and economies of size is a "treadmill phenomenon". Producers are motivated to expand production to reduce costs. The increased supply of products reduces the value of output because of inelastic demand. The reduced value of output forces additional adjustment to maintain economic viability. It is hypothesized that a cost price squeeze existed in the 1970s and that producers changed structure to cope with declining gross margins.

In a situation where the "treadmill phenomenon" exists, a polarized industry structure develops in terms of income distribution and rates of structural adjustment. Because the initial distribution of resources is not equal, certain producers will adjust more rapidly than others. The non-adjusting group will fall back in income and rates of adjustment. It is hypothesized that a gap between low income non-adjusting producers and the high income adjusting group is expanding.

B. Procedures Followed

The first step was to develop a farming system classification. The classification system was based on the work of Ruthenberg and Whittlesey. The cereal farming systems were tested for uniqueness by applying statistical tests to retabulated census data. The original classification was simplified after testing. The four systems used were determined to be statistically unique.

The farming system classification was then applied in CD's 5, 10 and 15 of Alberta in census years 1971 and 1981. The census data were retabulated into farming systems indicating the values and change in numerous structural variables including: number of producers, area, organization, age, labour use, off-farm work, machinery, sales, margins, capital per acre, capital per year of labour, capital per dollar of sales, sales per acre, sales per year of labour, and gross margin per acre.

The farming systems were further disaggregated by studying certain variables at specified sales categories. The relationship between sales and: the capital/labour ratio, sales per acre, unit cash costs, and gross margin per acre were tested. The farm size and change in relationship were determined by weighted least squares regression and Chow tests.

Based on the strength of the relationships between volume and several structural variables, two simulations were developed. The first simulation compared the gross margins of the farming systems at 500 and 1,500 acres in CD's 5, 10 and 15. The objective was to determine the incentive to move to more intensive cropping systems at different farm areas. The second simulation tested the adjustment in sales volumes required to compensate for an arbitrary 20 percent cost increase and, alternatively, a 20 percent price decline. The adjustments to area, machinery, and sales per acre required to obtain the original gross margin per acre were determined.

To study the polarization problem, the industry was reclassified into sales percentiles. The proportion of sales and gross margins accounted for by various percentile groupings were evaluated in 1971 and 1981. The rates of change in sales per acre, cropping frequency and area were evaluated in each percentile grouping.

C. Results

The results indicate that the farming system classification was effective in separating producers into unique groups. The system-based classification indicated the conditions in the 1970s favoured intensification. The number of producers in the continuous cropping classes increased from 8,408 to 13,967.

Continuous farms showed other signs of vitality. They increased area more rapidly than fallow farms and tended toward reduced age and off-farm work. In 1971, there was little difference in machinery, sales and gross margins between fallow and continuous farms. By 1981 continuous farms had more machinery, higher sales and higher gross margins than fallow farms. The movement to continuous cropping may be partly explained by higher sales per year of labour and low capital per dollar of sales for continuous farms in both years. The movement to continuous cropping brought about a small increase in provincial cropping intensity; from 0.55 to 0.61.

The proportion of production accounted for by continuous cropping classes increased to 50 percent from 25 percent in 1971. The movement to continuous cropping is a manifestation of improved biological technology. Increased use of fertilizer, improved plant breeds and better methods of snow and soil management are partly responsible for the transition to continuous cropping.

Strong regional differences in farm structure were noted. Farm area, rented area, labour use, sales, gross margins, sales per acre, sales per year of labour and gross margin per acre all decline in a northerly pattern. In addition, the differences between farming systems diminished in northern regions.

The relationship between the capital/labour ratio and size indicated rapid increase in the use of capital relative to labour, and a change in the form of the relationship indicating induced technical innovation. The form of the relationship changed from a second degree polynomial to a log linear form indicating the elimination of barriers to the continuous substitution of capital for labour at large farm sizes.

The cash cost curve declined with farm size expansion, indicating economies of size. The function was continuously downward sloping indicating no diseconomies of size. Over the decade, the function shifted upward indicating a cost price squeeze. The magnitude of increase in costs was in the range of a 100 percent. The upward shift in the curve accentuated economies of size apparent in 1971.

The sales per acre function was found to be positively related to volume of sales. The function was positive in all sizes. Over time, the intercept of the function tended to decline while slope increased. Largest producers increased sales per acre by the greatest amount. The regional differences in sales per acre function, particularly between CD's 5 and 15 fallow producers, were surprisingly small.

The gross margin per acre function indicated that sales increases were insufficient to offset cost increases in most sales categories. The positive slope of the relationship increased over time while the intercept of the function decreased. The movement in costs and lack of improvement in sales has had particularly adverse effects on smaller producers.

The disaggregation into sales groups highlighted problems of aggregation. For the gross margin per acre function, values declined for sales categories below $200,000. Yet the census division averages for gross margin per acre increased by more than 30 percent for the provincial aggregate. This apparent anomaly indicates how the increase in sales per farm compensated for increasing costs.

A simulation was used to determine the gross margins and sales per acre at 500 and 1,500 acres for farming systems in CD's 5, 10 and 15. The results indicated that movement to continuous grain systems from fallow grain did not increase gross margins at small sizes. At larger sizes of grain farms, there was an advantage for continuous grain producers over fallow grain producers. In the mixed systems, an advantage was demonstrated for intensification at all farm sizes.

The second simulation modeled adjustments in sales required to regain the original gross margin per acre after a 20 percent cost increase and alternatively, a 20 percent output price decline at $50,000 and $150,000 of sales. It was found that in 1971 a 20 percent cost increase required a 10-14 percent increase in sales. This requirement increased by 1981 to a 25-30 percent increase in sales. In 1971, a 5-7 percent increase in area, machinery, and sales per acre would accommodate the increase in sales. By 1981, this increase was in the range of 12 to 15 percent. There were small differences between the two sizes of farms.

A 20 percent price decline as opposed to a cost increase required an 80 to 100 percent increase in sales at $50,000 and a 110 to 150 percent increase in sales at the $150,000 size of grain farm. Increases in machinery, area, and sales per acre were in the range of 30-50 percent at the $50,000 size and 40-70 percent at the $150,000 size. There was little change in the adjustment over time. The salient points are the increase in magnitude of adjustment as costs became a greater portion of sales and secondly, the major structural changes required to compensate for a minor price decline. A 5 to 10 percent price reduction could be a major force for change.

The results on the question of polarization indicate the concentration of sales and gross margin in the top 5 percentile has increased over the decade. The top 5 percentile controlled 34 percent of sales and 39 percent of gross margin in 1981. At the same time, the bottom 50 percentile group shared less than 15 percent of the sales and only 10 percent of gross margin. The 95th-50th percentile held a constant position over the decade sharing 45-50 percent of sales and margins. The low income of the bottom half of the industry has greatly reduced if not eliminated their ability to adjust. This group showed retarded rates of change in area, cropping intensity and sales per acre. This group is commonly described as being typical family farms with the average labour use in the range of 0.86 man years indicating full-time commitment to farming and little support from off-farm employment.

D. Implications of Results

Structural change, particularly size expansion, has been instrumental in maintaining profitability in the 1970s. The interaction of technology and structure allowed sales per farm to double in real terms over the decade. Changes in the economic conditions of the 1980s have implications for structural change and perhaps productivity growth. In the 1970s, real interest rates were low, inflation was high, and land prices escalated faster than inflation. In these circumstances, the opportunity cost of structural adjustments was near zero. Inflation made structural change cheap. In the 1980s, conditions have changed. Real interest rates are high at 6 percent, inflation is low and land prices are declining. In this situation, the incentive to increase farm area through purchase and to substitute capital for labour are reduced by the macroeconomic environment of cereal systems. Structural change is more expensive in the non-inflationary 1980s. Since a portion of productivity growth may be attributed to the shift of the production to larger farms, the slow down in structural change caused by economic conditions could reduce productivity growth.

The internal organization of farms raises questions about the potential benefits of continued structural adjustments. The results indicate that as costs become a large proportion of the value of sales, the effectiveness of increasing volume to compensate for cost increases is diminished. Secondly, it was demonstrated that for output price declines, the adjustments required to compensate are greatest for large farms, indicating diminishing benefits of size expansion as farm size increases. A prolonged period of structural rigidity or diminishing returns to adjustment could affect the capability to finance sufficient structural adjustment to maintain viability. This incapacity to finance change has already stricken half the human resources in the industry.

The WGTA is another factor promoting change. A 5 and 10 percent output price decline for wheat and barley respectively will be sufficient to motivate structural change. Under 1981 conditions, increases of sales in the range of 25 to 50 percent would be required to regain lost margin. The implication of the price drop associated with the WGTA may be more significant than the method of payment, as the proportion of farms who were not in a position to change in 1981 can be expected to increase beyond one-half into the 1990s.

The polarization of the industry and the large regional differences in ganization raise serious questions about the usefulness of universal support programs. In an industry with diverse organizations, equitable treatment is leading to inequitable results. Subsidies based on production have a definite regional and size bias. The Crow rate, fuel tax rebates, fertilizer subsidies, low interest loans, etc., provide the greatest benefits to the groups in the best position to adjust and do relatively little to benefit the group that is really "out of the game" already.

E. Research Issues

The degree of disaggregation required to study structural change was substantial. There are large problems in using provincial or even census division aggregates to represent structural variables. Disaggregation to farming systems and farm size was required to gain a clear picture in most cases.

The census data base offered a number of benefits relative to primary data collection. The population was enumerated. Data manipulation was easy. Cross-tabulations by variables were possible. Deficiencies were also present and include a lack of debt information, and no information on off-farm income. There is a possibility of under-reporting of sales at small sizes that cannot be checked. The census authorities refuse to provide researchers with a sample frame to "ground truth" results themselves. The census does allow the tracing of producers through time, however, the turnaround time on this request is prohibitive.

Censuses are reported at 5 year intervals making the weather and macroeconomic conditions in each year important to interpretations. The years 1971 and 1981 were reasonably similar in that there was no drought in either year. The LIFT program in 1970 was a factor in 1971.

Causality is not addressed in the thesis. It is assumed that technical changes are required to facilitate or even enable structural movements. Whether structural adjustments demand technical change or vice versa is a point of contention. The "treadmill" theory suggests technology changes first. Induced innovation sees structure-demanding technical developments. Perhaps if "technical change" is expanded to mean research and development, extension and adoption, and finally structural adjustment to maximize technical potentialities, the two forces become one. In this case, sorting out the external factors that influence each step of the process can be the focus of work, rather than debate over direction of causality.

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APPENDIX A

Structural Variables of Cereal Agriculture in Alberta

Raw frequency distributions were retabulated from the 1971 and 1981 Census of Agriculture for Alberta for the following census items. In most, if not all cases, the frequency is the number of farms reporting.

The reported quantities/levels for census items are not grouped. For example: Improved acres are listed as they are reported; 312 acres - frequency 6; 314 acres - frequency 2; 315 acres - frequency 7; and so on. The exception is for census items originally reported according to classes, e.g., age of operator.

The following frequency distributions have separate ID codes corresponding to the item, the census year (1971, 1981), the province/the census division, and the farm type corresponding to the six-way classification.

The list is:

a. **Census Items:**

improved area
irrigated area
total area
capital
total assets
labour
sales
area in wheat
area in barley
area in oats
area in canola (rapeseed)
area in other crops
area in improved forage
area in fallow
number of beef cows
number of cattle
number of sows
number of hogs
age of operator
number of days of off-farm work
area operated
area owned
area rented
type of organization
number of years farming current farm

b. **Ratios:**

labour use per farm
improved area per farm
machinery value per farm
livestock value per farm
land and building value per farm
assets per farm
sales per farm
expenses per farm
gross margin per farm
machinery value per acre
machinery value per year labour
machinery value per dollar of sales
machinery value per dollar of assets
sales per improved acre
sales per year of labour
rented area per farm
area cropped per improved acre
cattle per improved acre

c. **Cross-classifications for the four commerical categories of cereal farms:**

each ratio by improved area operated:

321- 640 acres
641- 960 acres
961-1280 acres
1281-1600 acres
1601-1920 acres
1920-2560 acres
over 2560 acres

each ratio by age of operator:

under 35
35-54
55 years and over

each ratio by type of organization:

individual farm
partnership with written agreement
partnership without written agreement
legally constituted family company
other legally constituted company
other organization

each ratio by proportion of rented land to improved area operated:

0.0 rented area
0.01-0.25 rented area
0.26-0.50 rented area
0.51-0.75 rented area
0.76-1.00 rented area

each ratio by number of days of off-farm work:

zero days
0-48 days
49-96 days
97-156 days
157-204 days
205-252 days
over 252 days

each ratio by value of agriculture products sold:

under $25,000
$25,000-$49,999
$50,000-$99,999
$100,000-$149,999
$150,000-$199,999
$200,000-$249,999
$250,000 and over

Definitions

1. **Farm** = any census farm with over 320 acres of total area and with 100 acres of grain or oilseeds.
2. **Improved area** = land in crop, summerfallow, and pasture improved by seeding, draining, irrigating, fertilizing, or by brush and weed control.
3. **Forage area** = improved area in pasture, hay, fodder and silage.
4. **Net cropped area** = total improved area minus forage area minus fallow area
5. **Cropping intensity** = net cropped area divided by total improved area.
6. **Operator labour years** = (300 minus off-farm days worked) divided by 300.
7. **Hired labour years** = total weeks hired labour divided by 52.

8. **Person years of labour** = operator labour years + hired labour years.

9. **Capital** = machinery.

10. **Total cattle** = beef cows + bulls + dairy cows + heifer steers + calves.

11. **Total sales** = revenue from the sale of grain, oilseeds, livestock, and receipts from insurance and stabilization payments.

12. **Cash costs** = (share and cash rent, wages paid, feed, seed, fertilizer, fuel, repairs, electricity, chemicals, machinery rental) divided by total sales.

13. **Capital/labour ratio** = machinery value divided by person years of labour.

14. **Sales/acre** = total sales divided by improved area.

15. **Gross margin/acre** = total sales minus cash costs divided by improved area.

For all other terms, the census definitions as shown in Appendix D are used.

APPENDIX B

The results of the differences in means tests (z-tests) for commercial grain farms in classes 3 through 6 in CD's 5, 10 and 15 in 1981.

Variable	Classes tested 3 + 5	4 + 6	3 + 6
Census Division 5			
Age	1.08	0.55	1.29
Machinery ($)	1.30	*2.95	*2.28
Land ($)	0.21	0.25	*2.09
Sales ($)	0.64	1.26	0.98
Margin per acre ($)	0.31	1.18	0.48
Capital/labour ratio ($)	0.85	1.64	*2.21
Sales per acre ($)	0.78	0.45	*1.97
Census Division 10			
Age	0.00	0.41	*3.55
Machinery ($)	*2.14	1.00	*3.77
Land ($)	1.03	0.05	*3.16
Sales ($)	0.64	0.28	*3.33
Margin per acre ($)	0.90	0.88	1.84
Capital/labour ratio ($)	*2.50	0.72	*3.16
Sales per acre ($)	0.30	*2.27	*5.62
Census Division 15			
Age	*2.26	1.00	*3.63
Machinery ($)	*2.71	1.25	*2.11
Land ($)	*2.08	0.78	0.56
Sales ($)	1.00	0.83	*2.26
Margin per acre ($)	0.40	0.44	1.30
Capital/labour ratio ($)	*2.50	0.81	*1.41
Sales per acre ($)	0.30	0.66	*3.42

*Indicates a significant difference at the 95 percent confidence level, i.e., the calculated value exceeded the critical value of ∓1.96.

APPENDIX C

Values of structural variables used in regression analysis for each class in CD's 5, 10 and 15 in 1971

	No. Obs.	Acres	Total Sales	Machinery Value	AVC	Sales/ Acre	GM/ Acre	Capital/ Labour	ATC
CENSUS DIVISION 5									
Class 1	41.00	453.00	14400.00	28300.00	.42	32.00	18.00	31000.00	1.03
	14.00	728.00	34300.00	44400.00	.32	47.00	22.00	45000.00	1.24
	8.00	859.00	71700.00	78000.00	.31	75.00	50.00	58000.00	.82
	4.00	705.00	112800.00	82600.00	.30	160.00	112.00	58000.00	.57
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.00	.00	.00	.00	.00	.00	.00	.00	.00
Class 2	786.00	572.00	18300.00	31000.00	.40	27.00	16.00	33000.00	1.04
	774.00	858.00	38500.00	50200.00	.29	41.00	29.00	47000.00	1.15
	462.00	1275.00	67600.00	78600.00	.27	53.00	39.00	60000.00	.83
	113.00	1685.00	124000.00	107000.00	.27	73.00	53.00	67000.00	.67
	31.00	1806.00	173700.00	111000.00	.25	81.00	68.00	53000.00	.56
	21.00	2171.00	226700.00	117000.00	.24	104.00	78.00	57000.00	.50
	22.00	3103.00	481600.00	201000.00	.27	155.00	113.00	31000.00	.48
Class 3	28.00	517.00	14814.00	28286.00	.56	28.00	13.00	24308.00	2.28
	36.00	650.00	36611.00	58500.00	.35	56.00	36.00	56601.00	1.24
	30.00	889.00	67667.00	54333.00	.27	68.00	50.00	46758.00	.82
	5.00	1387.00	130800.00	86200.00	.23	94.00	72.00	67320.00	.58
	7.00	2000.00	174286.00	158571.00	.28	87.00	63.00	77566.00	.64
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.00	.00	.00	.00	.00	.00	.00	.00	.00
Class 4	160.00	579.00	16580.00	30340.00	.39	29.00	18.00	33472.00	1.05
	181.00	825.00	36824.00	47804.00	.29	45.00	32.00	45088.00	1.12
	165.00	1147.00	70000.00	71461.00	.26	61.00	45.00	59826.00	.80
	45.00	1515.00	124000.00	87156.00	.28	82.00	59.00	56833.00	.66
	22.00	1842.00	172273.00	111045.00	.21	85.00	61.00	58364.00	.62
	12.00	2351.00	216333.00	147800.00	.22	92.00	71.00	60331.00	.51
	26.00	3184.00	418288.00	230462.00	.22	131.00	103.00	44027.00	.48
CENSUS DIVISION 10									
Class 1	125.00	233.00	11000.00	28000.00	.43	33.00	18.80	31000.00	2.33
	28.00	644.00	34000.00	47000.00	.32	53.00	35.90	45000.00	1.23
	18.00	666.00	66000.00	59000.00	.24	99.00	75.30	53000.00	.80
	3.00	641.00	115000.00	63000.00	.28	179.00	134.60	37000.00	.60
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.00	.00	.00	.00	.00	.00	.00	.00	.00
Class 2	1686.00	404.00	13000.00	27000.00	.37	32.00	20.30	29000.00	2.13
	472.00	669.00	34000.00	47000.00	.28	51.00	36.60	45000.00	1.19
	180.00	828.00	66000.00	65000.00	.28	71.00	51.20	58000.00	.84
	32.00	1111.00	123000.00	89000.00	.26	111.00	81.30	64000.00	.63
	13.00	1400.00	169000.00	102000.00	.21	121.00	95.40	62000.00	.53
	7.00	2224.00	224000.00	121000.00	.28	101.00	72.90	44000.00	.53
	9.00	2504.00	302000.00	156000.00	.24	121.00	91.70	17000.00	.50
Class 3	246.00	388.00	12976.00	26537.00	.40	35.00	21.07	29191.00	2.03
	167.00	573.00	35455.00	43731.00	.27	62.00	45.30	41844.00	1.11
	94.00	787.00	70340.00	60681.00	.27	89.00	65.20	47483.00	.78
	16.00	1288.00	116125.00	77750.00	.29	90.00	64.20	46630.00	.68
	7.00	1415.00	168857.00	87571.00	.33	120.00	82.10	51182.00	.56
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	11.00	1739.00	346364.00	143455.00	.23	199.00	153.00	53649.00	.46
Class 4	1217.00	444.00	14888.00	38000.00	.36	34.00	21.70	29167.00	1.84
	701.00	631.00	34449.00	44489.00	.27	55.00	38.90	40808.00	1.12
	232.00	843.00	65526.00	57526.00	.24	78.00	58.90	50830.00	.78
	40.00	1245.00	118600.00	80850.00	.20	96.00	76.50	61453.00	.58
	17.00	1520.00	170058.00	99412.00	.18	112.00	90.60	53628.00	.50
	8.00	1272.00	217000.00	107000.00	.11	171.00	151.80	.00	.38
	12.00	2262.00	386500.00	131000.00	.10	175.00	144.00	24842.00	.28
CENSUS DIVISION 15									
Class 1	347.00	315.00	9000.00	24000.00	.43	29.00	16.60	24000.00	2.64
	30.00	565.00	34000.00	50000.00	.30	57.00	40.00	55000.00	1.11
	7.00	856.00	66000.00	66000.00	.38	77.00	55.50	51000.00	.75
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.00	.00	.00	.00	.00	.00	.00	.00	.00
Class 2	1282.00	450.00	11000.00	28000.00	.39	24.00	14.50	36000.00	2.14
	254.00	844.00	35000.00	58000.00	.30	41.00	29.00	56000.00	1.13
	51.00	1057.00	64000.00	73000.00	.30	61.00	43.00	64000.00	.81
	7.00	1743.00	125000.00	130000.00	.32	72.00	48.50	81000.00	.68
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.00	.00	.00	.00	.00	.00	.00	.00	.00
Class 3	1020.00	447.00	11482.00	28620.00	.38	26.00	15.50	36016.00	2.10
	276.00	765.00	34369.00	57377.00	.30	44.00	30.60	56068.00	1.16
	56.00	1306.00	66607.00	81286.00	.24	55.00	42.00	65646.00	.78
	12.00	1615.00	118833.00	112167.00	.31	74.00	50.50	60325.00	.68
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.00	.00	.00	.00	.00	.00	.00	.00	.00
Class 4	1603.00	512.00	12420.00	31849.00	.39	24.00	14.80	37984.00	2.06
	425.00	820.00	33606.00	53607.00	.30	41.00	28.40	53242.00	1.13
	98.00	1251.00	65800.00	88643.00	.28	53.00	38.30	75603.00	.81
	14.00	1793.00	114286.00	110286.00	.25	64.00	47.60	78603.00	.66
	5.00	2263.00	175400.00	156800.00	.25	78.00	56.30	60680.00	.54
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	6.00	3738.00	418800.00	216400.00	.38	112.00	81.10	50479.00	0.00

APPENDIX C (continued)

Values of structural variables used in regression analysis for each class in CD's 5, 10 and 15 in 1981

Class	No. Obs.	Acres	Total Sales	Machinery Value	AVC	Sales/ Acre	GM/ Acre	Capital/ Labour	ATC
CENSUS DIVISION 5									
Class 1	36.00	624.00	11800.00	68000.00	1.80	18.00	-16.60	63000.00	4.83
	30.00	865.00	36700.00	107000.00	.47	44.00	35.00	106000.00	1.80
	62.00	785.00	73800.00	126000.00	.84	84.00	43.30	114000.00	1.14
	33.00	1028.00	124300.00	166000.00	.83	117.00	55.40	117000.00	.97
	14.00	1342.00	166900.00	231000.00	.44	124.00	60.60	127000.00	.86
	12.00	1356.00	221600.00	287000.00	.40	163.00	88.10	156000.00	.74
	27.00	3701.00	771800.00	473000.00	.37	205.00	180.00	152000.00	.86
Class 2	235.00	548.00	14800.00	57000.00	.72	27.00	7.30	56000.00	2.87
	421.00	734.00	37400.00	81000.00	.49	51.00	26.00	84000.00	1.44
	268.00	1074.00	68700.00	141000.00	.45	64.00	35.70	116000.00	1.12
	180.00	1607.00	118800.00	213000.00	.43	73.00	42.10	141000.00	.89
	72.00	2074.00	167400.00	264000.00	.54	80.00	37.10	147000.00	.87
	43.00	2378.00	221600.00	301000.00	.41	93.00	55.10	158000.00	.78
	60.00	3824.00	482000.00	438000.00	.38	128.00	78.50	191000.00	.84
Class 3	26.00	627.00	13231.00	54823.00	1.21	22.00	-4.50	68000.00	3.80
	53.00	604.00	37830.00	65434.00	.48	64.00	32.80	63508.00	1.38
	97.00	895.00	71010.00	110626.00	.47	78.00	42.30	103010.00	1.08
	40.00	1106.00	121700.00	163728.00	.47	111.00	57.80	121478.00	.94
	28.00	1378.00	167428.00	208143.00	.43	122.00	69.70	146000.00	.83
	11.00	1538.00	216364.00	248495.00	.48	141.00	73.90	185000.00	.83
	24.00	2258.00	885176.00	328118.00	.31	264.00	181.60	110353.00	.48
Class 4	65.00	872.00	19268.00	48708.00	.78	27.00	6.00	54528.00	2.80
	110.00	802.00	36727.00	82808.00	.47	46.00	24.10	83401.00	1.47
	172.00	1087.00	68966.00	109883.00	.45	64.00	35.40	101062.00	1.07
	66.00	1478.00	118838.00	167182.00	.42	81.00	46.70	126818.00	.88
	31.00	2061.00	167032.00	211613.00	.43	83.00	46.60	140689.00	.82
	11.00	2603.00	221081.00	224818.00	.48	90.00	44.40	88106.00	.83
	23.00	3084.00	864865.00	211886.00	.33	218.00	122.80	181788.00	.83
CENSUS DIVISION 10									
Class 1	201.00	363.00	13600.00	60000.00	1.00	37.00	3.33	68000.00	2.88
	200.00	485.00	36400.00	82000.00	.58	75.00	31.50	82000.00	1.53
	180.00	710.00	69900.00	141000.00	.53	98.00	46.30	134000.00	1.18
	86.00	1212.00	122200.00	218000.00	.51	100.00	49.40	182000.00	1.01
	33.00	1280.00	168200.00	221000.00	.48	131.00	68.20	172000.00	.86
	18.00	1516.00	218900.00	278000.00	.46	145.00	78.30	205000.00	.80
	37.00	2525.00	382000.00	427000.00	.52	151.00	72.60	155000.00	.80
Class 2	518.00	287.00	14400.00	84000.00	.71	37.00	10.80	86000.00	2.55
	484.00	546.00	35900.00	87000.00	.51	65.00	32.20	84000.00	1.48
	202.00	783.00	67800.00	140000.00	.44	85.00	47.80	121000.00	1.13
	88.00	1182.00	118800.00	185000.00	.41	98.00	54.50	156000.00	.90
	41.00	1510.00	167500.00	230000.00	.47	110.00	58.80	165000.00	.86
	17.00	1568.00	222400.00	260000.00	.40	141.00	85.10	177000.00	.73
	18.00	3347.00	431000.00	517000.00	.40	128.00	77.30	150000.00	.70
Class 3	236.00	430.00	14247.00	47118.00	.80	34.00	3.40	57287.00	2.74
	301.00	561.00	36565.00	75342.00	.57	70.00	27.80	80296.00	1.80
	341.00	810.00	70000.00	113938.00	.47	81.00	46.10	106540.00	1.10
	128.00	1130.00	120836.00	171638.00	.48	111.00	55.90	128855.00	.96
	48.00	1238.00	171167.00	225042.00	.47	146.00	72.90	138417.00	.88
	24.00	1480.00	217333.00	206333.00	.50	151.00	72.80	84667.00	.83
	28.00	2721.00	858128.00	280378.00	.30	332.00	223.10	112241.00	.43
Class 4	340.00	423.00	14768.00	43471.00	.81	35.00	6.50	82074.00	2.87
	370.00	576.00	35276.00	73276.00	.48	61.00	31.70	74660.00	1.47
	282.00	868.00	67688.00	116915.00	.42	78.00	45.70	108617.00	1.08
	60.00	1227.00	117467.00	128000.00	.45	96.00	53.80	104878.00	.87
	30.00	1724.00	168500.00	246333.00	.45	98.00	54.10	178368.00	.87
	7.00	1577.00	222286.00	181571.00	.28	142.00	100.30	121812.00	.60
	12.00	3212.00	428750.00	412250.00	.40	128.00	78.80	188487.00	.68
CENSUS DIVISION 15									
Class 1	383.00	381.00	11100.00	58000.00	1.08	28.00	-2.60	74000.00	3.35
	170.00	650.00	35200.00	95000.00	.68	54.00	17.30	108000.00	1.64
	125.00	888.00	67400.00	151000.00	.62	75.00	36.40	140000.00	1.33
	34.00	1278.00	118000.00	231000.00	.51	92.00	45.30	202000.00	1.03
	12.00	1570.00	168000.00	280000.00	.58	107.00	45.20	182000.00	1.02
	3.00	1850.00	220800.00	295000.00	.60	118.00	58.70	193000.00	.84
	6.00	2267.00	480000.00	272000.00	.37	211.00	154.60	148000.00	.45
Class 2	803.00	450.00	12300.00	52000.00	.91	27.00	3.40	64000.00	3.06
	518.00	716.00	25100.00	86000.00	.54	48.00	22.60	104000.00	1.53
	306.00	1044.00	66100.00	151000.00	.50	63.00	31.70	144000.00	1.31
	87.00	1680.00	115000.00	243000.00	.52	67.00	32.50	168000.00	1.07
	21.00	1860.00	163000.00	303000.00	.43	87.00	50.00	212000.00	.91
	4.00	2983.00	226000.00	577000.00	.55	75.00	34.00	383000.00	1.08
	8.00	3007.00	377000.00	358000.00	.38	125.00	77.70	162000.00	.68
Class 3	583.00	477.00	12200.00	50741.00	.92	26.00	2.30	68550.00	3.03
	380.00	680.00	36000.00	83474.00	.57	53.00	22.50	93743.00	1.55
	287.00	865.00	66870.00	136485.00	.52	68.00	33.30	131288.00	1.33
	61.00	1368.00	118482.00	183852.00	.50	87.00	43.40	143266.00	1.00
	29.00	1630.00	165758.00	243828.00	.48	102.00	52.10	155908.00	.84
	7.00	2348.00	223286.00	306786.00	.59	96.00	38.00	142828.00	.86
	19.00	3446.00	483158.00	305579.00	.46	151.00	76.30	145406.00	.71
Class 4	637.00	505.00	12500.00	40808.00	.84	25.00	1.50	64686.00	2.93
	324.00	765.00	35756.00	88537.00	.55	47.00	20.80	84867.00	1.54
	228.00	1088.00	67000.00	143685.00	.48	62.00	33.40	140244.00	1.18
	42.00	1521.00	115680.00	229024.00	.42	76.00	44.30	191067.00	.87
	17.00	2234.00	160882.00	262060.00	.47	76.00	38.30	173443.00	.91
	10.00	2463.00	218600.00	418600.00	.46	88.00	48.30	176548.00	.82
	5.00	8174.00	881200.00	830600.00	.60	150.00	41.10	118800.00	.88

APPENDIX D

Statistics Canada Statistique Canada

FORM 6

1981 CENSUS OF AGRICULTURE

CENSUS REPRESENTATIVE USE

Farm Operator's Residence

PROV.	FED No.	EA No.	VN
001	002	003	

Visit No.	Ag. Quest. No.	Office Use	
004	005	006	007

Farm Headquarters 008 ☐ same EA as residence OR

PROV.	FED No.	EA No.	VN
009	010	011	

Aux francophones

Si ce questionnaire anglais vous a été remis par erreur et si vous désirez un questionnaire français, veuillez demander à la téléphoniste préposée aux appels interurbains le numéro ZENITH 0 1981 à compter du 28 mai, 9 heures à 21 heures; celle-ci vous mettra en communication sans frais avec le bureau de recensement le plus près, qui vous fera parvenir la version française du questionnaire.

The Legal Requirement for the Census

The Census of Canada is taken under the authority of the Statistics Act which requires everyone to provide the information requested.

Legal Confidentiality

The information you give will be kept confidential and used only for the production of statistics. No one will see the answers you give except for employees sworn to secrecy under the Statistics Act. Persons who have been sworn under the Statistics Act are subject to prosecution and legal penalties if they disclose personal census information.

INSTRUCTIONS

1. Complete this questionnaire if you operate a farm, ranch or other agricultural holding with sales of agricultural products during the past 12 months of $250 or more.
2. The holding or operation is all land you operate, regardless of ownership or location.
3. Agricultural products include any of the following:
   - livestock and poultry
   - dairy products and eggs
   - field crops
   - fruits or vegetables
   - mushrooms, greenhouse and nursery products
   - fur bearing animals
   - honey and beeswax
   - maple products
4. Answer all questions that apply to your holding. Mark the "Yes", "No" and "None" boxes, where they apply, with an "X".
5. Use your records, if possible. Otherwise, enter your best estimate.
6. Do not report fractions except where space has been provided.
7. For Telephone Assistance, call the long distance operator and ask for ZENITH 0 1981 and you will be connected to the nearest Census Office without charge.

Note

1. If you wish to report your land area in metric, check the "Metric" box below and answer the area questions in metric units (hectares instead of acres, square metres instead of square feet).

   "Metric" ☐ 074

2. In some regions of the Province of Quebec the land is surveyed in arpents. If your holding is in one of these regions, check the "Arpents" box below and answer the area questions in arpents.

   "Arpents" ☐ 075

PLEASE COMPLETE THIS QUESTIONNAIRE ON JUNE 3, 1981
THEN KEEP IT FOR THE CENSUS REPRESENTATIVE
WHO WILL PICK IT UP. DO NOT MAIL.

Section I – OPERATOR AND RESIDENCE, JUNE 3, 1981

- The operator is the person responsible for the day-to-day decisions made in the operation of the holding.
- If the holding is operated as a partnership, enter the name and address of one of the partners. (For other partners see Question 4.)
- Please be sure only one Agricultural questionnaire is completed for this holding.

1. Name and mailing address of the operator (Owner, tenant, or hired manager)

Family or last name (Print)
Usual first name and initials (Print)
P.O. Box No., R.R. No. or name of road or street
Name of post office
Postal code
Area code   Telephone Number

2. How old were you (the operator) on your last birthday? *(Mark an "X" in appropriate box.)*

01 ☐ 15-19 years	04 ☐ 30-34 years	07 ☐ 45-49 years	10 ☐ 60-64 years	006
02 ☐ 20-24 years	05 ☐ 35-39 years	08 ☐ 50-54 years	11 ☐ 65-69 years	
03 ☐ 25-29 years	06 ☐ 40-44 years	09 ☐ 55-59 years	12 ☐ 70 years and over	

3. How many months did you (the operator) live on the holding during the past 12 months? *(Mark an "X" in appropriate box.)*

1 ☐ 9-12 months	3 ☐ 4 months or less	077
2 ☐ 5-8 months	4 ☐ Did not live on this holding	

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APPENDIX D (continued)

Section II – TYPE OF ORGANIZATION, JUNE 3, 1981

4. Mark (x) the one box which best describes this holding

1 ☐ Individual or family holding (excluding partnerships and corporations) ——→ Skip to Section III

Partnership

2 ☐ with a written agreement, or

3 ☐ with no written agreement (a verbal partnership)

- Enter second partner's name and address in the space provided below. For additional partner(s) use "Comments" section at the end of the questionnaire
- Please be sure only one Agricultural questionnaire is completed for the partnership holding

Corporation (a legally constituted company):

4 ☐ with most of the shares owned by you and your family, or

5 ☐ with most of the shares owned by other person(s) or business

- Enter corporation name and head office address in the space provided below

Other types of organization

6 ☐ Institution

7 ☐ Community Pasture

8 ☐ Hutterite Colony

9 ☐ Other – please specify type ____________________

- Enter organization name and address in the space provided below

201 Name (Print)

202 Mailing address (Print) P.O. Box No., R.R. No. or name of road or street

203 Name of post office | 204 Postal code

Section III – LOCATION, AREA AND VALUE, JUNE 3, 1981

5. Location
- List each lot, section or part separately. Include all land operated, whether owned, rented or leased from others.
- Do not include land rented or leased to others.
- Do not include land used under a per head grazing permit or fee (Community Pasture, Crown Land, etc.)
- List on the top line the parcel of land on which the headquarters (main buildings or main gate) is located.
- If a farm manager operates land owned by the employer, report the land as owned. If the employer rents or leases the land from others, it should be reported as rented or leased.
- In areas where it is possible to record land descriptions, make sure they are accurate and complete so as to permit locating the land on a map.
- If more space is required, continue in the "Comments" section at the end of the questionnaire or add a separate list.

AREA AND DESCRIPTION OF LAND YOU OPERATE

Quarter and section or Lot No.	Township	Range or Concession	Meridian (Western Provinces only)	Owned, rented or leased from others (check which): owned	rented or leased	Area in acres
Head quarters ——→				☐	☐	
				☐	☐	
				☐	☐	
				☐	☐	
				☐	☐	
				☐	☐	
				☐	☐	
				☐	☐	
				☐	☐	

6. What is the total area of all land you operate? (This is the total area of land recorded in Question 5) .... 600 / 601

7. (a) Area owned (Do not include land you rent or lease to others) 602

(b) Area rented or leased from others (Include land worked by you on share rent basis) ....
(The total of (a) and (b) must equal the total acreage in Question 6)

603 [illegible]

8. What is your estimate of the present market value of all the buildings and land you operate? (Include the value of the farm dwellings and the value of land and buildings rented or leased from others) .... $

APPENDIX D (continued)

- 3 -

Section IV – AREA OF FIELD CROPS, 1981

- Report the total area of the various crops seeded or to be seeded for harvest in 1981, even if they were sown or planted in an earlier year.
- If more than one crop is to be seeded on the same land for harvest also in 1981, report each crop. Be sure to enter details in the "Comments" section at the end of the questionnaire so that the land itself will not be counted twice.
- Report to the nearest acre.

	Acres
GRAINS	
9 Spring sown wheat *(Do not include durum or utility wheat)*	034
10 Durum wheat	035
11 Utility wheat (Western Provinces only)	036
12 Winter wheat (sown last fall)	037
13 Oats for grain *(Report oats to be cut for green feed, hay or silage in Question 28)*	038
14 Barley for grain *(Report barley to be cut for green feed, hay or silage in Question 29)*	039
15 Mixed grains for grain (two or more grains sown together)	040
16 Corn for grain *(Report corn for silage in Question 25. Report sweet corn in Question 61)*	041
17 Fall rye for grain (sown last fall)	042
18 Spring rye for grain	043
19 Buckwheat	044
OILSEEDS	
20 Flaxseed	045
21 Soybeans for beans	046
22 Sunflowers	047
23 Rapeseed (Canola)	048
24 Mustard seed	049
HAY AND FODDER CROPS	
25 Corn for silage	050
26 Alfalfa and alfalfa mixtures cut or to be cut for hay, silage or seed	051
27 All other tame hay cut or to be cut for hay, silage or seed *(Do not include alfalfa and alfalfa mixtures)*	052
28 Oats to be cut for green feed, hay or silage	053
29 Other fodder crops (to be cut for green feed, hay or silage) Specify ______	054
OTHER CROPS	
30 Potatoes grown for sale	[illegible]
31 Tobacco	[illegible]
32 Sugar beets for sugar	057
33 Dry field peas *(Report canning peas in Question 57)*	[illegible]
34 Dry field beans	[illegible]
35 Other field crops (from the list below, for each field crop, check the box and enter the code and area in the spaces provided) → Code ☐☐☐	
→ ☐☐☐	
→ ☐☐☐	

Crop	Code	Crop	Code
☐ Canary seed	[illegible]	☐ Sod grown for sale	[illegible]
☐ Fababeans (broad bean or horsebean)	081	☐ Sorghum	[illegible]
☐ Lentils	[illegible]	☐ Triticale	[illegible]
☐ Millet	[illegible]	☐ Other *(specify below)*	[illegible]
☐ Root crops for feed	[illegible]	______	
☐ Safflower	[illegible]		

CR USE ☐

APPENDIX D (continued)

Section V – SPECIALTY CROPS, 1981

TREE FRUITS

36. Have you 25 or more fruit trees on the holding? ☐ No → Skip to Question 44 ☐ Yes → Answer Questions 37 to 43

- Do not include trees that are abandoned
- For tree crops not listed below enter the number of trees and area in the "Comments" section at the end of the questionnaire

Enter the number of trees and area for the following
(Report area to the nearest tenth acre)

	Number of trees – Non-bearing age	Number of trees – Bearing age	Total acres all ages
	070 number	071 number	072 acres
37. Apple	073	074	075 acres
38. Pear	076	077	078 acres
39. Plum and prune	079	080	081 acres
40. Cherry (sweet)	082	083	[illegible] acres
41. Cherry (sour)	[illegible]	[illegible]	[illegible] acres
42. Peach	[illegible]	[illegible]	090 acres
43. Apricot			

CULTIVATED BERRIES AND GRAPES (grown for sale)

44. Do you grow any berries or grapes for sale? ☐ No → Skip to Question 48 ☐ Yes → Answer Questions 45 to 47

Enter the area harvested or to be harvested in 1981 of the following
(Report to the nearest tenth acre)

	Acres
	091
45. Strawberries	092
46. Grapes	093
47. Other (raspberries, cranberries, high bush blueberries, cultivated low bush blueberries, etc.) Specify	

VEGETABLES GROWN FOR SALE (Do not include greenhouse products)

48. Will any vegetables (excluding potatoes) be grown this year for sale (for fresh market, canning, freezing or other processing)? ☐ No → Skip to Question 64 ☐ Yes → Answer Questions 49 to 63

Enter the area of the following vegetables harvested or to be harvested in 1981 for sale
(If more than one crop is to be harvested from the same land in 1981, report each crop. Be sure to enter details in the "Comments" section at the end of the questionnaire so that the area itself will not be counted twice.)

(Report to the nearest tenth acre)

	Acres
	[illegible]
49. Asparagus	[illegible]
50. Beans (wax, green or snap)	[illegible]
51. Beets	097
52. Broccoli	[illegible]
53. Cabbage	[illegible]
54. Carrots	100
55. Cauliflower	101
56. Cucumbers	102
57. Green peas	103
58. Lettuce	104
59. Onions (dry)	

	Acres
	105
60. Rutabagas (turnips)	106
61. Sweet corn	107
62. Tomatoes	
63. Other (from the list below, for each vegetable grown check the box and enter the code and area in the spaces provided)	Code ☐

Crop	Code
☐ Brussels sprouts	[illegible]
☐ Cantaloupes	[illegible]
☐ Celery	110
☐ Green onions (shallots)	111
☐ Melons	112
☐ Parsnips	113
☐ Peppers	114
☐ Pumpkins	115
☐ Radishes	116
☐ Rhubarb	117
☐ Spinach	118
☐ Squash	119
☐ Vegetable marrow	120
☐ Other *(specify below)*	121

GREENHOUSES, MUSHROOMS, NURSERY PRODUCTS (grown for sale)

64. Do you have a greenhouse or grow mushrooms or nursery products for sale? ☐ No → Skip to Section VI ☐ Yes → Answer Questions 65 to 67

Enter the area in 1981 of the following

65. Nursery products (Include area of cut flowers, bulbs, shrubs, trees, vines, ornamentals, etc. grown out of doors. Report and in Question 35)	122 acres
66. Greenhouses (glass, plastic or other protection)	123 square feet
67. Mushroom houses	124 square feet

CR USE

APPENDIX D (continued)

- 8 -

Section VI – USE OF LAND IN 1981

	Acres
68 Cropland for harvest in 1981 (Total of the areas in Questions 9 to 35, 37 to 43, 45 to 47, 49 to 63 and 65 less double cropping)	125 126
69 Improved land for pasture (Including pasture or grazing land improved by seeding, draining, irrigating, fertilizing or brush or weed control. Do not include area to be cut this year for hay, silage or seed)	127
70 Summerfallow (Land from which no crop will be harvested in 1981 but which instead will be cultivated, worked or sprayed to control weeds or conserve moisture. Do not include idle land which has not been worked or sprayed for more than one year)	128
71 Other improved land (farm buildings, barnyards, lanes, home gardens, improved idle land, etc.)	129
72 Woodland (woodlots, Christmas trees, sugar bush, tree wind-breaks, cut-over land, etc.)	130
73 Other unimproved land (unimproved hay land, native pasture, range land, sloughs, marshes, etc.)	131
74 Total of Questions 68 to 73 (This total must equal the total area of the holding, Question 6)	

Section VII – AREA HARVESTED FOR FORAGE SEED, 1980

75 Did you harvest any grass, clover or alfalfa seed in 1980?
☐ No ——→ Skip to Section VIII
☐ Yes ——→ Answer Questions 76 to 83

Report only the area from which forage seed was actually harvested

	Acres harvested 1980		Acres harvested 1980
76 Alfalfa for seed	132	80 Red clover for seed	136
77 Alsike for seed	133	81 Sweet clover for seed	137
78 Bromegrass for seed	134	82 Timothy for seed	138
79 Creeping red fescue for seed	135	83 Other (specify) ____	139

Section VIII – FERTILIZER USE, 1980

84 Was any commercial fertilizer applied on this holding in 1980? (Do not include lime)
☐ No ——→ Skip to Section IX
☐ Yes ——→ Answer Questions 85 to 87

Report the area only once, no matter how many applications were made.

	Acres fertilized 1980	Total tonnes used 1980
85 Total cropland fertilized (excluding tame hay and improved pasture)	140 acres	141 tonnes
86 Total tame hay fertilized (excluding improved pasture)	142 acres	143 tonnes
87 Total improved pasture fertilized	144 acres	145 tonnes

Section IX – SPRAYING AND DUSTING, 1980

88 Was any chemical spray or dust applied to your land or crops in 1980? (Include herbicides, insecticides, fungicides. Do not include seed treatments.)
☐ No ——→ Skip to Section X
☐ Yes ——→ Answer Question 89

Include cropland, pasture, summerfallow, etc. Include applications by custom operators

	Acres sprayed or dusted in 1980
89 Land or crop area sprayed or dusted in 1980	
(a) For control of weeds and brush	146
(b) For control of insects and disease	147

Section X – IRRIGATION

(Include custom irrigation)

90 Is there a crop irrigation system on this holding capable of adding water by any artificial or controlled means? (Do not include ditches and equipment used exclusively for drainage) No ☐ Yes ☐ 148

	Acres irrigated
91 Total area irrigated in 1980 (Report the area only once regardless of how many times it was irrigated) None ☐	149
92 Of the total area irrigated in 1980, what was the area irrigated by sprinkler system? None ☐	150

APPENDIX D (continued)

Section XI – LIVESTOCK ON THIS HOLDING, JUNE 3, 1981

- Include all animals on this holding, regardless of ownership
- Do not include livestock owned by you but kept on a farm, ranch or feedlot operated by someone else
- Include any animals owned by you but pastured on a community pasture or public land

CATTLE AND CALVES

93. Are there any cattle or calves on this holding? { ☐ No → Skip to Question 96 / ☐ Yes → Answer the Questions below — 151 office use

	Number
(a) Bulls, 1 year and over	152
(b) Cows (all cows and heifers which have calved at least once) (i) mainly for dairy purposes	153
(ii) mainly for beef purposes	154
(c) Heifers, 1 year and over (which have never calved) (i) raised for dairy herd replacement	155
(ii) raised for beef herd replacement	156
(iii) raised for slaughter	157
(d) Steers, 1 year and over	158
(e) Calves, under 1 year	159
94. Total cattle and calves (total number reported in questions (a) to (e) above)	160

95. Of the cattle and calves reported above, how many weighing 500 pounds (225 kg) and over are being fattened or finished for slaughter? — Number 161

PIGS

96. Are there any pigs on this holding? { ☐ No → Skip to Question 98 / ☐ Yes → Answer the Questions below — 162 office use

	Number
(a) Boars 6 months and over for breeding	163
(b) Sows for breeding and bred gilts	164
(c) All other pigs (i) under 45 pounds (20 kg)	165
(ii) 45 to 130 pounds (20 to 60 kg)	166
(iii) over 130 pounds (60 kg).	167
97. Total pigs (total number reported in questions (a) to (c) above)	168

SHEEP

98. Are there any sheep or lambs on this holding? { ☐ No → Skip to Question 100 / ☐ Yes → Answer the Questions below

	Number
(a) Ewes, rams and wethers, 1 year and over	169
(b) Lambs, under 1 year	170
99. Total sheep and lambs (total number reported in questions (a) and (b) above)	171

OTHER LIVESTOCK AND BEES

100. Are there any other livestock on this holding? { ☐ No → Skip to Section XII / ☐ Yes → Answer Questions 101 and 102 — Number

101. Horses and ponies (all ages) — 172

102. Other livestock (from the list below, for each kind of other livestock, check the box and enter the code and number in the spaces provided) — Code

Name	Code
☐ Goats	173
☐ Rabbits	174
☐ Chinchillas	175
☐ Mink	176
☐ Fox	177
☐ Colonies of Bees (Report all colonies you own)	178
☐ Other (specify below)	179

APPENDIX D (continued)

- 7 -

Section XII – POULTRY, JUNE 3, 1981

- Include all poultry on this holding, regardless of ownership.
- Do not include poultry owned by you but kept on a farm or ranch operated by someone else.

103. Are there any poultry on this holding? ☐ No ——→ Skip to Section XIII ☐ Yes ——→ Answer Questions 104 to 109

HENS AND CHICKENS — Number

104. (a) Hens and pullets, 20 weeks and over, kept for laying

(b) Pullets and pullet chicks, under 20 weeks, intended for laying

(c) All other chickens (roasters, chicks, broilers, roosters, fryers, etc.)

105. Total chickens (total number reported in questions (a) to (c) above)

OTHER POULTRY

106. Turkeys (all ages)

107. Geese (all ages)

108. Ducks (all ages)

109. Other (pheasants, guinea fowl, etc.) Specify ______

Section XIII – MACHINERY AND EQUIPMENT, JUNE 3, 1981

- Report all machines and equipment on this holding on June 3, 1981 regardless of ownership.
- If a machine is owned on a share basis, report it only if it is located on this holding.
- Do not include old machines no longer in use.
- Present market value is the amount which machinery or equipment of a similar age and condition would bring at an auction sale in your district.

	Total number	Total present market value (dollars only)
110. Automobiles	188	189 $ /00
111. Farm trucks (Only report trucks used in the farm business)	190	191 $ /00
112. Tractors (other than garden tractors) (a) 20 – 49 p.t.o. hp. (15 – 37kw)	192	193 $ /00
(b) 50 – 99 p.t.o. hp. (38 – 74kw)	194	195 $ /00
(c) 100 – 149 p.t.o. hp. (75 – 111kw)	196	197 $ /00
(d) 150 p.t.o. hp. (112kw) and over	198	199 $ /00
113. Grain combines: (a) Self-propelled	200	201 $ /00
(b) Pull type	202	203 $ /00
114. Swathers (Report mower-conditioners in Question 117): (a) Self-propelled	204	205 $ /00
(b) Other	206	207 $ /00
115. Balers (Report field stack makers in Question 117): (a) making bales less than 200 lbs. (90 kg)	208	209 $ /00
(b) making bales 200 lbs. (90 kg) or more	210	211 $ /00
116. Forage crop harvesters	212	213 $ /00
117. Present market value of other machinery and equipment (Underline applicable machines) (Tillage and planting machinery, tractor attachments; mowers, conditioners, mower-conditioners; spraying equipment, threshers, specialized harvesters, wagons; shop tools, hand tools, portable irrigation equipment, field stack makers; grain, manure and forage handling machinery; dryers; dairy equipment, etc.)		214 $ /00
118. Total value of all machinery and equipment *(Total of values reported in Questions 110 to 117)*		215 $ /00

Section XIV – HIRED AGRICULTURAL LABOUR, 1980

15 years of age and over – (Do not include housework or custom work.)

- Calculate and record the total number of weeks of paid labour during 1980. *For example, 5 people hired for one week are to be reported as 5 weeks of labour.*

		Total weeks
119. Total weeks of paid hired labour during 1980 .... None ☐	Year-round	216
	Seasonal	217

Note: In calculating total weeks consider –
6 days or 48 hours as equivalent to 1 week
1 month equivalent to 4 weeks
1 year equivalent to 52 weeks.

4-3200-35.1

APPENDIX D (continued)

-8-

Section XV – SELECTED EXPENDITURES DURING 1980

(Include 1980 expenses, whether already paid or to be paid, by you or others for agricultural production on this holding.)

		Amount (dollars only)
120. Rent paid for agricultural land and buildings rented or leased from others. (Also include taxes paid by you on land and buildings rented or leased from others.)		218
(a) Cash basis	None ☐	$ /00
(b) Share or kind basis (Report estimated dollar value)	None ☐	219 $ /00
121. Cash wages paid to hired agricultural labour (Do not include wages paid for housework or custom work. Include any contributions for unemployment insurance, Canada Pension Plan, Quebec Pension Plan, Workmen's Compensation, etc. made on behalf of your employees)	None ☐	220 $ /00
122. Feed and supplements purchased (Also include hay)	None ☐	221 $ /00
123. Seed and seedlings purchased	None ☐	222 $ /00
124. Fertilizers and lime purchased	None ☐	223 $ /00
125. Agricultural chemicals purchased (Include insecticides, herbicides, fungicides and other pesticides)	None ☐	224 $ /00
126. Machine rental and custom work	None ☐	225 $ /00
127. Fuel, oil and lubricants used for farm business (Also include farm business share for automobiles and heating costs)	None ☐	226 $ /00
128. Repairs and maintenance to farm machinery (Also include farm business share for automobiles)	None ☐	227 $ /00
129. Repairs and maintenance to farm buildings and fences (Do not include additions and new construction)	None ☐	228 $ /00
130. Electricity used (Include farm business share only)	None ☐	229 $ /00

Section XVI – FOREST PRODUCTS AND MAPLE TAPPINGS

		Value (dollars only)
131. Value of forest products sold in 1980 (Include Christmas trees, fuelwood, pulpwood, logs, fence posts, pilings, etc. Do not include maple products)	None ☐	230 $ /00
		Number
132. Number of taps made on maple trees in the spring of 1981	None ☐	231

Section XVII – VALUE OF AGRICULTURAL PRODUCTS SOLD DURING 1980

Include:

- sales of all agricultural products (see Instruction 3, page 1)
- landlord's share of products sold (share rent)
- any Canadian Wheat Board payments received during 1980 regardless of the crop year to which they apply
- cash advances for stored grain, patronage dividends, crop insurance, stabilization and deficiency payments
- any Marketing Board and/or agency payments received during 1980.
- direct sales – roadside stands, farmers' markets, with your own, etc.

Do not include:

- sale of capital (for example, land, buildings or machinery).
- sales of products received from land rented or leased to others.
- value of forest products sold.

	Value (dollars only)
133. Total gross value of agricultural products sold during 1980	232 $ /00

Section XVIII – OFF-FARM WORK DURING 1980

(Do not include exchange work. Convert part days to full days on the basis of an 8 hour day.)

		Days
134. How many days did you (the operator) work off this holding in 1980 at		
(a) paid agricultural work?	None ☐	233
(b) paid non-agricultural work?	None ☐	234

COMMENTS

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