THE UNIVERSITY OF MANITOBA

THE IMPACT OF AN INCREASE IN GRAIN FREIGHT RATES AND TRUCKING DISTANCE ON FARMLAND MARKET PRICE IN MANITOBA

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

DEPARTMENT OF AGRICULTURAL ECONOMICS

WINNIPEG, MANITOBA

May, 1984

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ACKNOWLEDGEMENTS

I wish to express a special thanks to Dr. D. F. Kraft for his advice and patience over the several years of the project. The most rewarding aspect of graduate studies was the opportunity to work with Dr. Kraft and partially absorb his skills in conceptualization.

In addition the author would like to thank the following people who contributed to this study.

Dr. E.W. Tyrchniewicz who initially accepted me as a graduate student and continually supported my case with the Faculty of Graduate Studies for thesis extensions.

Mr. R. Chu, computer analyst, who helped me program and analyze the farmland sales data.

D. Haynes and K. Guilbault for their excellent typing skills.

And finally to my wife Louise, a special "thank you" for her encouragement and patience throughout the duration of the study.

ABSTRACT

The purpose of the study was to determine if an increase in grain transportation costs would decrease farmland prices. Specifically, the study examined the impact on land prices related to increases in grain delivery distance and grain freight rates. According to economic theory an increase in farmers' production cost ceteris paribus would cause a decrease in net income and expected future income levels and subsequently cause buyers to bid less for farmland.

The analytical model used in the study consisted of two interdependent components. The first component A estimated current farmland prices as a function of last year's farmland price, current net income and grain inventory stored on farms. Farmland price equations were estimated for three classes of land categorized according to their characteristics for producing cereal grains. Two locations were selected to represent different real estate markets and agricultural characteristics. Study area 1 was represented by the Red River Valley region and study area 2 was represented by the Birtle-Russell region. The second component B, modelled farm enterprises for study areas 1 and 2. A linear programming methodology was chosen for component B.

Grain transportation cost increases were simulated and imposed on the model farm enterprises to determine the effect on net income. Changes in net income were worked through the farmland price equations developed in component A to estimate the impact on farmland price.

Crop substitution in the model farms was limited as grain transportation costs increased. In both study areas, the three principal crops - wheat, oats and barley became less profitable as the statutory freight rate increased by four times. Other crops such as alfalfa-grass became relatively more profitable but remained significantly less profitable than the principal crops resulting in limited crop substitution.

An increase in grain delivery distance of up to 30 miles was found to have no measurable impact on farmland prices. An increase in grain freight rates reduced land prices under low grain price conditions but not under high grain price conditions. In study area 1, under 1977 low grain prices conditions, as the statutory grain freight rate was increased by 3, 3.5 and 4 times, the market price of class 1 farmland decreased by 6.3, 7.9 and 9.5 percent respectively. In study area 2, under 1977 prices, as the statutory freight rate was increased by 3.5 and 4 times, the market price of class 1 farmland decreased by 5.2 and 6.2 percent respectively.

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Chapter I

INTRODUCTION

1.1 Statement of Problem

The fundamental question addressed in this study is: Is there an inverse relationship between grain transportation costs and farmland prices.

Policy makers in both private and public institutions would be interested because it is unclear whether an increase in grain transportation costs, due to an increase in farmers' grain delivery distance and grain freight rates, would have a negative impact on farmland prices.

In 1981/82, the Crowsnest Pass Rate or statutory freight rate, which western producers currently pay on export bound grain, covered about 18.6 percent of the total cost incurred by the railways in the transportation of statutory grain.[1] Since farmers avoid over 80 percent of the total rail cost it could be argued the statutory rate subsidizes western grain producers. If this

[1]J.C.Gilson, Western Grain Transportation, a special report prepared for the Department of Transport, Government of Canada, Ottawa, June 1982, Chapter IV, p.32.

subsidy is removed and farmers incur higher transportation costs, then economic rent theory suggests that a drop in net revenue per acre would depress farmland prices in absolute terms or cause a slower rate of appreciation.

Some grain producers have argued that an increase in grain delivery distance from farm to primary elevator could affect farmland prices.[2] In many areas in Western Canada over the past 20 years, farmers have experienced an increase in delivery distance when railway branch lines and primary elevators were closed.

Consolidation of the primary elevator system has been occuring since the 1945-46 crop year. The number of country shipping points in Western Canada has decreased from a high of 2,152 in 1945-46 to 1,246 in 1981-82.[3] This represents a 42 percent decrease over that period. The trend has been the closure of uneconomical older elevators and the construction of larger high through-put elevators.

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[2]Canada Grains Council, Grain Handling and Transportation in the Brandon Area, January 1974, p.33.

[3]Canadian International Grains Institute, Grains and Oilseeds, Handling, Marketing and Processing, Second Edition, Winnipeg, Manitoba, May 1975, Appendix IV, p.87 and Canadian Grain Commission, Grain Elevators in Canada, Annual Reports from 1975/76 to 1981/82, Supply and Services, Ottawa.

A factor which may accelerate the centralization process is a change in the freight rate structure from the present statutory rate to a variable or incentive freight rate. A variable rate would be a negotiated rate between a railway and a shipper based on the category of the rail line and elevator through-put capability.

Alternately an increase in grain transportation costs may not have a negative impact on farmland prices because transportation costs are only one of many factors influencing the farmland market. In the case of an increase in grain freight rates the premise for the Federal Government's 1982 Crow Rate review was that a new freight rate structure, with farmers paying more, would facilitate the development of additional rail capacity for shipping grain. Assuming that additional rail capacity is realized in the 1980's western grain farmers should be able to consistently export relatively larger quantities. This in turn would likely encourage a more intensive type of grain production with higher levels of inputs per acre, increased yields per acre and higher net revenue per acre. If this scenario unflolds then an increase in production would tend to offset any negative impact on net revenue per acre brought about by higher freight rates.

In the case of an increase in grain delivery distance, over the past 60 years over-land bulk transportation has advanced from the horse and wagon era to a system of modern grain trucks. This advancement in technology has made the transportation cost component relatively less important when compared to other production costs. Producers may not base their selection of a delivery point purely on distance, but rather haul grain a greater distance because of better service, better grades and less dockage and a preference for a particular elevator manager.

As stated in United Grain Growers's Submission to the Grain Handling and Transportation Commission of Inquiry:[4]

> As the elevator system evolves, it is true that the producer who is left more remote from the remaining elevators will have relatively higher delivery costs. In time however, he can adopt his own operation to reflect these circumstances without significant adverse effects. A new farmer will find land values reflective of his ease of access to the handling system, and his relative disadvantage will thereby be further mitigated. It should also be noted that farm values are affected far more by other factors such as soil type and productivity than by distance from the elevator.

It would appear that some producer organizations do not support the argument that an increase in delivery distance

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[4]United Grain Growers, Submission to Grain Handling and Transportation Commission of Inquiry, Winnipeg, September 1975, p.50.

has a negative impact on farmland prices.

Several questions arise about the relationship between transportation costs and farmland prices. Would an increase in grain freight rates cause a change in rural economic organization and structure? Would the economic conditions (i.e. grain prices) prevailing at the time of the transportation policy change have any influence on the severity of the impact? Would all regions in Western Canada and classes of farmland be affected equally by an increase in transportation cost? How will farmers react to an increase in shipping costs? Will farmers shift partially or totally to production activities not directly affected by an increase in freight rates? Will farmers resist change because of entrenched habits, investments in equipment and traditional patterns in crop rotation?

1.2 Objectives and Scope of the Study

The intention of this thesis is to study the farmland market as influenced by transportation factors. The 3 general objectives are as follows:

(a) To develop an analytical model to estimate the impact of increasing transportation costs on farmland prices in two representative study areas of Manitoba.

(b) To determine if the market price of classes 1, 2 and 3 farmland in each area would respond in a similar manner to an increase in transportation cost.

(c) To determine if and to what degree cropping patterns would change in each study area as transportation costs increase.

The scope of the thesis includes the following:

(a) The use of multiple regression analysis to estimate farmland price equations for classes 1, 2 and 3 farmland in two study areas of Manitoba.

(b) The use of linear programming models to simulate net farm income and cropping pattern changes in each study area as transportation costs are increased.

(c) The integration of changes in net farm income through the farmland price equations to estimate the impact on farmland price of increasing transportation costs.

1.3 Areas Selected for Study

Study Area 1 (Red River Valley)

(a) Location and Rural Municipalities

As shown in Figure 1, study area 1 represents the area bounded by the United States border on the south, the Red River on the east and Lake Manitoba on the north. The western boundary is represented by the western borders of rural municipalities Portage La Prairie, Grey, Dufferin, Thompson, and Stanley. Other municipalities in the study area include Cartier, MacDonald, Morris, Montcalm, Rineland and Roland.

(b) Principal Agricultural Characteristics

Based on 1971 Census data[5], the area has 2,267,000 acres of total land area of which 90.8% is improved land. The area represents about 16% of the total improved land in Manitoba. There are 5,043 farms with an average size of 450 acres. The average capital investment (land, buildings, equipment and livestock) is about $71,200. Of the total revenue earned from field crops in 1976 wheat contributed about 51%, oats 11.7%, barley 16.6%, flaxseed 6.6%, sunflowers 4%, rapeseed 3.6%, field peas 3%, grain corn 2.2% and about 1% from buckwheat. In addition to crops, the area has a significant livestock industry (dairy, beef, hogs, poultry).

(c) Soil Type, Topography and Climate

The soils are generally clay to heavy clay loams with uniform texture, good fertility and few stones. The topography is generally flat and poorly drained. The annual precipitation is 19 to 21 inches and the area has one of the highest corn heat-unit ratings in the province.[6]

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5 1971 census data best represents the agricultural characteristics of each study area since the analytical model was based on the 1958-76 period.

6 University of Manitoba, Faculty of Agriculture, Principles and Practices of Commercial Farming, (Winnipeg: Publications Office - University of Manitoba, 1977), page 15.

Study Area 2 (Birtle - Russell)

(a) Location and Rural Municipalities

As shown in Figure 1, study area 2 is contained on the west side by the Saskatchewan border and lies southwest of Riding Mountain National Park. The area includes 13 rural municipalities which are as follows: Archie, Birtle, Blanshard, Ellice, Hamiota, Harrison, Miniota, Rossburn, Russell, Saskatchewan, Shoal Lake, Silver Creek and Strathclair.

(b) Principal Agricultural Characteristics

Based on 1971 Census data, study area 2 has 1,958,000 acres of total land area of which 66.3% is improved land. The area represents about 10% of the total improved land in Manitoba. There are 3,028 farms with an average size of 647 acres. The average capital investment (land, buildings, equipment and livestock) is about $60,700. Of the total revenue earned from field crops in 1976 wheat contributed about 51%, barley 30.5%, flaxseed 3% and rapeseed 2.5%. In addition to crops, the area has a significant livestock industry (beef, hogs, poultry, dairy).

(c) Soil Type, Topography and Climate

The soils are generally loam to clay loam with some rocks and stones. Topography is gently rolling with good to excellent drainage. Annual precipitation is about 18 to 20 inches.

1.4 Organization of the Thesis

This report consists of five chapters, three appendixes and a bibliography.

Chapter I identifies the problem, states the objectives and scope of the study and describes the areas selected for study.

Chapter II explores the economic theory and conceptual basis for the thesis. The relationship between farmland price and farmland productive value is examined.

In Chapter III the hypotheses are stated and the analytical model is developed in two interdependent components A and B. In component A, multiple regression analysis is used to estimate farmland price equations for classes 1, 2 and 3 farmland in study areas 1 and 2. In component B, linear programming (LP) models are designed to represent typical or average farm enterprises for each study area. Grain transportation cost increases are simulated and imposed on the model farm enterprises developed for study areas 1 and 2 to ascertain the impact on net farm income.

In Chapter IV the statistical results of component A and B are summarized independently and then integrated to estimate the impact of increasing transportation costs on farmland price.

Chapter V contains the summary, conclusions, limitations, policy implications and suggestions for further research.

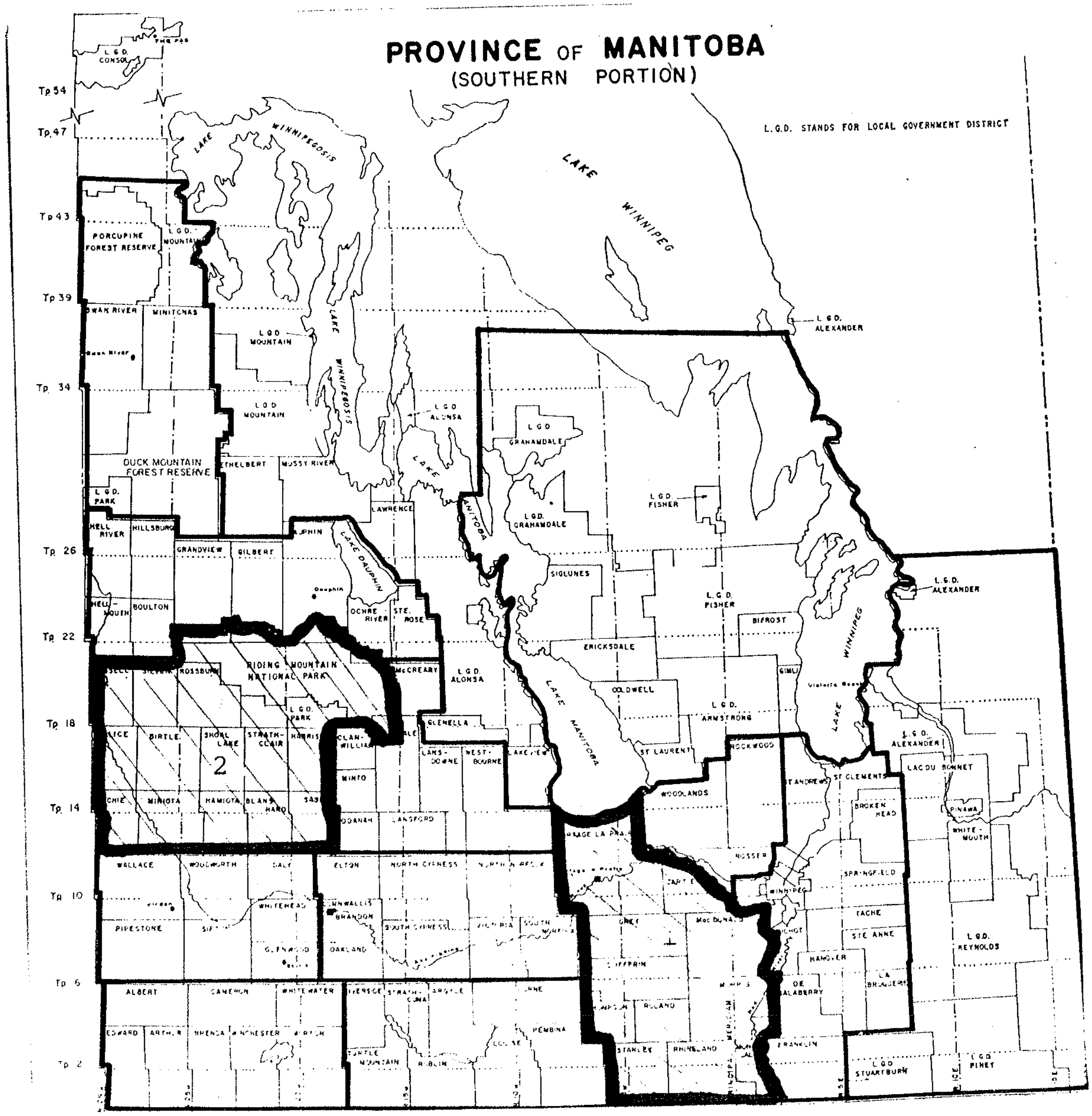


Figure 1

Geographical Location of Study Area 1: Red River Valley and Study Area 2: Birtle-Russell in the Province of Manitoba

Chapter II

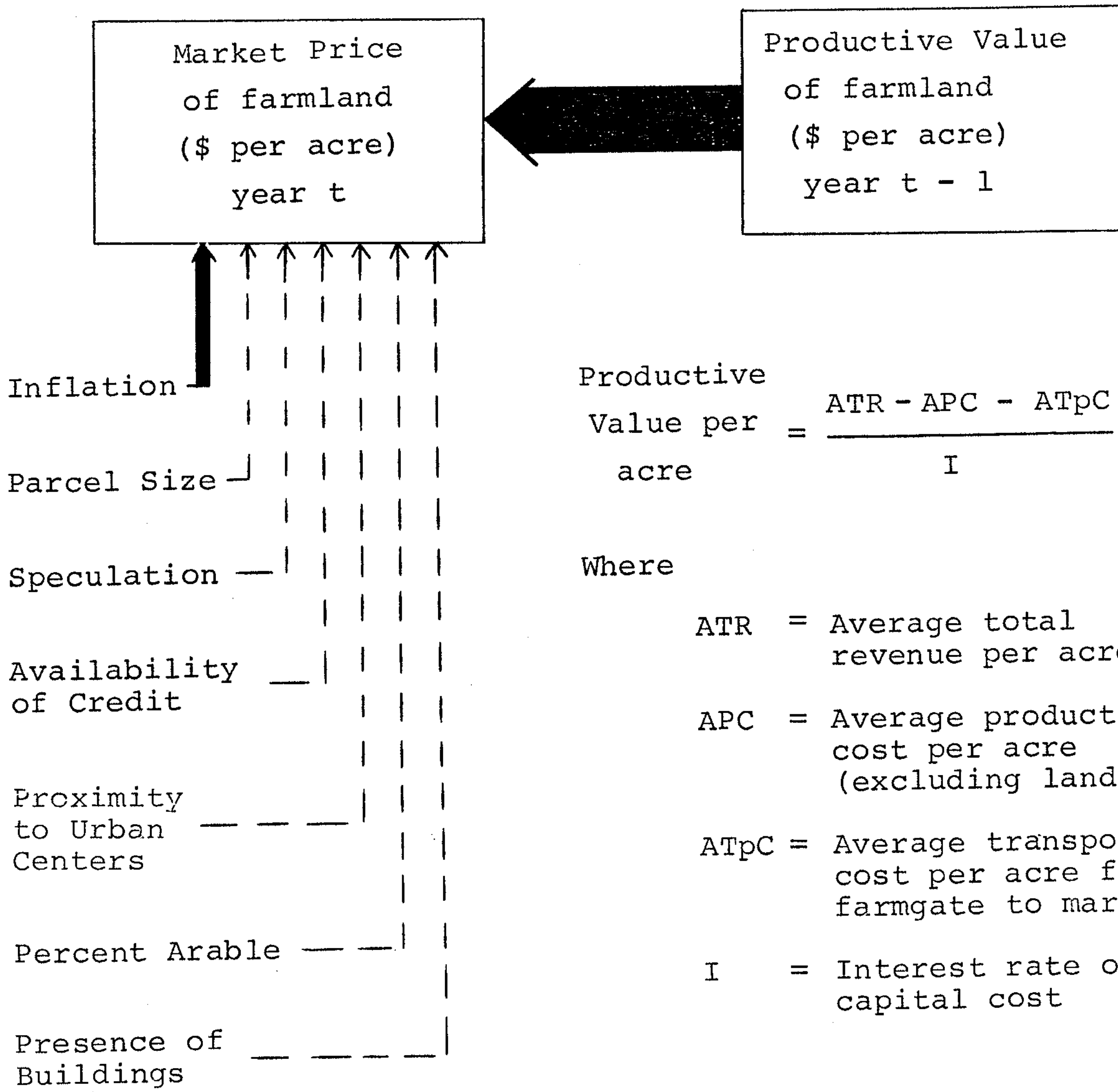
ECONOMIC THEORY AND CONCEPTUAL DESIGN

In this chapter the economic theory and conceptual basis for the thesis are examined. The relationship between farmland price and productive value is reviewed.

2.1 As shown in Figure 2, the relationship between market price and productive value of farmland is the theoretical basis of the study.

The market price or exchange value is the money price for which land will sell for in the open market at a particular time. Factors such as inflation, speculation, size of parcel, proximity to urban centers, presence of buildings and amount of arable land may cause the market price to exceed the productive value. Farmland buyers' expectations as to future grain prices, production costs and inflation dictate the extent farmland prices correspond to productive value.

The productive value is the value resulting from the capitalization of future net incomes anticipated from the property. The productive value is the maximum value of the land which can be economically justified by what the land will return after costs have been deducted. The productive value is the largest single variable influencing the price



$$\text{Productive Value per acre} = \frac{ATR - APC - ATpC}{I}$$

Where

ATR = Average total revenue per acre

APC = Average production cost per acre (excluding land)

ATpC = Average transportation cost per acre from farmgate to market

I = Interest rate or capital cost

Figure 2

Hypothesized Relationship Between Farmland Market Price and Independent Variables

Note* arrows indicate:

a) causality and direction of influence

b) degree of influence - the heavier the arrowed line the stronger the influence hypothesized of farmland. It is expected that the productive value and market price are positively related, that is as the productive value per acre increases the market price per acre will increase. The above relationship suggests that farmland price would decrease in relation to any downward movement in productive value, however market price tends to be somewhat rigid as the productive value declines. Farmland price will eventually trend downward if an economic downturn is prolonged and farmers' income expectations from the land remain relatively low.

Farmland price does not adjust instantaneously to changes in productive value. It is expected that market price adjustments lag one or two years behind adjustments in productive value. Historically, the relationship between market price and productive farmland value is such that in the adjustment process the market price moves at a rate of only 15 to 20 percent towards the productive value in any one year.[7]

As illustrated in Figure 2, it is hypothesized that a change in any factor influencing the productive value per acre would cause a change in the market price of farmland. For example, a change in one or more of the following factors would likely cause a change in productive

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[7] Personal conversation with Dr. D. Kraft, Department of Agricultural Economics, University of Manitoba, March 23, 1978.

land value and subsequently in farmland price.

(a) International grain trade trends such as rapidly increasing demand for grain resulting in higher farmgate grain prices or the converse.

(b) Technological changes in crop yields.

(c) Technological changes in crop production costs.

(d) Interest rate or cost of capital trends.

(e) An increase in grain transportation costs such as an increase in grain delivery distance and grain freight rates.

2.2 The productive value formula in Figure 2 consolidates most independent variables which were identified as influencing farmland price in previous studies.[8] The productive value formula is equal to net revenue per acre divided by a capitalization rate.

The independent variables accounted for in the productive value formula were as follows:

(a) soil productivity index

(b) expected gross farm income

(c) 5 year average yield of wheat

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8 R.G. Roehle, "An Econometric Analysis of Farmland Values in Western Canada", unpublished MSc thesis, Department of Agricultural Economics, University of Manitoba, Winnipeg, 1971 pp 32 - 36 and V.J. Fields, "The Influence of Grain Freight Rates on the Farm Land Market in the Prairie Provinces", unpublished MSc thesis, Department of Agricultural Economics, University of Manitoba, October, 1980, p.32.

(d) total crop receipts per acre in year t - 1
($ per acre)

(e) change in total crop receipts per acre
in year t - 1 from year t - 2 ($ per acre)

(f) technological advance time trend variable

(g) index of commodities and services used by farmers in
Western Canada

(h) ratio of debt to equity

(i) manhours of labor used per acre

(j) distance to the nearest shipping point

(k) farm mortgage rate

In the simplest case of agricultural land with no apparent prospect of appreciation from external influences such as urban or recreational uses, the capital land value would be simply the capitalization of net rental values. It would represent the present worth of all future incomes anticipated from the land.[9]

2.3 The productive value formula in Figure 2 is based on the following capital budgeting equation for farmland:

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[9] D.L. Fletcher, "A Review of Theory Related to Land Value and some Aspects of the Land Value Problem", unpublished M.A. thesis, University of Manitoba, Winnipeg, 1934, p.24.

$$V = \frac{a}{(1 + r)^1} + \frac{a}{(1 + r)^2} + \ldots \frac{a}{(1 + r)^n} \text{ or } \frac{a}{r}$$

Where V = present value of farmland which represents the present worth of all future net incomes anticipated from the land.

a = net income per acre per year for n years

r = interest or mortgage rate or capitalization rate

n = the number of years between the present and the time when the future income is received.

The previous long formula is a geometric progression which simplifies to a reduced formula $V = a/r$. This reduced version is used to capitalize an income which extends in perpetuity.[10]

The reduced present value formula ($V = a/r$) provides an accurate estimate for farmland price if the following three conditions are met:

1. the investment (i.e. land) is expected to produce the same annual rent over time.
2. the capitalization rate used to discount future net rent remains constant.

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10 Fletcher, op. cit., p.10

3. an infinite or very long planning period is considered.[11]

Condition 1 (constant rent) and condition 2 (constant interest rates) are subject to considerable variation over time. Constant rent per year never holds because crop yields tend to fluctuate depending on weather and the ability to sell grain is rarely consistent from year to year. Also, the cost of capital changes from year to year. Even with these limitations the present value reduced formula ($V = a/r$) or the productive value formula is useful to estimate a generalized farmland price.

In this chapter the economic theory and conceptual basis for the thesis was examined. The relationship between farmland price and productive value was reviewed. The type of independent variables incorporated in the productive value formula were examined. The productive value formula was shown to be equivalent to the present value reduced formula for farmland.

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11 W.F. Lee, "A Capital Budgeting Model for Evaluating Farm Real Estate Purchases", Canadian Farm Economics, Volume 11, Number 3, June 1976.

Chapter III

ANALYTICAL MODEL - HYPOTHESES, DATA AND PROCEDURE

In Chapter III the hypotheses are stated and the analytical model is developed in two interdependent components A and B. In component A, multiple regression analysis is used to estimate farmland price equations for classes 1, 2 and 3 farmland in study areas 1 and 2. In component B, a linear programming (LP) model is specified to represent typical or average farm enterprises for each study area. Grain transportation cost increases are simulated and imposed on the model farm enterprises to ascertain the impact on net farm income.

3.1 As shown in Chapter II activities which influence net revenue per acre could be expected to influence productive farmland value and subsequently farmland prices.

The first hypothesis deals with the effect an increase in grain delivery distance may have on farmland price.

The second hypothesis deals with the effect that an increase in grain freight rates may have on farmland prices. In both hypotheses, a negative impact on farmland prices is defined as a decrease in market price in absolute terms or an appreciation in market price at a relatively lower rate. For an alternative hypotheses to be accepted, the change in farmland price must be measurable and statistically significant.

3.2 Component A: Estimation of Farmland Price Equations by Multiple Regression Analysis.

Based on the hypothesized relationship between farmland price and independent variables as illustrated in Figure 2, equation 3.1 was formulated:

$$Y_{ik_t} = a_{ik} + b1_{ik} \; Y_{ik_{t-1}} + b2_{ik} \; PC_{ik_t} + u_{ik} \qquad (3.1)$$

Where Y_{ik_t} = average farmland price in study area i for class k in period t (dollars per acre)

a_{ik} = intercept for farmland class k in study area i

$b1_{ik}$ = the coefficient which represents the magnitude of the relationship between Y_{ik_t} and $Y_{ik_{t-1}}$ for class k in study area i

$Y_{ik_{t-1}}$ = average farmland price in study area i for class k in period t-1 (dollars per acre)

$b2_{ik}$ = the coefficient which represents the magnitude of the relationship between Y_{ik_t} and the principal component variable PC_{ik_t}

PC_{ik_t} = the principal component variable[12] for class k in study area i in period t

u_{ik} = error term for class k in study area i

i = study areas 1 and 2.

k = farmland classes 1, 2 and 3.

t = 17 years, 1960-76.

In the general equation the intercept a_{ik} is hypothesized to be statistically insignificant. Economic theory would suggest that if the productive value of farmland was set equal to zero then it should follow that the market price would be zero or nearly zero. The relationships between Y_{ik_t} and $Y_{ik_{t-1}}$ and between Y_{ik_t} and PC_{ik_t} are expected to be statistically significant. Farmland classes 2 and 3 will likely respond to changes in productive value (e.g. change in grain prices) in a similar manner as class 1 responds.

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12 The principal component variable represents the productive value of farmland by consolidating two major independent variables - net income per acre and grain inventory.

The econometric technique selected to estimate farmland price over a time series was multiple regression analysis.[13] In addition, the principal component[14] technique was used to consolidate two major independent variables thus retaining the contribution of the two variables and reducing the intercorrelation between the two variables.

Dependent Variable (Average Farmland Price)

In the regression analysis the dependent variable (Y_{ik_t}) was represented by an annual average farmland price (dollars per acre) of all farmland sales over a 17 year period (1960-1976). Six regression equations were estimated representing 3 classes of farmland in each study area.

The initial step in the design of the analytical model was the division of the farmland in each study area into 3 classes. The division of the farmland into classes

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13 For an introduction to the econometric technique see the following: Fred H. Kerlinger and Elazor J. Pedhazur, Multiple Regression in Behavioral Research, (New York: Holt, Rinehart and Winston Inc., 1973).

14 A more detailed explanation of the use of the principal component can be found in: A. Koutsoyiannis, Theory of Econometrics, (London, England: The MacMillan Press Ltd., 1973), Chapters 11 and 17.

was fundamental to both components A and B. For the purposes of this study the 3 classes of farmland were defined as follows:

Class 1: Prime Farmland - that land which would be best suited for the production of cereal grains and/or special crops in 9 out of 10 years. A large percent of the land is cultivated and has a high productivity rating.

Class 2: Marginal Farmland - that land which would be best suited for either grain production and/or forage crops depending on the relative price relationship of grains and livestock. The percentage of cultivation varies from medium to high and the soil productivity is somewhat lower than prime land.

Class 3: Sub-Marginal Farmland - that land which would be best suited for forage crops and/or livestock pasture in 9 out of 10 years. The percent of cultivation varies from low to medium and the soil productivity is somewhat lower than classes 1 and 2. In the event of high grain prices the land may be profitable in grain production.

Five criteria were used to divide farmland into classes 1, 2 and 3. First, a soil productivity index system was used to determine a weighted average wheat yield for each soil zone. Second, farmland assessment value represented agricultural productive capability and market price. Third, market price reflected the value of farmland in the open market. Fourth, soil characteristics as outline in government soil reports represented a descriptive analysis of soil types and recommended type of agriculture. A tentative farmland class division was established based on the first four criterion. The fifth criterion, the agricultural representatives' opinion was used to clarify the placement of border line soil types. See Appendix A for a more detailed explanation of the methodology of farmland class division.

Independent Variables

As shown in Figure 2, the hypothesized relationship between farmland price and independent variables indicates that such factors as productive value, inflation, parcel size, percent arable and presence of buildings contribute to farmland price.

In the final regression analysis the salient independent variables were average farmland price in the previous year, the sum of net income in t-1 and t-2 and the sum of grain inventory in t-1 and t-2. Initially, the grain inventory variable was thought to be accounted for in the income variable but it was later separated and regressed as an independent variable. Other independent variables such as parcel size, percent arable and presence of buildings were examined for suitability in time series regression analysis and eventually were deleted.

The income variable represented by average productive value and grain inventory on-farm were the principal independent variables.

Average Productive Value

The productive value results from the capitalization of future net incomes anticipated from the property. For the purpose of this study the average productive value was determined by equation 3.2.

$$APV_{ik_t} = \frac{ATR_{ik_t} - APC_{ik_t} - ATpC_{ik_t}}{I_t} \quad (3.2)$$

Where APV_{ik_t} = Average farmland productive value for class k land in study area i in period t ($ per acre).

ATR_{ik_t} = Average total revenue for class k land in study area i for period t ($ per acre)

APC_{ik_t} = Average production cost for class k land in study area i for period t ($ per acre)

$ATpC_{ik_t}$ = Average transportation cost from farmgate to primary elevator for class k land in study area i in period t ($ per acre).

I_t = Interest rate or capital cost in period t

i = Study areas 1 and 2

k = Farmland classes 1, 2 and 3

t = 19 years, 1958-76

See Appendix A for a more detailed explanation of average productive value.

Grain Inventory Variable

The second major independent variable regressed on farmland price was grain stocks on farm or grain inventory. As grain inventory increases grain sales and revenue are postponed into the future. Increasing grain stocks contribute to lower cash flow and have a negative influence on producers' expectations of the future.

The following three methods were developed to represent the inventory variable:

Inventory 1: Value of wheat, oats and barley stocks on farm ($ per crop activity acre)

Inventory 2: Wheat stocks on farm (bushels per crop activity acre)

Inventory 3: Wheat, oats and barley stocks on farm (bushels per crop activity acre)

In inventory 1 wheat, oats and barley stocks in each study area were multiplied by the respective average grain price at the primary elevator. The dollar value of the stocks was summed and divided by the crop activity acres.[15] In inventory 2 the wheat stocks in each area were divided by the respective crop activity acres. In inventory 3 wheat, oats and barley stocks in each area were summed and divided by the crop activity acres.

The grain stocks by study area were estimated by apportioning total provincial wheat, oats and barley stocks on farm on the same percentage basis as the study areas contributed to the total provincial production of each grain. Grain stocks on farm as of July 31 originate primarily from the crop production in the previous year.

Crop activity acres were used to reflect that grain stocks on any given farm must be carried by all

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[15] Crop activity acres were defined as annual crop acres (i.e. wheat, oats, barley, flaxseed, rapeseed) plus summerfallow.

active crop land including farmland being fallowed in preparation for crop production. Summerfallow was included because fallow is included in the seeded acreage and structure of the Canadian Wheat Board's quota system. As defined under the quota system fallow acreage tends to enhance a farmer's market access therefore fallow helps to reduce the burden of stocks and subsequently influences producer expectations.

Inventory 3 or the actual physical stocks on farm was selected to represent the inventory variable. Inventory 1 or value of grains was not used because the sharp grain price increase from 1973-76 distorted the inventory series. Based on actual stocks, 1968 shows the highest stock level during the period from 1958-76, but according to inventory 1, value of stocks, 1976 would appear to have the highest level. It is debatable whether physical stocks or stock value has the greatest impact on producer expectations but for the purpose of this study physical stocks were used.

3.3 Component B: Estimation of Model Farm Enterprises by Linear Programming

In this section two linear programming (LP) models were specified to represent typical enterprises for study areas 1 and 2. The LP models were static and represented only one year. The objective function of the

LP models was to maximize farm net income. The model farm enterprises were based on field surveys of agricultural representatives in each study area. The model farms were designed to show the effect on net farm income of increases in grain transportation costs.

A general form of the objective equation for the linear programming model is shown in equation 3.3.

$$Z_i = C_1 X_1 + C_2 X_2 + C_3 X_3 \ldots\ldots\ldots C_n X_n \quad (3.3)$$

Where Z_i = objective function to maximize farm net income for model farm enterprise in study area i (dollars).

C_n = net income per acre for each activity ($ per acre)

X_n = Crop activity (acres)

n = number of Crop activities

i = study area 1 or 2

Subject to the resource inequalities:

$$\begin{array}{ccccccc} a_{11} x_1 & + & a_{12} x_2 & \cdots\cdots\cdots & a_{1n} x_n & \leq & b_1 \\ \vdots & & \vdots & & \vdots & & \vdots \\ a_{m1} x_1 & + & a_{m2} x_2 & \cdots\cdots\cdots & a_{mn} x_n & \leq & b_m \end{array}$$

Where b_m = restraint levels

a_{mn} = resource requirement per unit of X_n activity

and $x_1 \geq 0,\ x_2 \geq 0 \ldots\ldots\ldots x_n \geq 0$

Linear programming is a modelling technique which solves for the most profitable product mix given certain restraints expected in the farm enterprise.[16]

There are several assumptions and limitations in the use of linear programming as an analytical technique.

Linear Programming Assumptions

1. Additivity and linearity - each activity is independent and additive
2. Divisibility - activity processes and restraints are divisible
3. Finite number of processes - linear programming has definable limits
4. Solution is one valued expectations
5. Each additional unit of output requires the same quantity of inputs
6. Each producer is fully rational and rational behaviour consists in trying to maximize net income.

Linear Programming Limitations

1. Major variables used in LP models such as relative prices and input/output coefficients are exogenous and cannot be estimated by the model

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16 Raymond R. Beneke and Ronald Winterboer, "Linear Programming Applications to Agriculture", The Iowa State University Press, Ames, 1973.

2. LP models do not take into account the risk preferences of the producer
3. Activities which involve decreasing costs cannot be treated adequately with present programming methods
4. Restraints are hard to specify due to uncertainties

Field Surveys of Study Area 1 and 2

The model farm enterprises were based on field surveys of agricultural representatives in study area 1 and 2. The surveys were conducted in November 1978 by telephone. In study area 1, Red River Valley, the interview was conducted with Mr. C. Harrison, Morris, Manitoba and in study area 2 it was conducted with Mr. W.E. Lambert, Shoal Lake, Manitoba.

The objectives of the study and description of the study areas were discussed with the agricultural representatives. The agricultural representatives were informed that a crop budgeting model[17] developed at the University of Manitoba was being used to estimate a typical or average farmer's crop production costs in 1977. The surveys or

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17 Crop budgeting model or crop production simulator model was developed by the Department of Agricultural Economics and Farm Management, University of Manitoba, July 1977.

questionnaires were designed in accordance to the information requirements of the crop budgeting model. Tentative answers were estimated from historical data, prior to the telephone interviews, to facilitate discussion and for comparison purposes.

Detailed agronomic crop production information such as sequence of field operations and application rates of fertilizer and chemicals were obtained from the field surveys. In study area 1, production costs were estimated for wheat, oats, barley, flaxseed, rapeseed, grain corn, corn silage, sunflowers, alfalfa-grass and bromegrass. In study area 2, production costs were estimated for wheat, oats, barley, flaxseed, rapeseed, alfalfa-grass and bromegrass. All major production costs with the exception of land investment were determined to represent the specific characteristics of each study area. See Appendix A for additional information on the design of the LP model farm enterprises. Details of the field survey are available from the author upon request.

3.4 In this section grain transportation cost increases were simulated and imposed on the model farm enterprises developed for study areas 1 and 2 to ascertain the effect on net farm income.

Grain transportation cost increases were represented by discounting the base year commodity prices. The base year commodity prices were represented by 1973 high grain price conditions and by 1977 low grain price conditions. The simulated grain transportation cost increases were as follows:

(a) Increased farm trucking cost was represented by an increase in average delivery distance from farm to primary elevator. In study areas 1 and 2 the base delivery distance was increased to 10, 15, 20 25 and 30 miles one-way.

(b) Increased grain freight rate (i.e. Crowsnest Rate) from primary elevator position to export position was represented by a multiple of 3.0, 3.5 and 4.0 of the average statutory freight rate for each study area.

(c) The combined effect of an increase in farm trucking cost as outlined in (a) and an increase in grain freight rates as outlined in (b).

In discounting grain prices to represent increases in grain transportation costs, it was assumed an average farmer had sufficient quota to sell wheat, oats and barley through a primary elevator to the export market in 1973 and 1977. It was necessary to make this assumption because in periods of low quota farmers tend to sell a portion of their grain to local feedmills and feedlots at a discount to the primary elevator price. In effect, farmers set a value on quota by the amount of the price discount. Similarly, the rapeseed price offered by domestic oilseed crushers was assumed to be equal to the export rapeseed price at primary elevators.

3.5 Simulated Increases in Farm Trucking Cost

In study areas 1 and 2 an increase in farm trucking cost was simulated by increasing the average delivery distance from farm to primary elevator. The increase in delivery distance was the difference between the simulated distances of 10, 15, 20, 25 and 30 miles and the 1976 average delivery distance of 4.2 miles which represented study area 2. The average delivery distance for area 1 in 1976 was estimated at 5.8 miles. The lower of the two average delivery distances was used as a base distance for both areas to ensure that the simulated increases were not underestimated.

The average farm trucking cost per bushel-mile for each simulated delivery distance was estimated by a function developed by Tyrchniewicz et al[18] in a 1967-68 farm trucking cost study. The increased trucking cost per bushel was equal to the difference between the base average cost per bushel and the average cost per bushel for each simulated delivery distance. The base year commodity prices for 1973 and 1977 were discounted by the increase in trucking cost.

3.6 Simulated Increases in Grain Freight Rates

The 1977 railway costs for moving statutory grain were estimated by Snavely[19] at an average cost of $14.11 per tonne. The farmers' share of the total cost was $4.58 per tonne or 32.5 percent. Based on 1977 data the average cost of moving grain was estimated to be about 3 times the cost to farmers. To simulate increases in the

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18 E.W. Tyrchniewicz, A.H. Butler and O.P. Tangri The Cost of Transporting Grain by Farm Truck, Research Report No. 8, Center for Transportation Studies, University of Manitoba, July 1971.

19 The Commission on the Costs of Transporting Grain by Rail Report, Supply and Services, Ottawa, October 1978.

grain freight rate a multiple of 3 was used as a starting point. Representative statutory rates in study areas 1 and 2 were multiplied by a factor of three. In addition, to simulate future increases in railway grain transportation costs the statutory rate was increased by 3.5 and 4 times.

Statutory freight rates to export position at Thunder Bay and Vancouver were selected by reviewing rates at representative shipping points in each study area. In study area 1, 15 cents per cwt was selected to represent the statutory rate for grain to Thunder Bay. Since over 90 percent of the rapeseed exports in 1977 were shipped through Vancouver, a freight rate of 35.5 cents per cwt was selected to represent rapeseed. The rate for flaxseed to Thunder Bay was represented by 16.5 cents per cwt. In study area 2, 18 cents per cwt was selected to represent the freight rate for grain to Thunder Bay. The rapeseed freight rate was 35.5 cents per cwt to Vancouver and the flaxseed rate to Thunder Bay was 19.5 cents per cwt.

The statutory freight rates for wheat, oats, barley, flaxseed and rapeseed for study areas 1 and 2 were increased by 3, 3.5 and 4 times. The net freight rate increase per bushel for each commodity was the amount discounted from the base year commodity prices represented by 1973 and 1977 (See Appendix A, Tables A.13 to A.19).

3.7 Summary

In Chapter III the hypotheses were stated and the analytical model was developed. The economic model was developed in two components. In component A, multiple regression analysis was used to estimate farmland price equations for farmland classes 1, 2 and 3. In component B, linear programming models were developed to represent average farm enterprises for study area 1 and 2. The model farms were designed to show the effect on net farm income of an increase in grain transportation costs.

Transportation cost increases were simulated and imposed on the LP model farm enterprises. Each grain transportation cost increase was represented in the model farms by discounting the 1973 and 1977 base year commodity prices by the net transportation cost increase for each simulation. The total farm net income and crop mix resulting from each simulation was compared to the status quo as represented by the base years. Changes in net farm income were worked through the farmland price equation in component A to estimate the impact of the transportation cost increases on farmland price.

Chapter IV

STATISTICAL RESULTS

In this chapter the statistical results of component A and B of the analytical model are summarized independently and then integrated to estimate the effect of increasing grain transportation costs on farmland price.

4.1 Component A: Farmland Price Equations

Statistical Criteria

Statistical criteria are based on statistical theory and are used to evaluate the statistical reliability of the estimates of the model parameters. In component A three statistical measures were used to assess the degree to which the theoretical model describes the farmland market. They were (a), (b) and (c).

(a) Coefficient of Multiple Determination
(b) Standard Errors of the Estimate
(c) The Student's t test

Statistical Estimation Problem: Multicollinearity

Multicollinearity or intercorrelation arises when two or more independent variables are highly correlated. Intercorrelation makes it nearly impossible to separate the individual influences of the explanatory variables. If two or more independent variables are highly correlated, large standard errors of the regression coefficients may result.

In the study, intercorrelation between the income variable and grain inventory variable ranged from .6 to .7. Since it was desirable to retain both variables the principal component technique was used.

Statistical Results

The farmland price regression equations are presented in this section. The selection of the best estimating equations was based on the statistical criteria previously discussed. The regression equations selected were those which best predicted the turning points in farmland price over the time series. Of special interest were those equations which best predicted the downturn in land prices from 1968 to 1969.

In study area 1, class 1 farmland price was estimated to be a function of farmland price in t-1 and a principal component variable consisting of sum of net income in t-1 and t-2 and sum of grain inventory in t-1 and t-2 (See Table 4.1, equation 1). The regression coefficients for farmland price t-1 and the principal component were significant at the 1% level. As shown in Figure 3, both the actual price and predicted price for class 1 land peaked in 1968 and then turned down in 1969. Also, both the actual and predicted prices turned up in 1973.

In study area 2, class 1 farmland price was estimated to be a function of farmland price in t-1 and a principal component variable consisting of sum of net income in t-1 and t-2 and grain inventory in t-1 (See Tables 4.4, equation 1).

As shown in Figure 4, the actual land price peaked in 1967 while the predicted price peaked in 1968. The actual and predicted prices moved up in a similar manner from 1971 to 1976.

In study areas 1 and 2, class 2 farmland price was estimated by three regression equations with similar statistical significance (See Tables 4.2 and 4.5). Two equations estimated farmland price to be a function of farmland price in t-1 and a principal component variable consisting of an income and grain inventory variable. Equation 1 in both study areas estimated class 2 market price to be a function of class 1 market price. The R^2's were 93.5 and 94.2 percent for study area 1 and 2 respectively. The relationship between class 1 and 2 indicates that as class 1 farmland responds to economic changes (e.g. grain prices) then class 2 would be expected to respond in a similar manner (See Figure 3 and 4).

In study areas 1 and 2, class 3 farmland price was also estimated by three regression equations with similar explanatory powers (See Tables 4.3 and 4.6). In study area 1, equation 1 estimated class 3 market price to be a function of class 1 farmland price. Equation 3 estimated class 3 price to be a function of farmland price t-1, livestock price in t-1 and a principal component variable consisting of an income and grain inventory variable. Each equation was significant with an R^2 of over 90 percent. In study area 2, class 3 market price was estimated in a similar manner. Even though livestock price as an independent variable showed some influence on the price of class 3 land, class 3 price as a function of class 1 price suggests that as class 1 land responds to economic changes, class 3 would respond in a similar manner.

4.2 Component B: Impact on Model Farm Enterprises of Simulated Increases in Grain Transportation Costs

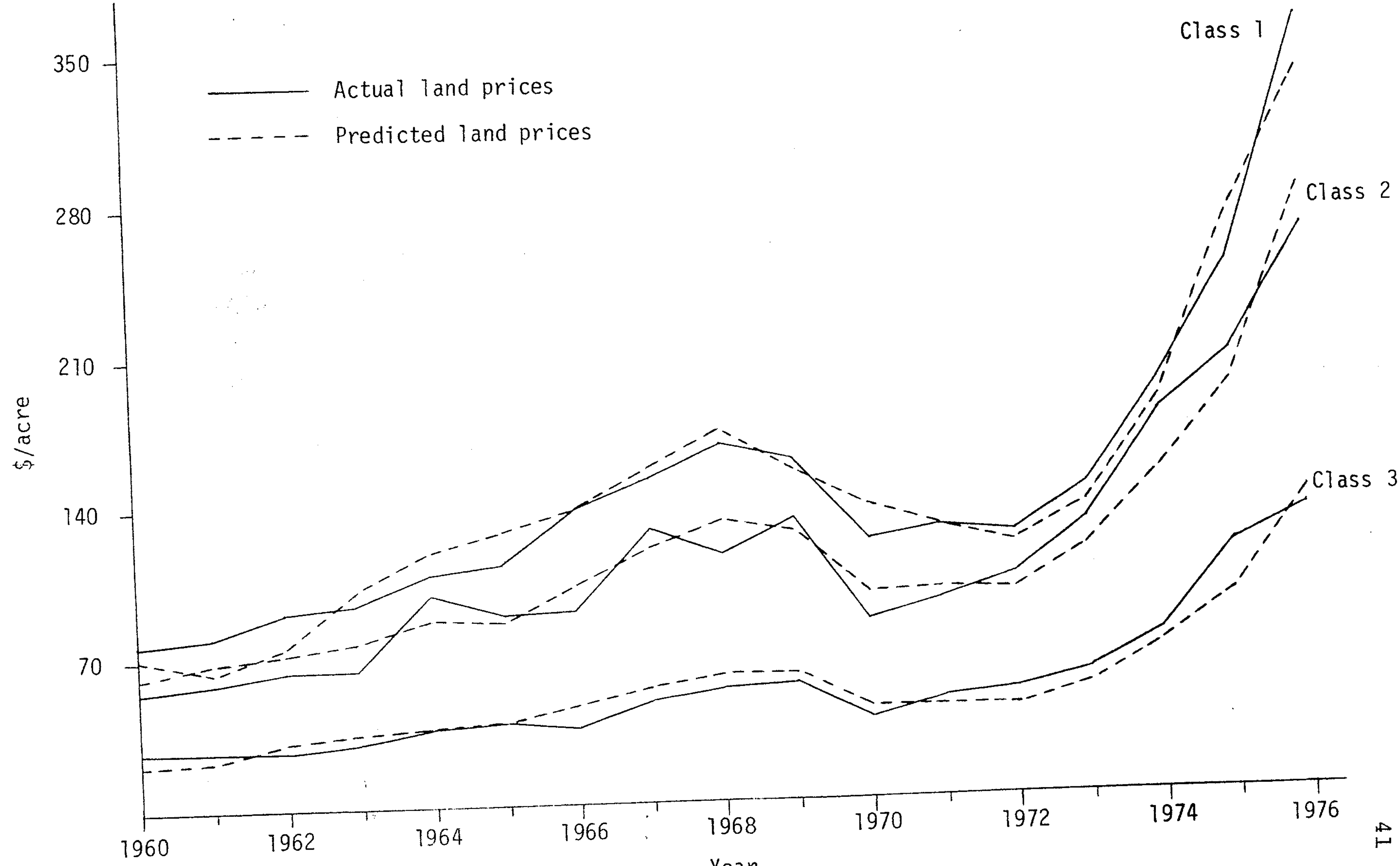

Figure 3

Actual and Predicted Land Prices for Classes 1, 2 and 3
(Study Area 1: Red River Valley)

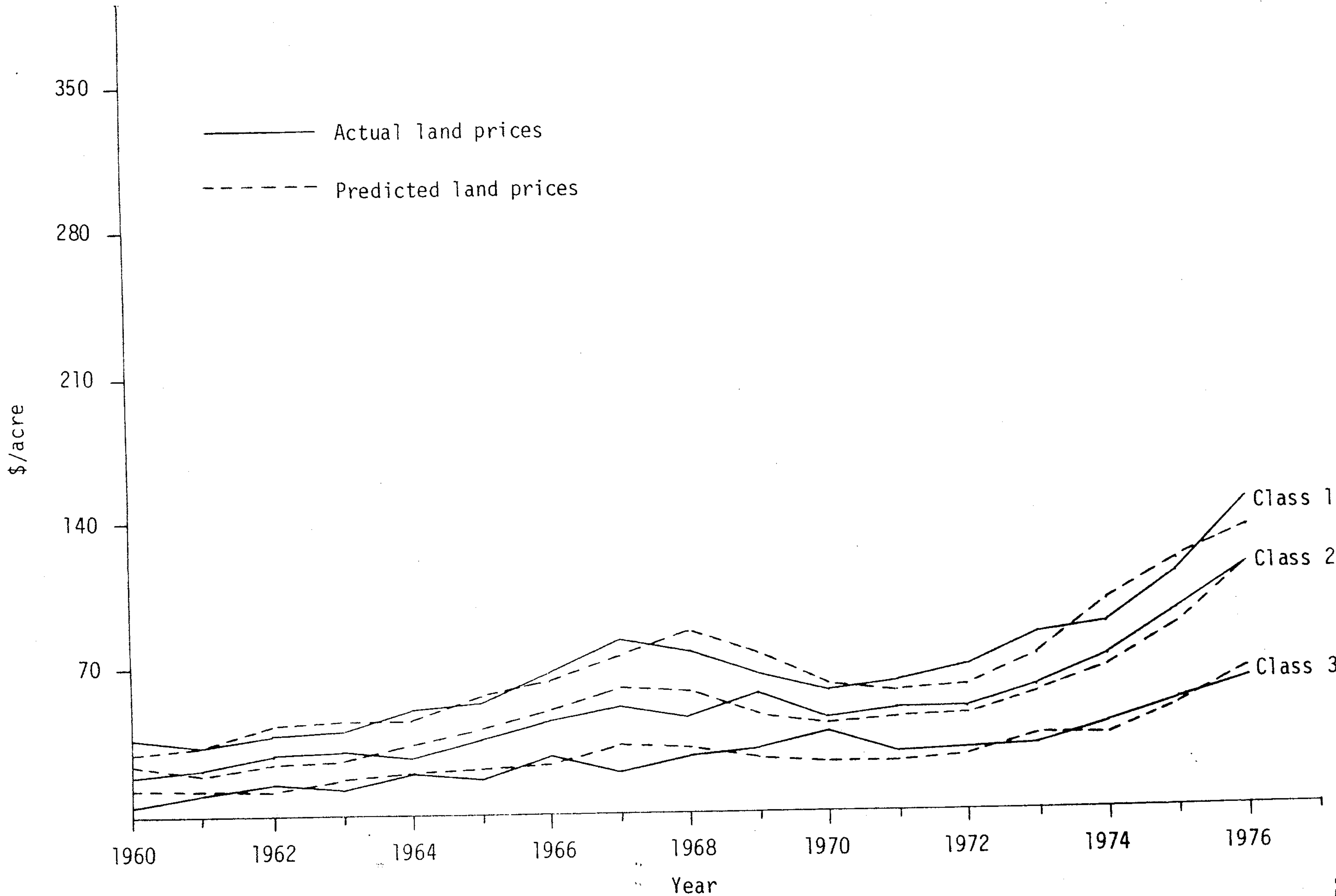

Figure 4

Actual and Predicted Land Prices for Classes 1, 2 and 3
(Study Area 2: Birtle-Russell)

TABLE 4.1

Regression Estimates of Class 1 Prime Farmland Market Price
(Study Area 1: Red River Valley)

Equation Number	Constant Term	Class 1 Farmland Market $Price_{t-1}$	Principal Component	Variables in Principal Component	R^2 (%)	Standard Error of the Estimate ($ per acre)
	Regression Coefficients and Standard Errors[1]					
1 "Best"	-9.4[d] (7.32)	1.192[a] (.055)	18.702[a] (1.87)	$Net_{t-1} + Net_{t-2}$, $Iven^3_{t-1} + Iven^3_{t-2}$	98.4	12.15
2	-9.99[d] (8.17)	1.196[a] (.061)	18.484[a] (2.09)	$P.V._{t-1} + P.V._{t-2}$, $Iven^3_{t-1} + Iven^3_{t-2}$	97.9	13.11
3	-12.18[c] (7.98)	1.212[a] (.06)	18.739[a] (2.10)	$Net_{t-1} + Net_{t-2}$, $Iven^3_{t-1}$	98.0	13.47
4	-17.03[c] (8.53)	1.251[a] (.064)	-17.95[a] (2.2)	Net_{t-1} , $Iven^3_{t-1} + Iven^3_{t-2}$	97.7	13.23

1 - Standard errors are in parenthesis below regression coefficients.
a - significant at 1% level
b - significant at 5% level
c - not significant at the 10% level
d - not significant at the 20% level
Net - average net revenue ($ per acre)
P.V. - average farmland productive value ($ per acre)
$Iven^3$ - on farm stocks of C.W.B. grains (wheat, oats, barley) - bushels per crop activity acre
Class 1 mean market price (1960-76) = $145.90 per acre
Durbin h statistics were not reported but considered in the statistical analysis as to whether autocorrelation was present. Cochrane-Orcutt methodology was followed.

TABLE 4.2

Regression Estimates of Class 2 Marginal Farmland Market Price
(Study Area 1: Red River Valley)

Equation Number	Regression Coefficients and Standard Errors[1]: Constant Term	Class 1 Farmland Market Price$_t$	Class 2 Farmland Market Price$_{t-1}$	Principal Component and Variables Included	R^2 (%)	Standard Error of the Estimate ($ per acre)
1 "Best"	3.15[b] (3.43)	.773[a] (.053)			93.5	14.45
2	2.68[b] (6.81)		1.088[a] (.063)	10.625[a] (2.0) $Net_{t-1} + Net_{t-2}$, $Iven^3_{t-1} + Iven^3_{t-2}$	97.2	14.64
3	3.96[b] (6.71)		1.075[a] (.063)	10.99[a] (1.995) $P.V._{t-1} + P.V._{t-2}$, $Iven^3_{t-1} + Iven^3_{t-2}$	97.3	14.34

1 - Standard errors are in parentheses below regression coefficients.

a - significant at 1% level

b - not significant at 20% level

Class 2 mean market price (1960-76) = $115.90 per acre.

TABLE 4.3

Regression Estimates of Class 3 Sub-Marginal Farmland Market Price
(Study Area 1: Red River Valley)

	Regression Coefficients and Standard Errors[1]						
Equation Number	Constant Term	Class 1 Farmland Market Price$_t$	Class 3 Farmland Market Price$_{t-1}$	Livestock Price$_{t-1}$	Principal Component and Variables Included	R^2 (%)	Standard Error of the Estimate ($/acre)
1 "Best"	-7.75[c] (4.87)	.414[a] (.031)				92.5	8.36
2	.294[d] (3.021)		1.132[a] (.063)		6.754[a] (1.061) $P.V._{t-1} + P.V._{t-2}, Iven^3_{t-1} + Iven^3_{t-2}$	97.7	6.52
3	-7.90[b] (3.661)		.998[a] (.068)	.5728[a] (.1908)	6.515[a] (.864) $P.V._{t-1} + P.V._{t-2}, Iven^3_{t-1} + Iven^3_{t-2}$	98.5	5.26

1 - Standard errors are in parentheses below regression coefficients.

a - significant at 1% level

b - significant at 5% level

c - not significant at 10% level

d - not significant at 20% level

Class 3 mean market price (1960-76) = $52.63 per acre.

TABLE 4.4

Regression Estimates of Class 1 Prime Farmland Market Price
(Study Area 2: Birtle-Russell)

Equation Number	Constant Term	Class 1 Farmland Market Price$_{t-1}$	Principal Component	Variables in Principal Component	R^2 (%)	Standard Error of the Estimate ($/acre)
	Regression Coefficients and Standard Errors[1]					
1 "Best"	2.139[b] (5.46)	1.07[a] (.086)	6.683[a] (1.466)	$Net_{t-1} + Net_{t-2}$, $Iven^3_{t-1}$	94.5	7.00
2	3.16[b] (5.38)	1.053[a] (.085)	-6.834[a] (1.456)	$P.V._{t-1} + P.V._{t-2}$, $Iven^3_{t-1}$	94.8	7.00
3	2.543[b] (6.64)	1.065[a] (.105)	5.95[a] (1.69)	$Net_{t-1} + Net_{t-2}$, $Iven^3_{t-1} + Iven^3_{t-2}$	92.6	7.70
4	3.64[b] (6.49)	1.046[a] (.103)	-6.212[a] (1.677)	$P.V._{t-1} + P.V._{t-2}$, $Iven^3_{t-1} + Iven^3_{t-2}$	93.2	7.64
5	-.586[b] (6.0)	1.115[a] (.094)	5.72[a] (1.594)	Net_{t-1} , $Iven^3_{t-1}$	93.1	7.93
6	-.056[b] (6.07)	1.106[a] (.095)	5.769[a] (1.63)	$P.V._{t-1}$, $Iven^3_{t-1}$	93.1	8.01

1 - Standard errors are in parentheses below regression coefficients.

a - significant at 1% level

b - not significant at 20% level

Class 1 mean market price (1960-76) = $67.50 per acre.

TABLE 4.5

Regression Estimates of Class 2 Marginal Farmland Market Price
(Study Area 2: Birtle-Russell)

Equation Number	Constant Term	Class 1 Farmland Market Price$_t$	Class 2 Farmland Market Price$_{t-1}$	Principal Component and Variables Included	R^2 (%)	Standard Error of the Estimate ($/acre)
	Regression Coefficients and Standard Errors[1]					
1 "Best"	-6.787[b] (3.87)	.828[a] (.053)			94.2	6.12
2	.461[c] (2.32)		1.117[a] (.050)	4.179[a] (.731) $Net_{t-1} + Net_{t-2}$, $Iven^3_{t-1} + Iven^3_{t-2}$	97.9	4.67
3	2.025[c] (2.462)		1.081[a] (.054)	4.484[a] (.799) $P.V._{t-1} + P.V._{t-2}$, $Iven^3_{t-1} + Iven^3_{t-2}$	97.9	4.69

1 - Standard errors are in parentheses below regression coefficients.

a - significant at 1% level

b - not significant at 10% level

c - not significant at 20% level

Class 2 mean market price (1960-76) = $49.10 per acre.

TABLE 4.6

Regression Estimates of Class 3 Sub-Marginal Farmland Price
(Study Area 2: Birtle-Russell)

	Regression Coefficients and Standard Errors[1]						
Equation Number	Constant Term	Class 1 Farmland Market $Price_t$	Class 3 Farmland Market $Price_{t-1}$	Livestock $Price_{t-1}$	Principal Component and Variables Included	R^2 (%)	Standard Error of the Estimate ($/acre)
1 "Best"	-3.43[c] (4.46)	.453[a] (.061)				78.6	7.04
2	.466[c] (2.19)		1.108[a] (.084)		1.633[b] (.752) $Net_{t-1} + Net_{t-2}$, $Iven^3_{t-1} + Iven^3_{t-2}$	93.0	5.58
3	-13.76[b] (6.09)	.351[a] (.071)		.693[b] (.311)		84.0	6.26

1 - Standard errors are in parentheses below regression coefficients.

a - significant at 1% level

b - significant at 5% level

c - not significant at 20% level

Class 3 mean market price (1960-76) = $27.14 per acre.

In this section the impact on the model farm enterprises of increasing grain transportation costs will be discussed. Crop acreage trends and the impact on net farm income will be reviewed.

Crop Acreage Trends

In study areas 1 and 2, crop substitution was insignificant as the average delivery distance was increased from a base of 4.2 miles to 30 miles.

As shown in Tables 4.7 to 4.10, crop substitution[20] was limited as the statutory freight rate increased by four times. There was only one case in which a major crop acreage shift occured due to an increase in grain freight rates. In study area 1, under 1973 grain price conditions, barley and rapeseed acreage decreased by 61 and 75 percent respectively while flaxseed acreage increased by 210 percent (See Table 4.7). In study area 1, under 1977 price conditions, the crop mix did not change. In study area 2, under 1973 and 1977 price conditions, crop substitution was insignificant.

Crop substitution was limited as grain transportation costs increased but the relative economic return per

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20 Production activity substitution was limited in part by the design of the LP models. Livestock activities were not represented in terms of enterprises,but rather in terms of a producer's opportunity cost in producing and selling feed grains and forage crops.

TABLE 4.7

Summary of Crop Acreage Under 1973 Prices
(Study Area 1: Red River Valley)

	Wht	Ots	Bly	Flax	Rape	Sun	GC	SC	AG	BG	SF
					-- acres --						
Status quo Base year 1973	210	38	46	29	44	0	90	0	0	0	41
4x Statutory Rate	210	38	18	90	11	0	90	0	0	0	41
Acreage Change	-	-	-28	+61	-33	-	-	-	-	-	-

TABLE 4.8

Summary of Crop Acreage Under 1977 Prices
(Study Area 1: Red River Valley)

	Wht	Ots	Bly	Flax	Rape	Sun	GC	SC	AG	BG	SF
					-- acres --						
Status quo Base year 1977	113	38	18	0	69	90	90	0	39	0	41
4x Statutory Rate	113	38	18	0	69	90	90	0	39	0	41
Acreage Change	-	-	-	-	-	-	-	-	-	-	-

Notation: Wht - wheat, Ots - oats, Bly - barley, Flax - flaxseed, Rape - rapeseed, Sun - sunflowers, GC - grain corn, SC - silage corn, AG - alfalfa-grass, BG - bromegrass, SF - summerfallow.

TABLE 4.9

Summary of Crop Acreage Under 1973 Prices
(Study Area 2: Birtle-Russell)

	Wht	Ots	Bly	Flax	Rape	AG	BG	SF
				-- acres --				
Status quo Base year 1973	165	45	75	25	2	0	0	168
4x Statutory Rate	165	45	75	25	2	0	0	168
Acreage Change	-	-	-	-	-	-	-	-

TABLE 4.10

Summary of Crop Acreage Under 1977 Prices
(Study Area 2: Birtle-Russell)

	Wht	Ots	Bly	Flax	Rape	AG	BG	SF
				-- acres --				
Status quo Base year 1977	74	31	42	6	85	69	5	168
4x Statutory Rate	74	31	42	6	77	77	5	168
Acreage Change	-	-	-	-	-8	+8	-	-

Notation: Wht - wheat, Ots - oats, Bly - barley, Flax - flaxseed, Rape - rapeseed, AG - alfalfa-grass, BG - bromegrass, SF - summerfallow.

crop to the model farms did change. The economic return for each crop was expressed in the model as a reduced cost (See Appendix B, Tables B.5 to B.8). The reduced cost is the profit adjustment on net farm income as one acre of a given crop is brought into the solution. For example, a $10 per acre reduced cost for wheat means that for each additional acre of wheat brought into the solution net farm income would increase by $10.

In both study areas under 1973 and 1977 prices, the three principal crops - wheat, oats and barley became less profitable as the statutory freight rate increased by four times. For example, in study area 1 (1973 prices), the reduced cost for wheat on stubble declined from $19.52 per acre to $15.26. Crops such as alfalfa-grass and bromegrass became relatively more profitable but remained significantly less profitable than the three principal crops resulting in limited crop substitution.

Net Farm Income Trends

The impact on the model farms' net income of increasing grain transportation costs is discussed in this section. As shown in Tables 4.11 and 4.12, net farm income after each simulated grain transportation cost increase was compared to the base year net farm income (status quo).

Net farm income decreased as the average delivery distance was increased from a base of 4.2 miles to a one-way distance of 30 miles. The impact on net income of an increase in delivery distance was more severe under 1977 grain price conditions than under 1973 prices. Under 1973 prices, net farm income in study areas 1 and 2 declined by 4.1 and 5.6 percent respectively as the grain delivery distance increased to 30 miles. Under 1977 prices, net farm income in study areas 1 and 2 decreased by 13 and 19 percent respectively. As expected the effect on net farm income was more severe under low grain price conditions.

In study areas 1 and 2, net farm income decreased sharply as the statutory freight rate was increased by 3, 3.5 and 4 times. Under 1973 grain prices and 4 times the statutory rate, net farm income in study area 1 declined by only 16.1 percent as compared to a 28 percent decrease in study area 2. The effect in study area 1 was less severe primarily due to crop substitution. In study area 1 the shift in acreage into flaxseed reduced the full impact of an increase in grain freight rates. In study area 2 the crop mix did not change as the Crow Rate increased by 4 times resulting in the same crop activity but at a significantly lower level of profit. Under 1977 grain prices and 4 times the statutory rate, net farm income in study areas 1 and 2 declined by 59.5 and 71.6 percent respectively. Under 1977 prices crop substitution was very limited in both areas.

TABLE 4.11

Net Farm Income Trends as Grain Transportation Costs Increase
(Study Area 1: Red River Valley)

Base Year	Net Farm Income Status Quo	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
			-- dollars --				
1973 Commodity Prices	17,826	17,339	17,090	15,860	15,381	14,955	14,154
		(-2.7%)	(-4.1%)	(-11.0%)	(-13.7%)	(-16.1%)	(-20.6%)
1977 Commodity Prices	3,604	3,294	3,136	2,160	1,809	1,460	1,080
		(-8.6%)	(-13.0%)	(-40.0%)	(-49.8%)	(-59.5%)	(-70.0%)

Note* Numbers in parentheses represent percent change of net farm income for each transportation simulation as it relates to net farm income basis status quo.

D.D. - delivery distance.

TABLE 4.12

Net Farm Income Trends as Grain Transportation Costs Increase
(Study Area 2: Birtle-Russell)

Base Year	Net Farm Income Status Quo	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
			-- dollars --				
1973 Commodity Prices	9,783	9,422 (-3.7%)	9,236 (-5.6%)	7,959 (-18.6%)	7,502 (-23.3%)	7,046 (-28.0%)	6,500 (-33.6%)
1977 Commodity Prices	3,240	2,831 (-12.6%)	2,622 (-19.1%)	1,672 (-48.4%)	1,295 (-60.0%)	921 (-71.6%)	505 (-84.4%)

Note* Numbers in parentheses represent percent change of net farm income for each transportation simulation as it relates to net farm income basis status quo.

D.D. - delivery distance.

In study area 1, under 1977 grain price conditions, the impact on net farm income of an increase in freight rates of 4 times Crow was 3.7 times as severe as the impact under 1973 prices. In study area 2 the effect on net income was 2.5 times as severe under 1977 grain price conditions.

4.3 Integration of Results of Component A and B

The analytical model was developed in two interdependent components. In component A, farmland price equations were estimated for classes 1, 2 and 3 in study areas 1 and 2. In component B, an average farm enterprise was designed to represent each study area. Grain transportation cost increases were simulated and imposed on the model farms to determine the impact on net farm income. In this section the effect on net farm income is worked through the farmland price equations to estimate the effect on farmland price of increasing grain transportation costs.

Integration Methodology

The SHAZAM[21] computer program used in the study normalized the two intercorrelated variables, net income and grain inventory, before combining the variables

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21 White, K.J. "A General Computer Program for Econometric Methods - SHAZAM", Econometrica, January 1978.

into a principal component variable. Since the variables were measured in different units the correlation matrix was used to normalize the two variables. Normalization consisted of subtracting the mean value from each of the two variables and dividing by the respective standard deviations. The unitless normalized variables were then added to form one component variable.

To use the farmland price equations for prediction purposes the normalization procedure was reversed as follows:

(a) The means, variances and standard deviations were calculated for the net income and grain inventory variables for the period from 1960-76.

(b) X_1 and X_2 in the principal component function, $PC = a_1 \cdot x_1 + a_2 \cdot x_2$, were estimated by subtracting the mean value from observation i and dividing by the respective standard deviations. Observation i represented the net income and grain inventory variables in a particular year.

As shown in Figure 5, the integration of component A and B results consisted of representing a percent change in net farm income in the respective farmland price equations. The percent change in net farm income is shown in Tables 4.11 and 4.12. It was assumed that each simulated grain transportation cost increase was introduced in 1974.

$$Y_{11_{1976}} = +1.192 \; Y_{11_{1975}} + 18.702 \; PC \left[\underset{-x\%}{Net_{1975}} + \underset{-x\%}{Net_{1974}} , \; \underset{k}{Iven_{1975}} + \underset{k}{Iven_{1974}} \right]$$

$$Y_{11_{1975}} = +1.192 \; Y_{11_{1974}} + 18.702 \; PC \left[\underset{-x\%}{Net_{1974}} + \underset{\text{No change}}{Net_{1973}} , \; \underset{k}{Iven_{1974}} + \underset{k}{Iven_{1973}} \right]$$

Notation:

$Y_{11_{1976}}$ = average farmland price for class 1, study area 1 in 1976

PC = principal component variable consisting of net income and grain inventory variable.

x% = percent change in net farm income as grain transportation costs increase.

k = the grain inventory variable was assumed to be constant.

Figure 5

Example of the Integration of Component A and B Results

The grain inventory variable was assumed to be constant before and after the simulated transportation cost increases.

Under 1973 and 1977 grain price conditions, 1976 class 1 farmland prices were estimated to reflect the impact of reduced net farm income brought about by the simulated transportation cost increases. The resulting 1976 farmland prices were compared to the status quo farmland price which represented the price of land prior to transportation changes.

Impact on Farmland Classes 1, 2 and 3 of Increases in Grain Transportation Costs

If a change in farmland price brought about by an increase in transportation cost was equal to or less than the standard error of the estimate of the land price equations then it was concluded that either -

(a) the simulated transportation cost increase does not have a negative influence on farmland price or

(b) the analytical model developed in the study is not sensitive enough to measure the effect of the transportation cost increase on farmland price.

In study area 1, the standard error of the estimate for class 1 farmland price was estimated to be $12.15 per acre (Table 4.1, equation 1). The standard error as a percent of the average price was 8.3 percent.

In study area 2, the standard error of the estimate was $7 per acre or 10.4 percent of the average price (Table 4.4, equation 1).

In study area 1, under 1973 grain price conditions, the effect on farmland price of an increase in grain delivery distance to 30 miles was statistically insignificant. Also, the effect on land price of the simulated cost increases of 3, 3.5 and 4 times the statutory freight rate were insignificant. The simulated cost increase of the combined effect of the average delivery distance increased to 30 miles plus 4 times the Crow Rate was marginally significant. In summary, in study area 1, under 1973 grain price conditions the impact of the transportation changes on farmland price were generally insignificant (See Table 4.13).

In study area 1, under 1977 grain price conditions, the effect on land price of an increase in grain delivery distance to 30 miles was insignificant. The impact on land price of the simulated cost increases of 3, 3.5 and 4 times the Crow Rate were statistically significant. Also, the combined impact of an increase in delivery distance to 30 miles plus 4 times the Crow Rate was significant. In all four simulations the negative impact on land price ($ per acre) greatly exceeded the standard error of the estimate for equation 1.

As the statutory freight rate was increased by 3, 3.5 and 4 times, the market price of class 1 farmland decreased by 6.3, 7.9 and 9.5 percent respectively. The combined impact of an increase in delivery distance to 30 miles plus 4 times the Crow Rate caused the price of class 1 land to decrease by 11.1 percent.

In study area 2, under 1973 grain price conditions, the effect on farmland price of all simulated grain transportation cost increases were statistically insignificant (See Table 4.14).

In study area 2, under 1977 grain price conditions the effect on farmland price of an increase in grain delivery distance to 30 miles was insignificant. The impact on land price of 3 times the Crow Rate was marginally within the standard error of the estimate and subsequently classified as insignificant. The impact on land price of the simulated cost increases of 3.5 and 4 times the Crow Rate and the combined effect of an increase in delivery distance and freight rate were statistically significant. As the statutory rate was increased by 3.5 and 4 times, the price of class 1 land decreased by 5.2 and 6.2 percent respectively. The combined impact of an increase in delivery distance to 30 miles plus 4 times the Crow Rate caused the price of class 1 land to decline by 7.3 percent.

TABLE 4.13

Impact on Class 1 Farmland Price as Grain Transportation Costs Increase
(Study Area 1: Red River Valley)

Base Year	1976 Farmland price Status Quo 1/	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
			-- dollars per acre --				
1973 Commodity Prices	376.80	375.20 (-0.42%)	374.30 (-0.66%)	370.20 (-1.75%)	368.60 (-2.18%)	367.20 (-2.55%)	364.50 (-3.26%)
1977 Commodity Prices	376.80	371.70 (-1.35%)	369.00 (-2.07%)	352.90 (-6.34%)	347.00 (-7.91%)	341.20 (-9.45%)	334.90 (-11.12%)

1. 1976 farmland Price as estimated by equation 1.

Note* Numbers in parentheses represent percent change of farmland market price for each transportation simulation as it relates to farmland market price basis status quo.

D.D. - delivery distance.

TABLE 4.14

Impact on Class 1 Farmland Price as Grain Transportation Costs Increase
(Study Area 2: Birtle-Russell)

Base Year	1976 Farmland price Status Quo 1/	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
	-- dollars per acre --						
1973 Commodity Prices	152.80	152.40 (-0.26%)	152.10 (-0.46%)	150.40 (-1.57%)	149.80 (-1.96%)	149.20 (-2.36%)	148.50 (-2.81%)
1977 Commodity Prices	152.80	151.20 (-1.05%)	150.30 (-1.64%)	146.50 (-4.12%)	144.90 (-5.17%)	143.40 (-6.15%)	141.70 (-7.26%)

1. 1976 farmland price as estimated by equation 1.

Note* Numbers in parentheses represent percent change of farmland market price for each transportation simulation as it relates to farmland market price basis status quo.

D.D. - delivery distance.

4.4 Comparison of Results with Other Studies

The study showed that an increase in freight rates had a more significant effect on net farm income than an increase in farm trucking cost. Under 1973 commodity prices, an increase in grain delivery distance of up to 20 miles decreased net farm income by only 2.7 and 3.7 percent in study areas 1 and 2 respectively. Under 1973 commodity prices, as the statutory freight rate was increased by 3.5 times net farm income in study areas 1 and 2 declined by 13.7 and 23.3 percent respectively. Tyrchniewicz et al[22], in a Manitoba study, also found that the impact on farmers of raising the level of statutory rates on grain was much more significant than the impact of branch line abandonment and the subsequent increase in farm trucking cost. Of the total provincial increase in farm costs due to the combined effect of route and freight rate changes for 1973-74, the change in farm trucking cost represented only 1.4 percent as compared to about 98.6 percent for the effect of freight rate changes.[23]

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22 E.W. Tyrchniewicz, C.F. Framingham, J.A. MacMillan and J.W. Craven, The Abandonment of Uneconomic Branch Lines and Unremunerative Grain Rates: Effects on Agriculture and Regional Development, paper prepared for presentation at the Canadian Transportation Research Forum in Winnipeg, June 13, 1978, p.22

23 Ibid., p.11

The study showed that crop substitution was very limited as freight rates increased. The economic return for the three principal crops - wheat, oats and barley decreased as the statutory rate increased but in terms of relative profitability the principal crops tended to surpass other crops resulting in an insignificant amount of crop substitution. In Tyrchniewicz et al[24], the changes in agricultural production, under 1973-74 market conditions, induced by changes in farm trucking cost and freight rates also showed limited crop substitution. The provincial production of wheat, oats, flax and rapeseed remained unchanged while barley and rye production declined by only 1.2 and 0.8 percent respectively. The value of all crops was reduced as the transportation cost increased. Most changes in crops involved a change in the type of use for the three major grains - wheat, oats and barley within and among farm size categories. On an aggregate basis the increase in livestock production tended to offset the reduction in the value of grains.[25]

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24 Ibid., p.17

25 Ibid., p.13

The study showed that as the statutory freight rate increased net farm income decreased sharply, especially under 1977 low grain price conditions. Under 1977 grain prices and 3.5 times the Crow Rate, net farm income in study areas 1 and 2 decreased by 49.8 and 60 percent respectively. Olsen et al[26], under 1978 commodity prices and 3.4 times the statutory rate found that average net farm income for the Central and Northwest (Parklands) regions declined by 55.6 and 31.9 percent respectively. In both studies the impact on farm net income for study area 1 or the Central region was similar, 49.8 percent compared to 55.6 percent. The estimated decline in farm net income for study area 2 or the Northwest (Parkslands) region was significantly different. The Olsen study found a 31.9 percent decline in net income as compared to 60 percent in this study. The livestock production activities in the Olsen study are thought to have reduced the impact on net farm income of an increase in freight rates.

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26 K. Olsen, E.W. Tyrchniewicz and C.F. Framingham, Impact of Changes in Statutory Grain Rates and Rail Branchline Configurations on Manitoba's Agricultural Economy, special report prepared for the Government of Manitoba, March 1980, p.15.

In study area 1 as the statutory freight rate was increased by 3, 3.5 and 4 times, the market price of class 1 farmland decreased by 6.3, 7.9 and 9.5 percent respectively. In study area 2, as the Crow Rate was increased by 3.5 and 4 times, the price of class 1 farmland decreased by 5.2 and 6.2 percent respectively. In comparison, Fields[27] found that 14 percent of the 1979 farmland price in Manitoba was attributed to the statutory rate.

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27 V.J. Fields, "The Influence of Grain Freight Rates on the Farm Land Market in the Prairie Provinces", unpublished MSc thesis, Department of Agricultural Economics, University of Manitoba, October, 1980, p.118.

Chapter V

SUMMARY AND CONCLUSIONS

5.1 Summary

The purpose of this study was to determine if an increase in grain transportation costs would have a negative effect on farmland price. Specifically, the study examined the effect on market price of increases in grain delivery distance and increases in grain freight rates.

Since grain producers currently avoid about 80 percent of the total rail cost of shipping grain it could be argued that the statutory freight rate is a subsidy to western grain producers. Also, it could be argued that if the subsidy is removed and farmers are forced to incur higher transportations costs then economic theory suggests that net farm income and subsequently farmland price could decrease.

The principal objective of the study was to develop an analytical model to estimate the impact of increasing transportation costs on farmland price. The secondary objectives were to determine if the market price of classes 1, 2 and 3 farmland respond to economic changes in a similar manner; and to determine the degree of crop substitution as grain transportation costs increased.

The theoretical basis of the study was the relationship between market price and productive value of farmland. The productive value of land was defined as expected net revenue per acre divided by a capitalization rate. Economic theory suggests that as net farm income and productive land value change, there would be a corresponding change in farmland market price.

The hypotheses were that an increase in a producer's delivery distance from farm to primary elevator and an increase in grain freight rates would have a negative impact on farmland price. The analytical model was designed in two interdependent components A and B. In component A, multiple regression analysis was used to estimate farmland price equations for classes 1, 2 and 3 in study areas 1 and 2. Farmland price in year t was estimated to be a function of farmland price lagged one year and a principal component variable consisting of a net income and grain inventory variable. The net income variable was based on a long-term moving average crop insurance wheat yield. The grain inventory variable was represented by total on-farm stocks of wheat, oats and barley per acre. In component B, two static linear programming (LP) models were designed to represent typical or average farm enterprises for study areas 1 and 2. The model farms were designed to show the impact on net farm income as grain transportation costs increased. Crop yields and production costs used in the LP model farms were based on 1977 data and represented the particular characteristics of each study area. LP model restraints included land, labor, operating capital, quota and crop rotation.

Grain transportation cost increases were simulated and imposed on the model farm enterprises to ascertain the impact on net farm income. The transportation cost increases were represented by discounting the base year commodity prices. The base year commodity prices were represented by 1973 high grain price conditions and by 1977 low grain price conditions. The simulated grain transportation cost increases were represented by an increase in the average delivery distance from farm to primary elevator (i.e. one-way distance increased to 10, 15, 20, 25 and 30 miles) and an increase in the statutory freight rate of 3, 3.5 and 4 times. In addition, the combined effect of an increase in delivery distances and freight rates was simulated. The total farm net income and crop mix resulting from each simulation was compared to the status quo as represented by the base years. Changes in net farm income were worked through the farmland price equations in component A to determine the effect of the grain transportation cost increases on farmland price.

5.2 Summary of Results

In component A, class 1 farmland price was estimated to be a function of farmland price in t-1 and a principal component variable consisting of two independent variables. In study area 1, the two variables represented by the component variable were sum of net income in t-1 and t-2 and sum of grain inventory in t-1 and t-2. In study area 2, the two variables in the principal component were sum of net income in t-1 and t-2 and grain inventory in t-1. The R^2 in both cases were over 94 percent. The farmland price for class 2 and 3 land was shown to be a function of class 1 land price in both study areas. The relationship between the three classes of farmland indicates that as class 1 responds to economic changes, then class 2 and 3 would respond proportionately equal.

In component B, crop substitution in the LP model farms was limited as grain transportation costs increased. In both study areas under 1973 and 1977 commodity prices, the three principal crops - wheat, oats and barley became less profitable as the Crow Rate increased by four times. Other crops such as alfalfa-grass became relatively more profitable but yet remained significantly less profitable than wheat, oats and barley resulting in limited crop substitution.

In study areas 1 and 2, under 1973 and 1977 grain price conditions, the effect on class 1 farmland price of an increase in grain delivery distance to 30 miles was statistically insignificant.

In study areas 1 and 2 under 1973 price conditions, the effect on land price of the simulated cost increases of 3, 3.5 and 4 times the statutory freight rate were statistically insignificant. The one exception was the combined effect of the average delivery distance increased to 30 miles plus 4 times the Crow Rate which was marginally significant in study area 1.

In study area 1, under 1977 grain price conditions, the effect on land price of the simulated cost increases of 3, 3.5 and 4 times the Crow Rate and the combined effect of increased distance and freight rate were statistically significant. As the statutory freight rate was increased by 3, 3.5 and 4 times, the market price of class 1 farmland decreased by 6.3, 7.9 and 9.5 percent respectively. The combined impact of an increase in delivery distance to 30 miles plus 4 times the Crow Rate caused the market price of class 1 land to decrease by 11.1 percent.

In study area 2, under 1977 grain price conditions, the effect on land price of 3 times the Crow Rate was marginally insignificant. The impact on land price of the simulated cost increases of 3.5 and 4 times the Crow Rate and the combined effect of increased delivery distance and freight rate were statistically significant. As the statutory rate was increased by 3.5 and 4 times, the market price of class 1 land decreased by 5.2 and 6.2 percent respectively. The combined effect of an increase in delivery distance to 30 miles plus 4 times the Crow Rate caused the market price of class 1 farmland to decline by 7.3 percent.

5.3 Conclusions

Class 1 farmland price was found to be a function of farmland price lagged one year and a component variable consisting of net income and grain inventory. Class 2 and 3 farmland price was shown to be a function of class 1 land price in both study areas. Therefore, any negative effect on class 1 land brought about by an increase in grain transportation costs, would result in a proportionately equal effect on farmland classes 2 and 3.

As grain transportation costs were increased crop substitution was limited in both areas. In study area 1 (Red River Valley), under 1973 grain price conditions, crop acreage shifted from barley and rapeseed to flaxseed as the statutory freight rate was increased by 4 times. In study area 2 (Birtle-Russell), under both 1973 and 1977 grain price conditions, the degree of crop substitution was insignificant. Generally, in study area 1 crop acreage shifted somewhat to minimize higher transportation costs but in study area 2 the crop alternatives were relatively limited resulting in the same crop mix at a lower level of net return per acre.

In the first hypothesis the null hypothesis was accepted. That is, an increase in grain delivery distance from farm to primary elevator of up to 30 miles did not have a negative effect on farmland price in study areas 1 and 2.

In the second hypothesis the null hypothesis was accepted but only under 1973 high grain price conditions. That is, an increase in grain freight rates from the statutory rate to compensatory rates did not have a negative effect on farmland price. Under 1977 low grain price conditions the alternative hypothesis was accepted. That is, as the statutory freight rate was increased to compensatory levels there was a negative effect on farmland price.

In study area 1, under 1977 prices, as the statutory freight rate was increased by 3, 3.5 and 4 times, the market price of class 1 farmland decreased by 6.3, 7.9 and 9.5 percent respectively. The combined effect of an increase in delivery distance to 30 miles plus 4 times the Crow Rate caused class 1 market price to decrease by 11.1 percent.

In study area 2, under 1977 prices, as the statutory freight rate was increased by 3.5 and 4 times, the market price of class 1 land decreased by 5.2 and 6.2 percent respectively. The combined effect of an increase in delivery distance up to 30 miles plus 4 times the Crow Rate caused the market price of class 1 land to decrease by 7.3 percent.

5.4 Limitations

In the farmland price equations the regression coefficients for farmland price lagged one year were greater that 1. Coefficients greater than 1 cause forecasted farmland price to increase year after year in spite of major changes in economic conditions. One explanation for the unstable coefficients may lie in the fact that the income variable was only based on wheat production. Even though wheat accounted for about 50 percent of the total crop revenue in each study area, income from the crops representing the remaining 50 percent was not included. In study area 1, revenue from oats, barley, rapeseed, flaxseed, sunflowers, peas, potatoes, corn and sugar beets was not included in the net income variable. In study area 2, revenue from oats, barley, flaxseed and rapeseed was excluded.

In the LP models the impact on net farm income may have been overestimated due to the abscence of livestock production activities. Livestock enterprise options were only represented by sell activities for feed grains, alfalfa grass and bromegrass. The inclusion of livestock production activities may have reduced the impact of higher freight rates on net farm income.

The study did not take into account to what extent an increase in grain production per acre would offset an increase in freight rates. The yields in each study area were represented by historical average yields.

The study was designed to represent the effect on farmland price of increasing grain transportation costs by a percent decrease in farmland price. In reality, farmland owners would not likely experience a decrease in land price but rather a lower rate of appreciation in future years. Also, due to the static nature of the model the farmland price adjustment was assumed to have been completed in two years. It is expected that the land price adjustment would continue over several years following an increase in the Crow Rate.

5.5 Policy Implications

The study examined the effect on farmland market price of increases in grain delivery distance and grain freight rates. The following policy implications would be representative for areas in the prairie provinces with similar resource characteristics and farmland market behavior as study area 1, Red River Valley and study area 2, Birtle-Russell.

1. An increase in delivery distance, caused by such factors as rail line abandonment and primary elevator consolidation, is not expected to have a negative effect on farmland price.

2. An increase in grain freight rates is expected to decrease net farm income unless grain production increases to offset higher freight rates. An increase in freight rates, especially under low grain price conditions should be phased in gradually over a number of years to minimize the impact on net farm income.

3. As grain freight rates increase crop substitution is expected to be limited resulting in similar cropping patterns at lower levels of profitability.

4. Under low grain price conditions and assuming an immediate increase of 3, 3.5 and 4 times the statutory

freight rate, farmland price would decline by 5-10 percent in the two Manitoba study areas. This negative impact is relatively low when compared to the 1958-76 average farmland price adjustment of 8-9 percent for the same study areas. A gradual increase in the freight rates over a number of years could be expected to have a minimal effect on farmland price.

5.6 Suggestions for Further Research

The study did not address two issues which should be explored in future research. The first issue is to what extent would an increase in grain production per acre, encouraged by an improved transportation system, offset higher freight rates. The second issue involves farmland price adjustment. In the study price adjustment was assumed to have been completed in two years, however farmland price moves at a rate of only 15-20 percent per year towards the productive value. Future research could examine how farmland price would adjust over several years as grain freight rates increase.

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APPENDIX A

DETAILED DESCRIPTION OF ANALYTICAL MODEL

The analytical model is supported by 80 tables of data which are available from the author upon request

1. Methodology of Farmland Class Division

As shown in Table A.1 and A.2, the quarter sections in each study area were divided into 3 classes of farmland. In study area 1, Red River Valley, classes 1, 2 and 3 represented 73.4%, 15.4% and 11.2% respectively. In study area 2, Birtle - Russell, classes 1, 2 and 3 represented 51%, 37% and 12% respectively.

The farmland was divided into Class 1: Prime Farmland, Class 2: Marginal Farmland and Class 3: Sub-Marginal Farmland by using the following criteria.

Criteria for Farmland Class Division

- Soil Productivity Index
- Farmland Assessment Value
- Farmland Market Price
- Soil Characteristics
- Agricultural Representatives' Opinion

Soil Productivity Index

The Manitoba Crop Insurance Corporation (MCIC) soil productivity index rates soils on their capability to produce wheat, oats, barley and flax. Each quarter section of cultivated land was placed into one of ten categories from the most productive class of 100 or A to the least productivity category of 10 or J.[1]

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[1] University of Manitoba, Faculty of Agriculture, Principles and Practices of Commercial Farming, (Winnipeg: Publications Office - University of Manitoba, 1977) pp. 42-43.

TABLE A.1

Farmland Class Division by Soil Zone[1]
(Study Area 1: Red River Valley)

Class 1		Class 2		Class 3	
Soil Zone	Quarter Sections per Zone	Soil Zone	Quarter Sections per Zone	Soil Zone	Quarter Sections per Zone
A11	454	D05	400	H05	73
B11	319	E05	96	H10	1010
B12	178	E10	33	H11	196
C05	44	E11	63	J10	273
C11	436	F05	56		
C12	875	F10	34		
C32	1037	F11	76		
D11	168	F12	458		
D12	1094	F32	76		
D32	3093	G05	59		
E12	734	G10	654		
E32	1659	G12	108		
Class Totals	10,091		2,113		1,552
Percent of Study Area	73.4%		15.4%		11.2%

1. Total number of quarter sections in Study Area 1 equals 13,756.

TABLE A.2

Farmland Class Division by Soil Zone[1]
(Study Area 2: Birtle-Russell)

Class 1		Class 2		Class 3	
Soil Zone	Quarter Sections per Zone	Soil Zone	Quarter Sections per Zone	Soil Zone	Quarter Sections per Zone
B06	3101	C03	503	G03	110
B07	1357	C06	735	G07	180
C07	1942	D06	833	H03	348
		D07	628	I03	452
		E03	200	J03	411
		E07	316		
		F03	983		
		F06	253		
		F07	127		
		G06	51		
Class Totals	6400		4629		1501
Percent of Study Area	51%		37%		12%

1. Total number of quarter sections in Study Area 2 equals 12,530.

Starting with 1961 Veteran's Land Act data, MCIC analyzed crop yields back 35 years. Long-term average crop yields were determined for several "benchmark" soils using crop yield statistics obtained from elevator shipping points, Statistics Canada and from other sources.[2] Other soils were assessed an index rating relative to the benchmark soils and some soils were correlated to the extend they were similar or different. This procedure was adjusted for climatic and precipitation conditions. The minor soils were rated interpretively.[3] On the basis of this data a yield value, largely based on wheat, was assigned to each soil and placed in one of the ten productivity index classes.[4]

Since 1961 MCIC has obtained the actual yields each year by use of a post harvest survey in each risk area. Post-harvest surveys collect yield information by producer, by quarter section, by crop acres in each crop

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2 Ibid.

3 Personal conversation with Mr. C. Wood, Research Officer, Manitoba Crop Insurance Corporation, Portage La Prairie, Manitoba, April 17, 1978.

4 Principles and Practices of Commercial Farming, Loc. cit.

and record the pounds of fertilizer applied to produce specific yields. In most areas the productivity index system is based on a 25 year moving average yield with some areas such as the Interlake region based on 20 years due to a limited amount of data.[5] The productivity index system is used exclusively by the Manitoba Crop Insurance Corporation to establish premium rates and to determine extent of coverage in the event of crop failure.[6]

The crop insurance soil productivity index A to J was of limited use for quantitative analysis. Since the index system was originally based on average crop yields, largely wheat, a bushel of wheat equivalent[7] was developed on a risk area basis. The bushel of wheat equivalent system is based on the Manitoba Crop Insurance land productivity assessment with the productivity rating per quarter section equalling the expected 20 year average yield of wheat.

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5 Mr. C. Wood, MCIC, Loc. cit.

6 Principles and Practices of Commercial Farming, Loc. cit.

7 The bushel of wheat equivalent was developed prior to this study by Dr. D. F. Kraft, Department of Agricultural Economics, University of Manitoba.

As a criterion for the farmland class division a weighted average wheat yield (bushels per acre) was used to take into account different wheat yields on stubble and summerfallow in varying proportions for each soil type in each risk area. The weighted average yields are fairly representative of each soil zone because 40 - 50 percent of all potential farmers in the province are normally insured by MCIC.[8]

The soil zones were ranked in descending order of the weighted average wheat yields and used as one of five criterion to divide the A - J soils in each study area into classes 1, 2 and 3.

Farmland Assessment Value

Tax assessment value of farmland is based upon agricultural productive capability and market prices. The assessment values are estimated by the regional municipal assessment offices of the provincial government. As a criterion for the farmland class division the 1977 assessment values for each soil classification were averaged and the A - J soil types were ranked in

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8 Personal conversation with Mr. John Ewanek, Director of Research and Development, Manitoba Crop Insurance Corporation, Portage La Prairie, Manitoba, April 1978.

descending order of assessment value. The 1977 assessment values were based on 1976 data.

Farmland Market Price

The market price is the price for which land will sell for in the open market at a particular time. It is an indication of how buyers rank soil types by voting with dollars. In study area 1, three years of farmland prices - 1958, 1967 and 1973, were used to compare A - J soil types in terms of market price. In study area 2, market price for 1967 was used to compare soil types. As a criterion for farmland class division the annual average price for each A - J soil type was ranked in descending order of market price.

Soil Characteristics

As a general guide an official soil classification[9] and description was used to evaluate the rank of each A - J soil type as established by the first three

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9 Reports of Reconnaissance Soil Survey by Region in the Province of Manitoba, published by the Manitoba Department of Agriculture.

criterion. The following soil reports include a descriptive analysis of the soil types and recommended type of agriculture.

Soil Report Number	Region (Map sheet areas)
4	South - Central Manitoba, March, 1943
5	Winnipeg and Morris, October, 1953
6	Rossburn and Virden, April, 1956
7	Carberry, 1957
8	West-Lake, 1958
12	Fisher and Teulon, 1961
18	Morden - Winkler, 1973

Agricultural Representatives' Opinion

A tentative farmland class division was established based on the previous four criterion. To clarify the placement of borderline soil types agricultural representatives in each study area were interviewed by telephone.[10] The agricultural representatives were informed of the basic definitions of classes 1, 2 and 3 used in the study. The actual production activity of each soil type was discussed, with the agricultural representatives recommending which of class 1, 2 and 3 each A - J soil type should be assigned. The agricultural representatives interviewed were as follows:

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[10]The telephone interviews were conducted on August 25, 1978.

Study Area 1: Red River Valley	Study Area 2: Birtle-Russell
I. Wifshart, Morden	W.E. Lambert and G. Rannie, Shoal Lake
A. Domes, Portage La Prairie	O. Penner, Russell
C. Harrison, Morris	A. Dickson, Stonewall

Summary: Farmland Class Division

Farmland class division was based on five criterion - soil productivity index, farmland assessment value, farmland market price, soil characteristics and agricultural representatives' opinion. The A - J soil types were ranked in descending order for each criterion and compared for similarities. No single criterion was the deciding factor in a soil class assignment.

In study area 1, the weighted average yields of soil types C32, D32 and E32, which represent 42 percent of the area, were relatively low as compared to their actual productive capability. If the soil productivity index had been the sole criterion these soils would have been incorrectly assigned to class 3. By using the other criterion the three soil types were assigned to class 1. In study area 2 all criterion were fairly consistent in the placement of soil types.

2. Average Productive Value

Over the next several pages each component of the average productive value formula will be defined and the methodology used to estimate each component will be discussed.

Average Total Revenue

The average total revenue is equal to the average net effective yield multiplied by the average total wheat price received at the primary elevator. In more specific terms the average total revenue was represented by equation 1.

$$ATR_{ik_t} = ANEY_{ik_t} \times ATWP_t \quad (1)$$

Where ATR_{ik_t} = Average total revenue for class k land in study area i for period t ($ per acre)

$ANEY_{ik_t}$ = Average net effective yield for class k land in study area i for period t (bushels of wheat per acre)

$ATWP_t$ = Average total wheat price at primary elevator in period t ($ per bushel)

i = Study areas 1 and 2

k = Farmland classes 1, 2 and 3

t = 19 years, 1958-1976

Average Net Effective Yield

Average net effective yield ($ANEY_{ik_t}$) was represented by equation 2.

$$ANEY_{ik_t} = (AWYRA_{i_t} \times SZC_i \times EYC_{i_t}) - 1.5\ SD \quad (2)$$

Where $ANEY_{ik_t}$ = Average net effective yield for class k land in study area i in period t (bushels of wheat per acre)

$AWYRA_{i_t}$ = 25 year moving average wheat yield per crop insurance risk area in study area i in period t (bushels per acre)

SZC_i = 1976 soil zone yield coefficient for A - J soil zones in study area i

EYC_{i_t} = Effective yield coefficient for study area i in period t

1.5 SD = A seed deduction of 1.5 bushels of wheat per acre

i = Study areas 1 and 2

k = Farmland classes 1, 2 and 3

t = 19 years, 1958-1976

25 Year Moving Average Wheat Yield per Crop Insurance Risk Area

The farmland price data (i.e. dependent variable) were assigned by A - J soil types to farmland classes 1, 2 and 3, for each of the 19 years (1958-76). As each farmland sale was assigned to a class it contributed a weighed average wheat yield to the independent variable, average productive value of farmland.

In determining the price of land a producer's income expectations over time are best represented by an historical average yield than a yield in any given year. This is the basis of productive value which is defined as the capitalization of the net incomes anticipated from the land. The 25 year moving average wheat yield per crop insurance risk area ($AWYRA_{i_t}$) was used as the yield base in the calculation of average total revenue.

Study area 1 was represented by crop insurance risk areas 5, 10, 11 and 12; and study area 2 was represented by risk areas 3, 6 and 7. The 25 year moving average wheat yield is a weighted average of wheat yields on stubble and summerfallow in proportion to stubble/fallow percent of total wheat acres calculated for each risk area independently.[11]

In study area 1, Red River Valley, the 25 year moving average wheat yields for soil zones C32, D32, E32 and F32,[12] which represent about 58 percent of the study area, were adjusted up to reflect more realistic yields brought about by improved water management. Excessive water and field drainage continues to be a concern but drainage investments have significantly reduced yield losses. To represent contemporary crop productivity a 10 year moving average yield (1967-76) was used to represent the four special soil zones. Up to 1966 the 10 year moving average yield was similar to the 25 year moving average yield. During the ten year period from 1967 to 1976, the 10 year moving average yield was nearly 7 percent higher on average than the 25 year moving average wheat yield.

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11 The annual crop insurance post-harvest farmer surveys record acres of wheat insured and wheat yields on stubble and fallow for each risk area by soil zone. Based on this data a weighted average yield of stubble and fallow is estimated for each A - J soil zone. In addition an annual weighted average yield is estimated to represent each risk area.

12 In soil zones C32, D32, E32 and F32 the numeric subscripts represent a common risk area or hail rate area. For example, in soil zone C32 the first digit "3" in the subscript denotes a historical problem with water drainage and its effect on yield. The second digit "2" represents risk area 12.

The 25 year moving average wheat yield for each of the 19 years in the time series represents an overall average yield for a crop insurance risk area. A risk area represents a production area which has a common or uniform risk factor due to similar soils and/or climate. Each risk area is a separate entity. The Manitoba Crop Insurance Corporation has defined sixteen risk areas in the province of Manitoba.

Soil Zone Yield Coefficient

Since each observation or farmland sale contributing to the dependent variable has a A - J soil zone identification, a soil zone yield coefficient (SZC_i) was estimated by the ratio of each soil zone average wheat yield to the corresponding risk area average wheat yield. For example, in study area 1 a B12 soil zone was estimated to have a yield 26.8 percent higher than the weighted average wheat yield for risk area 12 in each of the 19 years. In summary, the use of the soil zone yield coefficients provides for a more exact estimation of each sale's weighted average wheat yield.

Effective Yield Coefficient

The effective yield coefficient (EYC_{i_t}) was designed to estimate an effective or realized yield as compared to an actual yield. It was necessary to estimate an effective yield to reflect the crop acreage in a farm enterprise must support unproductive summerfallow acreage. The effective yield is equal to the weighted average wheat yield per acre discounted by the effective yield coefficient. The effective yield coefficient is equal to the ratio of total crop acreage to total cultivated acreage. Total cultivated acreage was represented by crop acreage plus summerfallow acreage in each rural municipality.

In the study two separate methods were used to estimate the effective yield coefficients. In study area 1, simple Ordinary Least Square Regression analysis[13] was used to estimate an annual effective yield coefficient for each of the 19 years from 1958-76.

Summerfallow acres in time period t were regressed against time to produce equation 3.5.

$$\text{Percent Summerfallow} = .229094 - .0077\ (X_1) \qquad (3.5)$$

Where X_1 = time, 1958 = 1, 1959 = 2 ...

... 1976 = 19

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13 The effective yield coefficients for study area 1 were estimated by Dyck in J.D. Dyck, "The Impact of Adopted Technological Change on Farmland Prices in Manitoba", unpublished M.Sc. thesis, Department of Agricultural Economics, University of Manitoba, Winnipeg, 1979.

To calculate the effective yield coefficients for each year the percent summerfallow was substracted from 1. In study area 2, the regression equation was not significant, that is there was no significant summerfallow trend over the 19 years. The effective yield coefficients for study area 2 were based on coefficients calculated for 4 time intervals - 1961, 1966, 1971 and 1976.

Seed Deduction

To represent the grain production available for sale, a seed requirement of 1.5 bushels[14] of wheat per acre was deducted from the annual average effective yield to produce an average net effective yield for each class of farmland for each of the 19 years.

Average Total Wheat Price

Average total revenue equals the average net effective yield multiplied by the average total wheat price ($ATWP_t$) received at the primary elevator.

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14 Based on a personal conversation with Mr. A. Martin, Crop Specialist, Manitoba Department of Agriculture 1978 it was estimated that most farmers seed 1.25 to 1.5 bushels of wheat per acre. The high end of the range was selected as a representative seeding rate over the 1958-76 period. It was assumed that the average farmer would clean, and use his own seed.

(a) An average price for all grades of wheat. An average price for all wheat is somewhat lower than the final realized price for Number 1 Canadian Western Red Spring which is normally used as a benchmark wheat price. An average price for all wheat was thought to be more representative of the price of wheat for a given acre.

(b) The average price was calculated to represent an average total price realized by a producer selling to a primary elevator. All marketing, handling and transportation costs except for farm trucking cost were deducted. The average total wheat price was equal to the average price for all wheat at port position (Thunder Bay/Vancouver) minus an average rail freight rate from Manitoba to Thunder Bay minus the average primary elevator tariff plus an average final price in crop year t.

Average Production Cost

An average wheat production cost per acre (APC_{ik_t}) was estimated for each of the 19 years for study areas 1 and 2. The average cost of production regardless of the quality of the land was assumed to be similar.

The average production cost was estimated in three parts. The first part estimated expenditures for farm inputs having a minimal change in quantity used per acre over the 1958-76 period. The second part estimated fertilizer and chemical inputs which changed not only in price but also in quantity used. The third part estimated payments for crop insurance premiums. Part 1, 2 and 3 cost components were summed to produce an average production cost for wheat for each year from 1958-76 for each study area.

The 1977 average production costs per acre were estimated for all major crops in each study area by using a crop production simulator.[15] All major cost components were based on field surveys with agricultural representatives. All major elements with the exception of land investment were estimated to reflect the specific characteristics of each study area.

For the regression model the average wheat production cost estimated by the crop simulator model was selected to represent average production cost for all crops.

In the first part of the average production cost the 1977 input costs having a minimal change in quantity used per acre were isolated and summed. These inputs increased mainly in price per unit over time and to a lesser degree in quantity used per acre. For the purpose of this study it was assumed that the number of units per

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[15] Crop production simulator model was developed by the Department of Agricultural Economics and Farm Management, University of Manitoba, July 1977.

acre used remained constant over the 19 years. These inputs which remained constant accounted for over 65 percent of the total production cost. These expenditures were indexed back to 1958.[16] A weighted average base cost was estimated in proportion to stubble and fallow acres as a percent of total wheat acres.

The second part of the average production cost was the estimation of fertilizer and chemical expenditures from 1958-76. The two crop inputs have changed in both price and amount used over time. The fertilizer application rates for nitrogen and phosphorous were taken from Manitoba Crop Insurance Corporation data. The 1974 price levels for fertilizer were increased and decreased according to the fertilizer index for the years 1958-76. For each of the years a weighted average fertilizer expenditure was estimated to reflect the proportion of fertilizer used on wheat grown on stubble and fallow. The average chemical cost per acre was estimated by dividing the total provincial annual chemical expenditure by total improved acres under annual crops.

The third part of the average production cost was crop insurance cost per acre. In each study area a specific soil zone was selected[17] to represent the average risk of a crop failure.

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16 The grain production input price index (GPIPI) was estimated for the years 1958 to 1977 by use of the Laspeyres price index formula.

17 Soil zones E12 and B6 were recommended by Mr. T. Last, Research Officer, Manitoba Crop Insurance Corporation, Portage La Prairie, Manitoba, November 1978.

Soil zones E12 and B6 were selected to represent area 1 and 2 respectively. Between 1965 and 1976 the premium rates were for 60 percent coverage at the highest crop price. The degree of crop insurance used prior to 1965 was insignificant. An average crop insurance cost per acre was estimated by discounting the crop insurance premium to reflect that an average farmer does not insure all crop acres. The premium cost per acre was discounted by a ratio of insured wheat acres to total wheat acres for the representative municipalities.

Average Transportation Cost

The determination of farmland productive value is based on average net revenue per acre at the farmgate. The average farm trucking cost ($ per acre) from farm to primary elevator was estimated by equation 3.

$$ATpC_{ik_t} = ANEY_{ik_t} \times ADD_{i_t} \times AFTC_t \qquad (3)$$

Where $ATpC_{ik_t}$ = Average transportation cost from farmgate to primary elevator for class k land in study area i in period t ($ per acre)

$ANEY_{ik_t}$ = Average net effective yield for class k land in study area i in period t (bushels of wheat per acre)

ADD_{i_t} = Average one-way delivery distance from farmgate to primary elevator in study area i in period t (miles)

$AFTC_t$ = Average farm trucking cost per bushel - mile in period t ($ per bushel - mile)

i = Study areas 1 and 2

k = Farmland classes 1, 2 and 3

t = 19 years, 1958-1976

As previously discussed the average net effective yield was represented by bushels of wheat per acre moving off farm.

The average delivery distance from farmgate to primary elevator was represented by an average one-way distance of 20 sales or farmland observations selected randomly in each study area for 1958 and 1976. The criteria used to estimate the one-way delivery distance for each sale was as follows:

1. One-way distance was measured from the closest corner of an observation to the closest active delivery point. It was assumed that a producer would deliver to the closest primary elevator right up to the time of closure.
2. It was assumed that there was a gravel road every mile.
3. In tracing out delivery distance the grid road and paved road system was followed. Natural barriers such as rivers, ravines, depressions and

other areas where the grid road system was not indicated on rural municipal maps forced alternative routes and delivery points which may not have been the shortest distance.

The one-way distance was estimated by using the legal description of each observation and municipal maps to determine the one-way distance to the closest active elevator. In study area 1 the average delivery distance for 1958 and 1976 was estimated to be 4.2 and 5.8 miles respectively. In study area 2 the average delivery distance for 1958 and 1976 was estimated to be 3.6 and 4.2 miles respectively. The difference between the 1958 and 1976 one-way distance was divided by 17 years and the 1958 distance was incremented by the quotient.

The average farm trucking cost per bushel - mile was based on work by Tyrchniewicz et al[18] for the 1967-68 crop year. The study was based on a sample of 128 farm trucks in a large area of Manitoba to the west of Winnipeg and incorporating a portion of Saskatchewan.[19]

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18 E.W. Tyrchniewicz, A. H. Butler and Om P. Tangri, The Cost of Transporting Grain by Farm Truck, Research Report No. 8 Center for Transportation Studies, University of Manitoba, July 1971.

19 Ibid, p. 16 - 20.

The equation estimated the average cost per bushel - mile as a function of the size of truck, annual truck mileage, total bushels transported, year of truck, one-way distance to the elevator and percent of miles on paved roads.[20]

Using the mean values for all variables other than one-way distance to the elevator, Tyrchniewicz collapsed the function into an expression of average cost of farm trucking per bushel - mile as a function of distance to the elevator. The resulting function appears in equation 4.

$$Z = (-0.294) - 0.216 \text{ Log}_{10} D \qquad (4)$$

$$Y = 10^{Z}$$

Where Y = average costs per bushel - mile (cents)

D = one-way distance to elevator (miles)

Using the above average cost formula and a one-way delivery distance of 5.5 miles, an average cost per bushel - mile was estimated at .352 cents in 1968. The 1968 average cost per bushel - mile was indexed up and down by the grain production input price index (GPIPI) to estimate an average farm trucking cost per bushel - mile from 1958 to 1976.

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20 Ibid., p. 57, Equation 3.

Interest Rate

The average productive value was estimated by dividing the net revenue per acre by an interest rate or capitalization rate. The interest rate used for the years 1958-76 was an annual weighted average Farm Credit Corporation (FCC) interest rate.[21] On average the FCC extended about 65 percent of the long term (more than 10 years) farm credit in Canada over the 1966 - 75 period.[22]

The 1958-63 annual interest rate was constant at 5%. During the 1964-68 period FCC interest rates were frozen at 5% for loans up to a maximum of $20,000 Part II and $27,500 Part III. The 5% frozen interest rate was adjusted up over the 1964-68 period to account for the increasing frequency of loans exceeding the maximum. The interest rate on the loan value over the maximum was 6.75 percent. The interest rate from 1969-76 was a weighted average rate for 12 months. It was assumed that the interest rate in any given year was the same for all producers and all classes of farmland.

In summary, the average net revenue and average farmland productive value were estimated for farmland

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21 Farm Credit Corporation, Statistics 1977 Federal Farm Credit, Ottawa: Queen's Printer, 1977.

22 Ibid., p. 19.

classes 1, 2 and 3 in study areas 1 and 2 for years 1958-76.

Adjusted Average Farmland Productive Value

In the initial regression analysis, the regression coefficients were unstable at an unacceptable level. The income variable, average productive value, was considered to be underestimated. Based on work by Dyck[23] the average net effective yields for class 1 farmland in each study area were adjusted up to reflect the annual increase in yield from technological change over the years 1958-76.

Technological change over the 19 years included an increase in fertilizer use and improved varieties. Dyck showed that study area 1 had a trend increase in wheat yield of .5 bushels per acre per year for wheat on stubble and .36 bushels per acre per year for wheat on fallow. In study area 2 the trend increase in wheat yield on stubble was .25 bushels per acre per year and no trend increase for wheat on fallow.

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23 J.D. Dyck, "The Impact of Adopted Technological change on Farmland Prices in Manitoba", unpublished MSc. thesis, Department of Agricultural Economics, University of Manitoba, Winnipeg, 1979.

The wheat yield trend increase was weighted in proportion to acres of wheat on stubble and wheat on fallow as a percent of total wheat acres. As specified by the general formula for average productive value the weighted average yield increase was discounted by the effective yield coefficients to produce an actual yield increase. The actual yield increase was multiplied by the average total wheat price at the primary elevator to produce the adjustment to average productive value.

The adjustment of the income variable was significant in study area 1 especially in the latter years of the time series. The adjustment in study area 2 was insignificant. The income variable adjustments reduced the regression coefficients to a more stable level and improved the statistical significance of the farmland price equations.

3. Component A: Data Review

Farmland Market Price (Farmland Sales Data)

There was a total of 8645 farm sales in study area 1 and 2. In study area 1, farmland classes 1, 2 and 3 had 4402, 837 and 522 sales respectively. In study area 2, farmland classes 1, 2 and 3 had 1564, 1049 and 271 sales respectively.

Farmland market price represents the transaction price between a buyer and seller. The sales price takes into account the improved and unimproved acreage. The buildings assessed value was subtracted from the consideration value to isolate non-land factors for the period 1970-76. For the period of 1958-69 the assessed value of buildings was included.

There were elements of both cross-sectional and time series analysis in the handling of the farmland sales data. Cross-sectional analysis was used to produce the annual average farmland price from the total sales population in each year. Time series analysis was used when the annual averages from 1958-76 were used as the data base for the regression analysis.

Farmland sales were deleted from the population if:

(a) a parcel (i.e. sale) had less than 40 acres

(b) the sworn value was not equal to the consideration value. When the two values were not equal it was assumed the sale was not a bonafide transaction.

(c) a sale was considered to be non-agricultural e.g. urban, light industry.

An extensive manual review of all sales data was conducted to cull inconsistent data within a sale, within a soil classification and between classifications.

4. Design of LP Model Farm Enterprises for Study Area 1 and 2

Average Farm Size

The average farm size for each LP model farm enterprise was based on the 1976 weighted average farm size for each study area. In study area 1, the weighted average farm size was estimated at 527 acres and adjusted to 560 acres. In study area 2, the weighted average farm size was estimated at 739 acres and adjusted to 720 acres. The weighted average farm size was adjusted to the nearest multiple of 80 acres because farmland parcels normally sell in multiples of 80 acres.

In study area 1 about 520 acres or 93 percent of the total farm area was estimated to be arable land. The remainig 40 acres was defined as non-arable. The average field size was estimated to be 75 acres. In study area 2 about 480 acres or 67 percent was estimated to be arable land with the balance of 240 acres defined as non-arable land. The average field size was about 55 acres.

LP Model Activities

In linear programming there are three major types of activities or variables that are unknowns and the model solves for these activities.

The crop production and commodity sell activities in the model farm enterprises were as follows:

Study Area 1: Red River Valley

Production Activities		Units
Class 1: Prime Farmland		
Wheat	- stubble	acres
Wheat	- fallow	"
Oats	- stubble	"
Oats	- fallow	"
Barley	- stubble	"
Barley	- fallow	"
Flaxseed	- stubble	"
Flaxseed	- fallow	"
Rapeseed	- stubble	"
Rapeseed	- fallow	"
Sunflowers	- stubble	"
Grain Corn	- stubble	"
Corn Silage	- stubble	"
Alfalfa-Grass	- stubble	"
Bromegrass	- stubble	"
Summerfallow		"
Class 2: Marginal Farmland		
Wheat	- stubble	acres
Wheat	- fallow	"
Oats	- stubble	"
Oats	- fallow	"
Barley	- stubble	"
Barley	- fallow	"
Flaxseed	- stubble	"
Flaxseed	- fallow	"

Rapeseed	- stubble	acres
Rapeseed	- fallow	"
Sunflowers	- stubble	"
Grain Corn	- stubble	"
Corn Silage	- stubble	"
Alfalfa-Grass	- stubble	"
Bromegrass	- stubble	"
Summerfallow		"

Class 3: Sub-Marginal Farmland

Alfalfa-Grass	- stubble	"
Bromegrass	- stubble	"

Commodity Sell Activities		Units
Wheat	- export	bushels
Oats	- export	"
Barley	- export	"
Flaxseed	- export	"
Rapeseed	- export	"
Wheat	- domestic	"
Oats	- domestic	"
Barley	- domestic	"
Grain Corn	- domestic	"
Corn Silage	- domestic	tons
Alfalfa-Grass	- domestic	tons
Bromegrass	- domestic	tons
Sunflowers	- processors	bushels
Grain Corn	- distillery	"
Rapeseed	- processors	"

Study Area 2: Birtle - Russell

Production Activities		Units

Class 1: Prime Farmland

Wheat	- stubble	acres
Wheat	- fallow	"

Oats	- stubble	acres
Oats	- fallow	"
Barley	- stubble	"
Barley	- fallow	"
Flaxseed	- stubble	"
Flaxseed	- fallow	"
Rapeseed	- stubble	"
Rapeseed	- fallow	"
Alfalfa-Grass	- stubble	"
Bromegrass	- stubble	"
Summerfallow		"

Class 2: Marginal Farmland

Wheat	- stubble	acres
Wheat	- fallow	"
Oats	- stubble	"
Oats	- fallow	"
Barley	- stubble	"
Barley	- fallow	"
Flaxseed	- stubble	"
Flaxseed	- fallow	"
Rapeseed	- stubble	"
Rapeseed	- fallow	"
Alfalfa-Grass	- stubble	"
Bromegrass	- stubble	"
Summerfallow		"

Class 3: Sub-Marginal Farmland

No grain production activities - land used primarily for pasture

Commodity Sell Activities		Units
Wheat	- export	bushels
Oats	- export	"
Barley	- export	"
Flaxseed	- export	"

Rapeseed	- export	acres
Wheat	- domestic	"
Oats	- domestic	"
Barley	- domestic	"
Alfalfa-Grass	- domestic	tons
Bromegrass	- domestic	tons
Rapeseed	- processors	bushels

Livestock activities were not represented in terms of enterprises, but rather in terms of a producer's opportunity cost in producing feed grains and forage crops and selling those commodities. Non-arable land or pasture was considered as a production activity, especially in study area 2, but was eventually deleted. It was thought to be unrealistic to assume that for the average farm the non-arable land would be in one or two large blocks suitable for pasturing livestock. In addition, income from a pasture activity was estimated at about $2 per acre per year which was considered to be insignificant in terms of the overall farm income.

The amount of summerfallow in each model farm was based on historical summerfallow acreage in each study area. It was assumed that the amount of summerfallow would remain relatively constant.

LP Model Technical Coefficients (a_{mn})

The technical coefficients indicate the amount added to or substracted from the resource or restriction quantity b_m for a one unit operation of the X_n activity. Coefficients are stated in terms of the amount of input required per unit of activity. A positive coefficient denotes the use of the respective resources by the corresponding variable or activity. A negative coefficient denotes that the corresponding variable or activity is adding to the amount of the resources available.

Non-restricted input/output coefficients in the study were crop yields, crop production cost and commodity prices. Restricted input/output coefficients were land, labor, capital and grain delivery quota. A crop rotation element was represented by an upper and lower acreage bound on each crop activity.

Crop Yields Used in LP Model Farms

The crop activity yields for the model farm enterprises were estimated by equation 5.

$$CAY_t = HAY_t \times YAF_t \qquad (5)$$

Where CAY_t = Crop activity yield that an average producer could expect to receive in year t under normal conditions.

HAY_t = Historical average yield represented by a long-term average crop insurance yield and adjusted by a yield coefficient to reflect each crops yield on stubble and fallow

YAF_t = Yield adjustment factor was represented by a ratio of 1977 projected yield to average projected yield

t = 1977

Historical Average Yield

The historical average yield for each crop was based on long-term weighted average crop insurance yields and adjusted by a yield coefficient to reflect each crop's yield on stubble and fallow.

In study area 1 and 2 the weighted average yield per crop for farmland class 1 and 2 was based on Manitoba Crop Insurance Corporation (MCIC) soil zone yields for 1978. The soil zone yields in both study areas were represented by a 25 year (1953-77) average yield with the exception of 4 soils zones in study area 1. Soil zones C32, D32, E32 and F32 were represented by a 10 year average yield (1967-76) for crop insurance risk area 12.

In study area 1, soil zones C32, D32 and E32 made up 57.4 percent of the total number of quarter sections in class 1. In class 2, soil zone F32 made up only 3.6 percent of the total. As previously discussed, the 25 year average yield for the 4 soil zones was thought not to be representative of the soil zones' actual productivity. The crop yields of the four soil zones were adjusted up as follows:

Step 1 The 1976 ten year (1967-76) average wheat yield in crop insurance risk area 12 was estimated to be 24.19 bushels per acre. The 10 year average yield was about 11 percent greater than the 25 year (1952-76) average yield of 21.75 bushels per acre.

Step 2 To maintain the relative soil productivity of the 4 soil zones the 10 year average wheat yield of 24.19 bushels was adjusted by each of the soil zones' 1976 soil zone coefficients. The soil zone coefficients for C32, D32, E32 and F32 were .999, .959, .888 and .902 respectively. The four soil zones' wheat yields were increased and the relative position of the yields was kept constant.

Step 3 The soil zone productivity differential for the other crop yields was based on the wheat productivity differential estimated in step 2. Alfalfa-grass and bromegrass yields were not adjusted up because MCIC had only designed the forage program in 1978 so it was assumed that the forage yields used reflected water management improvements in the Red River Valley. The other crop yields were estimated by discounting the C12 benchmark yields by the wheat yield ratios (i.e. C32/C12 or .944, D32/C12 or .906, E32/C12 or .839 and F32/C12 or .852). In summary, by adjusting up the crop yields of the 4 soil zones, each soil zone's yield contribution to the weighted average yields was increased to a more representative level.

Corn silage was the only crop activity which was not based on MCIC yield data. Corn silage yield data was not available from MCIC in October, 1978, therefore the following method was used to estimate a corn silage yield for each soil zone in study area 1. At the time of the study most of the corn silage produced in Manitoba was grown in study area 1. Since most of the corn silage was grown in study area 1, a 25 year provincial corn silage average yield (1953-77) was estimated and assumed to represent the average yield for study area 1. The 25 year provincial corn silage average yield was 6.24 tonnes per acre.[24] The 1976 soil zone yield coefficients in study area 1 represented the relative soil productivity of each soil zone for wheat production. This relative soil productivity was assumed to be the same for corn silage as it was for wheat. The provincial average yield of 6.24 tonnes per acre was adjusted by the 1976 soil zone yield coefficients to produce a corn silage yield for each soil zone in study area 1.

The initial alfalfa-grass yields for farmland classes 1, 2 and 3 were adjusted down by deleting the second harvest in the fourth year.

In both study areas crop activity on class 3 land was assumed to be nil except for alfalfa-grass and bromegrass in study area 1.

A weighted average yield for each crop activity was estimated by representing each soil zone's yield in

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[24] 1976 Manitoba Department of Agriculture Yearbook, p. 72.

proportion to each soil zone's percent of the total number of quarter sections per class.

The historical yields were estimated by multiplying the weighted average yields by a stubble/fallow yield coefficient. The stubble coefficients were represented by a ratio of average stubble yield to a weighted average yield for each crop and similarly for the fallow coefficients. The estimation of the stubble and fallow coefficients was based on MCIC average yield data (1967-76) for wheat, oats, barley, flaxseed and rapeseed.

Yield Adjustment Factor

The historical yields represented an average yield that a producer could expect to obtain in any given year. The historical yields were based on long term averages. To make the crop yields more representative of 1977 actual yields, the historical yields were adjusted up by a 1977 yield adjustment factor developed by Dyck.[25] The yield adjustment factor was a ratio of 1977 projected yield to an average projected yield. The yield adjustment factor represented yield increases brought about by technological and varietal improvements.

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25 J.D. Dyck, "The Impact of Adopted Technological Change on Farmland Prices in Manitoba", Unpublished MSc. thesis, Department of Agricultural Economics, University of Manitoba, Winnipeg, 1979.

Crops excluded in Dyck's analysis were grain corn, corn silage, sunflowers, alfalfa-grass and bromegrass. The historical yields for these crops were not used. A five year average yield (1973-77) for each crop was estimated and adjusted by a yield adjustment index for each class to produce 1977 crop activity yields.

The yield adjustment factor as defined by Dyck was as follows:

$$\text{Yield Adjustment Factor (1977)} = \frac{\text{(1) 1977 Projected Yield}}{\text{(2) Average Projected Yield}} \qquad (6)$$

(1) 1977 Projected Yield = $C_1 + b_1 \ (PC_i)$

Where $PC_i = (a_1 \times n_2) + (a_2 \times P_2 0_5) + (a_3 \times \text{Variety Index})$

N_2 and $P_2 0_5$ = pounds per acre used in study area i in 1977

Variety Index = index for each crop in 1976

i = Study area 1 and 2.

(2) Average Projected Yield

$$AVP = C_1 + b_1 \ (\overline{PC_1}) \qquad (7)$$

Where C_1 = constant yield

$\overline{PC_1}$ = a principal component variable consisting of N_2, $P_2 0_5$ and a variety variable.

Commodity Prices Used in LP Model Farms

Commodity prices were estimated to represent 1973 and 1977 average farmgate prices in study area 1 and 2. The farmgate price normally referred to an average price basis a primary elevator or shipping point. The commodity prices used in the LP Model farms are shown in Tables A.3 and A.4.

Crop Production Cost per Activity

The average crop production cost per activity for the LP model farms was based on information collected in the field surveys. The crop simulator model was used to estimate total production cost per crop for 1977. The production cost for each activity was assumed to be the same for farmland class 1 and 2.

All major factor inputs with the exception of land investment were estimated for each crop. The average production cost per crop activity are shown in Tables A.5 and A.6.

TABLE A.3

Commodity Prices Used in LP Model Farm 1
(Study Area 1: Red River Valley)

Commodity Sell Activity	Average Farmgate Price* (1973)	Average Farmgate Price* (1977)
	-- dollars per unit --	
1. Wheat-export	4.42/bus	2.71/bus
2. Oats-export	1.61/bus	.95/bus
3. Barley-export	2.45/bus	1.67/bus
4. Flaxseed-export	9.55/bus	6.10/bus
5. Rapeseed-export	5.84/bus	6.33/bus
6. Rapeseed-processing	5.84/bus	6.33/bus
7. Wheat-domestic	3.74/bus	2.26/bus
8. Oats-domestic	1.61/bus	.97/bus
9. Barley-domestic	2.45/bus	1.52/bus
10. Corn (Grain)-domestic	2.80/bus	2.25/bus
11. Corn (Silage)-domestic	12.00/ton	15.00/ton
12. Alfalfa-Grass-domestic	30.00/ton	40.00/ton
13. Bromegrass-domestic	25.00/ton	35.00/ton
14. Sunflowers-processing	3.00/bus	3.00/bus
15. Corn (Grain) -distillery	3.05/bus	2.50/bus

* Farmgate Price refers to a shipping point or primary elevator price.

TABLE A.4

Commodity Prices Used in LP Model Farm 2
(Study Area 2: Birtle - Russell)

Commodity Sell Activity	Average Farmgate Price* (1973)	Average Farmgate Price* (1977)
	-- dollars per unit --	
1. Wheat-export	4.42/bus	2.71/bus
2. Oats-export	1.61/bus	.95/bus
3. Barley-export	2.45/bus	1.67/bus
4. Flaxseed-export	9.55/bus	6.10/bus
5. Rapeseed-export	5.84/bus	6.33/bus
6. Rapeseed-processing	5.61/bus	6.10/bus
7. Wheat-domestic	3.74/bus	2.26/bus
8. Oats-domestic	1.61/bus	.97/bus
9. Barley-domestic	2.45/bus	1.52/bus
10. Alfalfa-Grass-domestic	30.00/ton	40.00/ton
11. Bromegrass-domestic	25.00/ton	35.00/ton

* Farmgate Price refers to a shipping point or primary elevator price.

TABLE A.5

1977 Average Production Cost per Crop Activity
(Study Area 1: Red River Valley)

Crop	dollars per acre
Class 1 & 2 Farmland	
Wheat - ST	81.13
Wheat - F	102.17
Oats - ST	75.66
Oats - F	95.28
Barley - ST	83.72
Barley - F	99.77
Flaxseed - ST	77.21
Flaxseed - F	92.40
Rapeseed - ST	80.15
Rapeseed - F	99.02
Sunflowers - ST	85.91
Grain Corn - ST	133.52
Silage Corn - ST	129.19
Alfalfa-Grass - ST	
Class 1	61.59
Class 2	60.61
Class 3	60.20
Bromegrass - ST	
Class 1	61.00
Class 2	60.60
Class 3	60.26

Notation: ST - stubble, F - summerfallow.

Note - the fallow crop costs include all costs associated with summerfallow land in the previous year.

TABLE A.6

1977 Average Production Cost per Crop Activity
(Study Area 2: Birtle - Russell)

Crop	dollars per acre
Class 1 & 2 Farmland	
Wheat - ST	70.69
Wheat - F	84.61
Oats - ST	57.69
Oats - F	78.17
Barley - ST	70.81
Barley - F	85.94
Flaxseed - ST	68.23
Flaxseed - F	84.21
Rapeseed - ST	71.16
Rapeseed - F	82.97
Alfalfa-Grass - ST	
Class 1	55.51
Class 2	54.96
Bromegrass - ST	
Class 1	48.21
Class 2	48.05

Notation: ST - stubble, F - summerfallow.

Note - the fallow crop costs include all costs associated with summerfallow land in the previous year.

LP Model Restraints

Restraint equations specified in the LP model farm indicate a maximum quantity of resources available for the various activities.

The restraint equations specified included resources such as land, labor, operating capital and Canadian Wheat Board quota. Crop rotation was represented by upper and lower acreage bounds on each crop activity. The crop acreage bounds represented a farmer's risk management or his reluctance to make major acreage shifts into new crops.

Land

The model farms were divided into three classes of farmland to determine the degree of impact on each class of an increase in grain transportation cost from farmgate to market. The percent distribution of farmland class 1, 2 and 3 was based on the distribution of the total number of quarter sections per class in each study area.

In addition to the class breakdown, percent of improved acres, unimproved acres and summerfallow were represented in each model farm. In study area 1 the 40 acres of non-arable land was assigned to class 3. In study area 2 the 240 acres of non-arable land was subjectively divided between the three classes. It was assumed that the parkland features consisting of bluffs, potholes and waste land were scattered throughout all three farmland classes. By assuming that the 87 acres of class 3 land was totally non-arable the balance of 153 acres was divided between class 1 and 2. It was assumed that the parkland features would be similar for class 1 and 2 therefore the 153 acres was divided on an equal percentage basis (i.e. 24%) of the total acres in each class. The land parameters for the model farms are shown in Tables A.7 and A.8.

Labor

Labor was considered a scarce resource only during overlap farm operation periods such as field spraying and forage harvest. Based on historical data and the field surveys the total labor per farm was restricted to the owner-operator with some assistance from part-time or paid family labour. It was assumed that operations down-time reduced the labor by a .75 efficiency factor. A work week consisted of six days and the owner-operator worked twelve hours per day during the critical periods.

TABLE A.7

Land Parameters for Model Farm 1
(Study Area 1: Red River Valley)

Farmland Class	Crop on Stubble	Crop on Summerfallow [1]	Non-Arable Land [2]	Totals by Class [3]
		- acres -		
1	380	34	0	414
2	77	7	0	84
3	22	0	40	62
Totals	479	41	40	560

1 Crop acreage on summerfallow was based on average summerfallow acres (8.3%) represented by the average ratio of summerfallow acres to acres under crops plus summerfallow acres for all rural municipalities in Study Area 1 (1976 Statistics Canada census data).

2 Non-arable land was based on an average of 7% represented by the average ratio of unimproved acres to immproved acres plus unimproved acres for all rural municipalities in Study Area 1 (1976 Statistics Canada census data).

3 Farmland class distribution was based on the distribution of the total number of quarter sections per class in Study Area 1.

TABLE A.8

Land Parameters for Model Farm 2
(Study Area 2: Birtle-Russell)

Farmland Class	Crop on Stubble	Crop on Summerfallow [1]	Non-Arable Land [2]	Totals by Class [3]
		- acres -		
1	181	97	89	367
2	131	71	64	266
3	0	0	87	87
Totals	312	168	240	720

1 Crop acreage on summerfallow was based on average summerfallow acres (35%) represented by the average ratio of summerfallow acres to acres under crops plus summerfallow acres for all rural municipalities in Study Area 2 (1976 Statistics Canada census data).

2 Non-arable land was based on an average of 33% represented by the average ratio of unimproved acres to immproved acres plus unimproved acres for all rural municipalities in Study Area 2 (1976 Statistics Canada census data).

3 Farmland class distribution was based on the distribution of the total number of quarter sections per class in Study Area 2.

In study area 1, the total man-units were estimated to be 1.48 which consisted of the owner-operator and .48 man-units of hired part-time labor or paid family labor. As shown in Table A.9, the average number of paid weeks of hired farm labor was estimated at 18.9 weeks. Based on a work season of 6 months, a 6 day work week and a 8 hour work day it was estimated that the average farm had 5.8 hours per work day of hired labor. By assuming that the owner-operator worked an average of 12 hours per day it was estimated that the model farm in study area 1 had 1.48 man-units (i.e. 12 hours + 5.8 hours/12hours). In study area 2, the number of paid weeks of hired farm labor were estimated at 15.23 (Table A.10). Using the same reasoning as in study area 1, it was estimated that the model farm had available an average of 4.67 hours per work day of hired labor. By adding the 4.67 hours to the 12 hours provided by the owner-operator study area 2 was estimated to have 1.39 man-units.

The crop simulator model estimated hours of labor per acre based on the equipment used and number of field operations for each crop. Labor per acre was assumed to be the same for farmland classes 1, 2 and 3.

The labor restraint was represented by four critical operational periods during a six month period from April 1 to the end of September. The four periods were

TABLE A.9

Hired Agricultural Labor per Farm Group
(Study Area 1: Red River Valley)

Group	Weeks of Paid Farm Labor	Mid-point of Range (weeks)	Farms Reporting per group	Total Weeks Paid per group
1	1-4	2.5	292	730.0
2	5-13	9.0	267	2 403.0
3	14-26	20.0	130	2 600.0
4	27-52	39.5	135	5 332.0
5	53-78	65.5	18	1 179.0
6	79-104	91.5	17	1 555.5
7	105-156	130.5	13	1 695.0
8	157-208	182.5	6	1 095.0
Totals			878	16 591.5
Weighted Average Number of Paid Weeks per farm				18.9

Source: Statistics Canada, 1976 Census Data, Catalogue 96-807 (Bulletin 13-1), Table 20, Census Division 3.

TABLE A.10

Hired Agricultural Labor per Farm Group
(Study Area 2: Birtle-Russell)

Group	Weeks of Paid Farm Labor	Mid-point of Range (weeks)	Farms Reporting per group	Total Weeks Paid per group
1	1-4	2.5	348	870.0
2	5-13	9.0	265	2 385.0
3	14-26	20.0	129	2 580.0
4	27-52	39.5	102	4 029.0
5	53-78	65.5	19	1 244.5
6	79-104	91.5	11	1 006.5
7	105-156	130.5	6	783.0
8	157-208	182.5	3	547.5
Totals			883	13 445.5
Weighted Average Number of Paid Weeks per farm				15.23

Source: Statistics Canada, 1976 Census Data, Catalogue 96-807 (Bulletin 13-1), Table 20, Census Division 15.

TABLE A.11

Labor Restraint per Operational Period

Operational Period	Study Area 1 Red River Velley	Study Area 2 Birtle-Russell
	- maximum hours available -	
Spring Seeding[1]	240	225
Crop Spraying[2]	60	60
Forage Harvest[3]	140	128
Grain Harvest[4]	240	225

1. May 10 - June 10: 3 weeks of operational time.
2. June 21 - July 2: Spraying was restricted to 4 hours in the morning and evening to avoid wind drift and mid-day heat.
3. June 15 - July 2: A portion of the forage harvest period overlapped with crop spraying. It was assumed that spraying received first priority.
4. Cereals and oilseeds are normally harvested during August 10 - September 10 period (3 weeks operational time); sunflowers, grain corn and silage corn are harvested in September - October period and do not compete for the same labor.

spring seeding, crop spraying, forage harvest and grain harvest. The labor available per critical period is shown in Table A.11.

Capital

Working capital was not considered to be a limiting factor in the two model farms. An average farmer was assumed to have access to sufficient working capital to shift from one crop to another.

In the event of crop substitution farmers would likely be required to purchase new equipment for new crop activities. This would change the average farmer's capital requirements and level of fixed investment. Since the model farms were static, the new equipment question was not addressed. In a dynamic model a change in fixed costs could have been allocated over several years.

The total working capital available to each model farm was based on a representative operating cost per crop multiplied by the total arable acres in each study area. Total operating costs was equal to the sum of total variable cost, land taxes, machinery insurance, miscellaneous and overhead, crop insurance and interest on operating capital. In the case of crops grown on summerfallow, the operating costs for summerfallow was added to the operating costs for the crops seeded on fallow.

Study Area 1

The working capital requirement for the model farm representing the Red River Valley was estimated to be up to $30,000 per year (i.e. 520 acres x $57.70 per acre). The capital requirements in Study Area 1 were relatively higher than in Study Area 2 due to higher production costs associated with special crops and more intensive farming.

Study Area 2

The working capital requirement for the model farm representing the Birtle-Russell area was estimated to be up to $20,000 per year (i.e. 480 acres x $41.67 per acre).

Quota

In Western Canada farmers have complete freedom regarding the production of any given crop. The marketing structure divides crops into two groups. One group of crops require quota or marketing rights while the other group of crops do not. These crops are sold through a relatively unregulated marketing structure. The requirement of quota for some crops but not for others tends to become another factor in the farmers' decision making process during the selection of crop mix. Quota under certain conditions becomes a scarce resource and a restraint to production.

The six principal crops under quota are wheat, oats, barley, rye, flaxseed and rapeseed. The Canadian Wheat Board has sole export marketing jurisdiction over board-grains (wheat, oats and barley). The board grains are on a terminating quota system which divides the total quota for the crop year into specified time periods. If producers do not use the quota in each period, then the right to deliver that portion of grain is lost. Wheat, oats and barley sold as feed grain to the off-board market such as local feedmills and feedlots do not require quota.

Non-board grains (rye, flaxseed and rapeseed) are not sold by the Canadian Wheat Board, however, in conjunction with the western grain industry the CWB establishes export and domestic delivery quotas for these grains depending on market demand and available primary elevator space. The non-board grains are on an accumulative quota system which allows farmers to deliver at anytime throughout the crop year. In addition, special crops such as sunflowers, grain corn and forage are sold outside the jurisdiction of the Canadian Wheat Board and quota is not required.

If a producer wishes to market the six principal grains under quota, then for every one bushel of grain delivered a given amount of quota assignable acres must be used. The total number of quota assignable acres per farm was calculated by equation 8.

$$AsAc = A + (\text{the lower of } 1/3\ A \ \underline{\text{or}}\ B)^{26} \quad (8)$$

Where AsAc = total assignable acres per farm

A = seeded acres of six principal grains (wheat, oats, barley, rye, flaxseed and rapeseed), miscellaneous crops and summerfallow acres

B = acres of perennial forage

Summerfallow acreage tends to enhance a farmer's total assignable acres and thus his ability to market grain. The higher the percent of summerfallow in a given area the greater opportunity to market grain. In study area 2 where summerfallow acreage averages about 35 percent of the total arable land, quota as a restraint would be relatively less restrictive as compared to study area 1 where summerfallow is about 7 percent.

Quota Assignable Acres as an Input/Output Coefficient

An average producer considers quota assignable acres to be a scarce resource. In determining the quota coefficients it was assumed that the total assignable acres were assigned to each of the six principal crops.

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26 Canadian Wheat Board, Details of the Quota System and Permit Application for the 1977-78 Crop year, August, 1977.

The quota restraint coefficients were estimated by equation 9.

$$QRC_{nt} = \frac{1}{A_n} \times \frac{B_n}{C_n} \qquad (9)$$

Where QRC_{nt} = quota restraint coefficient is the number of assignable acres required to market one bushel of crop n in period t

A_n = average expected quota per crop n in period t (bushels per assignable acre)

B_n = total seeded acres to wheat, oats, barley, rye, flaxseed, rapeseed and miscellaneous crops in period t

C_n = total assignable acres per model farm in period t

n = five quota crops in study areas 1 and 2 (i.e. wheat, oats, barley, flaxseed and rapeseed)

t = 1977-78 crop year

Estimation of Quota Restraint Coefficients for Study Areas 1 and 2

The average expected quota (A_n) was represented by the level of quota received by an average producer in Western Canada during the 1977-78 crop year. The quota levels were based primarily on the 1977-78 crop year with some reference to the two previous crop years and the upcoming 1978-79 international demand for grain. The quota for each crop was the same for both study areas. The average quota levels in bushels per assigned acre were as follows: wheat - 12, oats - 12, barley - 12, flaxseed - 15 and rapeseed - 15.

Study Area 1: Red River Valley

The model farm parameters were as follows:

Total farm acres	560
Total arable acres	520
Total non-arable acres	40
Perennial forage acres	30
Summerfallow acres	41

B_n was estimated to be 449 acres by substracting summerfallow and perennial forage from the total arable acres. The total assignable acres (C_n) were estimated at 520 acres (i.e. 490 + the lower of 1/3 of 490 or 30 acres).

Study Area 2: Birtle - Russell

The model farm parameters were as follows:

Total farm acres	720
Total arable acres	480
Total non-arable acres	240
Perennial forage acres	45
Summerfallow acres	168

B_n was estimated to be 267 acres by subtracting summerfallow and perennial forage from the total arable acres. The total assignable acres (C_n) were estimated at 480 acres (i.e. 435 acres + the lower of 1/3 of 435 or 45 acres).

Quota Restraint Coefficients

The quota restraint coefficients represent the quantity of assignable acres required to market one bushel of crop n. The coefficients were estimated by equation 9. The number of assignable acres required to market one bushel was discounted by the ratio of total seeded acres to total assignable acres to reflect the influence of summerfallow and perennial forage acreage on the ability to market grain. The quota restraint coefficients for study areas 1 and 2 are shown in Table A.12.

TABLE A.12

Quota Restraint Coefficients for Study Areas 1 and 2

Study Area	Wheat	Oats	Barley	Flaxseed	Rapeseed
	- assignable acres required to market one bushel -				
1	.071955	.071955	.071955	.057564	.057564
2	.046354	.046354	.046354	.037083	.037083

Crop Rotation

A crop rotation restraint was imposed on the model farms for three reasons:

(a) to represent normal or expected farm practise

(b) to allow the model farms to maximize profits by allocating crop acres to any one crop up to a maximum of 50% of the total crop acres available

(c) to represent a degree of producer risk management. Farmers tend to be cautious in shifting from one crop to another regardless of attractive net returns per acre.

In study areas 1 and 2 the crop rotation requirements were reviewed and a minimum and maximum acreage was assigned for each crop. In the case of wheat, oats, barley, flaxseed, rapeseed and summerfallow a ten year (1966-76) average acreage percentage $\pm$ 2 standard deviations was used to establish the upper and lower acreage bounds. The upper bounds were represented by each crop acreage percentage mean plus 2 standard deviations and the lower bounds were represented by the mean minus 2 standard deviations. Upon estimating the upper and lower acreage bounds for each crop and summerfallow, the agricultural representatives interviewed during the field surveys were consulted as to the accuracy of the acreage bounds. The acreage bounds were generally agreed to with the exception of rapeseed in Study Area 1. The agricultural representative suggested that the upper bound on rapeseed be increased from 48 acres to 70 acres.

Equation 10 was used to estimate the upper and lower acreage bounds for each crop in Study Areas 1 and 2.

- Total crop acres available per study area *
  - Upper bound acreage % per crop i *
    - % of crop i on Class 1 *
      - % of crop i on stubble
      - % of crop i on fallow
    - % of crop i on Class 2 *
      - % of crop i on stubble
      - % of crop i on fallow
  - Lower bound acreage % per crop i *
    - % of crop i on Class 1 *
      - % of crop i on stubble
      - % of crop i on fallow
    - % of crop i on Class 2 *
      - % of crop i on stubble
      - % of crop i on fallow

(10)

where:

Total crop acres available per study area	= total class 1 and 2 crop acreage plus summerfallow
Upper and lower bound acreage % per crop i	= 10 year (1966-76) average acreage percentage per crop i ± 2 standard deviations[27]
Percent of crop i on Class 1 and 2	= percentage of crop i on class 1 and class 2 as estimated by ratios of class 1 and 2 acres to total crop acres available per study area
Percent of crop i on stubble and fallow acres	= a 10 year (1966-76) average percentage of crop i on stubble and fallow

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27 Manitoba Agriculture Yearbooks 1966-76. 1970 acreage data was deleted due to Federal Government's LIFT program.

Crop i = wheat, oats, barley, flaxseed and rapeseed

5. Component B: Data Review

The sources of input data for the crop budgeting models were as follows:

1. 1977 Farm Machinery Prices

   1976 prices were indexed up to a 1977 base by a farm machinery price index (Statistics Canada). 1976 farm machinery prices originated from two main sources:

   (a) "Machinery Price Data", Unpublished Data, Farm Machinery Board, Winnipeg, Manitoba, 1974-1977.

   (b) Department of Agricultural Engineering, University of Manitoba.

2. 1977 fertilizer prices were average prices based on prices obtained from four farm supply companies in the Winnipeg area.

3. 1977 chemical prices were average prices based on prices obtained from five major chemical distributors.

4. 1977 Seed Cost

Study Area 1: 1977 seed cost was based on 1976 Manitoba average farm price for each commodity plus 35% of the average farm price to cover the portion of the seed requirements purchased from commercial outlets. Sunflower and corn seed was assumed to have been purchased off-farm.

Study Area 2: 1977 seed cost was based on 1976 Manitoba average farm price for each commodity plus 25% of the farm price to cover the portion of the seed requirements purchased from commercial outlets.

5. 1977 Land Taxes

1976 land taxes per improved acre for Study Area 1 and 2 were indexed up to a 1977 base by using a 1977 Western Canada Property Tax Index (Statistics Canada, Publication 62-004). The farm land property tax for 1977 was estimated to average $3.71 per acre and $2.38 per acre for Study Area 1 and 2 respectively.

6. 1977 Baler Twine Price

1977 baler twine price was an average price based on prices obtained from several farm supply dealers.

TABLE A.13

Statutory Grain Freight Rates for Study Areas 1 and 2

Shipping Points to Export Position	Grain & Grain Products	Rapeseed, Flaxseed & Products
	- cents per cwt -	
Study Area 1: Red River Valley		
Thunder Bay		
Portage La Prairie	15	16.5
Carman	15	16.5
Gretna	15	16.5
Rate Used	15	16.5
Vancouver		
Carman	34	35.5*
Study Area 2: Birtle-Russell		
Thunder Bay		
Rapid City	17	18.5
Shoal Lake	18	19.5
Russell	18	19.5
Rate Used	18	19.5
Vancouver		
Shoal Lake	34	35.5

* In 1977, 92 percent of rapeseed exports were shipped through Vancouver.
Source: Mr. J. McTaggart, Canadian Pacific Railway, Winnipeg, Manitoba.

TABLE A.14

Simulated Increases in Grain Freight Rates
(Study Area 1: Red River Valley)

Commodity	Representative Statutory Rate (cents/cwt)	Representative Statutory Rate (cents/bushel)	Multiples of Statutory Rates (cents/bushel)		
			3.0 X	3.5 X	4.0 X
Wheat	15	9.0	27.0(18)	31.5(22.5)	36.0(27)
Oats	15	5.1	15.3(10.2)	17.85(12.8)	20.4(15.3)
Barley	15	7.2	21.6(14.4)	25.2(18)	28.8(21.6)
Flaxseed	16.5	9.24	27.72(18.5)	32.34(23.1)	36.96(27.7)
Rapeseed	35.5	17.75	53.25(35.5)	62.13(44.4)	71.0(53.3)

[1] Conversion based on Canadian Grain Commission contract weights as follows: Wheat - 60 lb./bu., Oats - 34 lb./bu., Barley - 48 lb./bu., Flaxseed - 56 lb./bu., and Rapeseed - 50 lb./bu.

Note: numbers in parenthesis represent a net freight rate increase per bushel for each multiple of a statutory rate.

TABLE A.15

Simulated Increases in Grain Freight Rates
(Study Area 2: Birtle-Russell)

Commodity	Representative Statutory Rate (cents/cwt)	Representative Statutory Rate (cents/bushel)	Multiples of Statutory Rates 3.0 X (cents/bushel)	3.5 X	4.0 X
Wheat	18	10.8	32.4(21.6)	37.8(27)	43.2(32.4)
Oats	18	6.12	18.36(12.2)	21.42(15.3)	24.48(18.4)
Barley	18	8.64	25.92(17.3)	30.24(21.6)	34.56(25.9)
Flaxseed	19.5	10.92	32.76(21.8)	38.22(27.3)	43.68(32.8)
Rapeseed	35.5	17.75	53.25(35.5)	62.13(44.4)	71.0(53.3)

[1] Conversion based on Canadian Grain Commission contract weights as follows: Wheat - 60 lb./bu., Oats - 34 lb./bu., Barley - 48 lb./bu., Flaxseed - 56 lb./bu., and Rapeseed - 50 lb./bu.

Note: numbers in parenthesis represent a net freight rate increase per bushel for each multiple of a statutory rate.

TABLE A.16

1973 Commodity Prices Discounted by Simulated Grain Transportation Cost Increases ($ per bushel)
(Study Area 1: Red River Valley)

Simulations	Wheat-Export	Oats - Export	Barley-Export	Flaxseed-Export	Rapeseed-Export	Rapeseed - Processors	Wheat - Domestic	Oats - Domestic	Barley-Domestic
Base year (1973) Commodity Prices	4.42	1.61	2.45	9.55	5.84	5.84	3.74	1.61	2.45
Average Delivery Distance Increased to:									
10 miles	4.389	1.579	2.419	9.519	5.809	5.84	3.74	1.61	2.45
15 miles	4.367	1.557	2.397	9.497	5.787	5.84	3.74	1.61	2.45
20 miles	4.346	1.536	2.376	9.476	5.766	5.84	3.74	1.61	2.45
25 miles	4.326	1.516	2.356	9.456	5.746	5.84	3.74	1.61	2.45
30 miles	4.308	1.498	2.338	9.438	5.728	5.84	3.74	1.61	2.45
Statutory Rate Increased by:									
3.0 X	4.240	1.508	2.306	9.365	5.485	5.485	3.56	1.508	2.306
3.5 X	4.195	1.482	2.27	9.319	5.396	5.396	3.515	1.482	2.270
4.0 X	4.150	1.457	2.234	9.273	5.307	5.307	3.47	1.457	2.234
D.D. (miles) + Multiple of Crow[1]									
10 + 3 X	4.209	1.477	2.275	9.334	5.454	5.485	3.56	1.508	2.306
10 + 3.5 X	4.164	1.451	2.239	9.288	5.365	5.396	3.515	1.482	2.27
10 + 4 X	4.119	1.426	2.203	9.242	5.276	5.307	3.47	1.457	2.234
15 + 3 X	4.187	1.455	2.253	9.312	5.432	5.485	3.56	1.508	2.306
15 + 3.5 X	4.142	1.429	2.217	9.266	5.343	5.396	3.515	1.482	2.270

TABLE A.16 (continued)

Simulations	Wheat-Export	Oats - Export	Barley-Export	Flaxseed-Export	Rapeseed-Export	Rapeseed - Processors	Wheat - Domestic	Oats - Domestic	Barley - Domestic
15 + 4 X	4.097	1.404	2.181	9.220	5.254	5.307	3.47	1.457	2.234
20 + 3 X	4.166	1.434	2.232	9.291	5.411	5.485	3.56	1.508	2.306
20 + 3.5 X	4.120	1.408	2.196	9.245	5.322	5.396	3.515	1.482	2.270
20 + 4 X	4.076	1.383	2.160	9.199	5.233	5.307	3.47	1.457	2.234
25 + 3 X	4.146	1.414	2.212	9.271	5.391	5.485	3.56	1.508	2.306
25 + 3.5 X	4.101	1.388	2.176	9.225	5.302	5.396	3.515	1.482	2.270
25 + 4 X	4.056	1.363	2.140	9.179	5.213	5.307	3.47	1.457	2.234
30 + 3 X	4.128	1.396	2.194	9.253	5.373	5.485	3.56	1.508	2.306
30 + 3.5 X	4.083	1.370	2.158	9.207	5.284	5.396	3.515	1.482	2.27
30 + 4 X	4.038	1.345	2.122	9.161	5.195	5.307	3.47	1.457	2.234

[1] Simulated combinations of increased delivery distance (D.D.) plus multiples of the statutory freight rate.

Note * 1973 domestic/local prices for other commodities: grain corn (feed) - $2.80/bushel, corn silage - $12/ton, alfalfa-grass - $30/ton, bromegrass - $25/ton, sunflowers (processors) - $3/bushel, grain corn (distillery) - $3.05/bushel. It was assumed that an increase in delivery distance and statutory freight rates would not affect the prices of these commodities.

TABLE A.17

1973 Commodity Prices Discounted by Simulated Grain Transportation Cost Increases ($ per bushel)
(Study Area 2: Birtle-Russell)

Simulations	Wheat-Export	Oats - Export	Barley-Export	Flaxseed-Export	Rapeseed-Export	Rapeseed - Processors	Wheat - Domestic	Oats - Domestic	Barley-Domestic
Base year (1973) Commodity Prices	4.42	1.61	2.45	9.55	5.84	5.615	3.74	1.61	2.45
Average Delivery Distance Increased to:									
10 miles	4.389	1.579	2.419	9.519	5.809	5.615	3.74	1.61	2.45
15 miles	4.367	1.557	2.397	9.497	5.787	5.615	3.74	1.61	2.45
20 miles	4.346	1.536	2.376	9.476	5.766	5.615	3.74	1.61	2.45
25 miles	4.326	1.516	2.356	9.456	5.746	5.615	3.74	1.61	2.45
30 miles	4.308	1.498	2.338	9.438	5.728	5.615	3.74	1.61	2.45
Statutory Rate Increased by:									
3.0 X	4.204	1.488	2.277	9.332	5.485	5.260	3.524	1.488	2.277
3.5 X	4.150	1.457	2.234	9.277	5.396	5.171	3.470	1.457	2.234
4.0 X	4.096	1.426	2.191	9.222	5.307	5.082	3.416	1.426	2.191
D.D. (miles) + Multiple of Crow[1]									
10 + 3 X	4.173	1.457	2.246	9.301	5.454	5.260	3.524	1.488	2.277
10 + 3.5 X	4.119	1.426	2.203	9.246	5.365	5.171	3.470	1.457	2.234
10 + 4 X	4.065	1.395	2.160	9.191	5.276	5.082	3.416	1.426	2.191
15 + 3 X	4.151	1.435	2.224	9.279	5.432	5.260	3.524	1.488	2.277
15 + 3.5 X	4.097	1.404	2.181	9.224	5.343	5.171	3.470	1.457	2.234

TABLE A.17 (continued)

Simulations	Wheat-Export	Oats - Export	Barley-Export	Flaxseed-Export	Rapeseed-Export	Rapeseed - Processors	Wheat - Domestic	Oats - Domestic	Barley - Domestic
15 + 4 X	4.043	1.373	2.138	9.169	5.254	5.082	3.416	1.426	2.191
20 + 3 X	4.130	1.414	2.203	9.258	5.411	5.260	3.524	1.488	2.277
20 + 3.5 X	4.076	1.383	2.160	9.203	5.322	5.171	3.470	1.457	2.234
20 + 4 X	4.022	1.352	2.117	9.148	5.233	5.082	3.416	1.426	2.191
25 + 3 X	4.110	1.394	2.183	9.238	5.391	5.260	3.524	1.488	2.277
25 + 3.5 X	4.056	1.363	2.140	9.183	5.302	5.171	3.470	1.457	2.234
25 + 4 X	4.002	1.332	2.097	9.128	5.213	5.082	3.416	1.426	2.191
30 + 3 X	4.092	1.376	2.165	9.220	5.373	5.260	3.524	1.488	2.277
30 + 3.5 X	4.038	1.345	2.122	9.165	5.284	5.171	3.470	1.457	2.234
30 + 4 X	3.984	1.314	2.079	9.110	5.195	5.082	3.416	1.426	2.191

[1] Simulated combinations of increased delivery distance (D.D.) plus multiples of the statutory freight rate.

Note * 1973 domestic/local prices for other commodities: alfalfa-grass - $30/ton, bromegrass - $25/ton. It was assumed that an increase in delivery distance and statutory freight rates would not affect the prices of these two commodities.

TABLE A.18

1977 Commodity Prices Discounted by Simulated Grain Transportation Cost Increases ($ per bushel)
(Study Area 1: Red River Valley)

Simulations	Wheat-Export	Oats - Export	Barley-Export	Flaxseed-Export	Rapeseed-Export	Rapeseed - Processors	Wheat - Domestic	Oats - Domestic	Barley-Domestic
Base year (1977) Commodity Prices	2.713	0.947	1.667	6.096	6.33	6.33	2.26	0.97	1.524
Average Delivery Distance Increased to:									
10 miles	2.682	0.916	1.636	6.065	6.299	6.33	2.26	0.97	1.524
15 miles	2.660	0.894	1.614	6.043	6.277	6.33	2.26	0.97	1.524
20 miles	2.639	0.873	1.593	6.022	6.256	6.33	2.26	0.97	1.524
25 miles	2.619	0.853	1.573	6.002	6.236	6.33	2.26	0.97	1.524
30 miles	2.601	0.835	1.555	5.984	6.218	6.33	2.26	0.97	1.524
Statutory Rate Increased by:									
3.0 X	2.533	0.845	1.523	5.911	5.975	5.975	2.08	0.845	1.523
3.5 X	2.488	0.819	1.487	5.865	5.886	5.886	2.035	0.819	1.487
4.0 X	2.443	0.794	1.451	5.819	5.797	5.797	1.99	0.794	1.451
D.D. (miles) + Multiple of Crow[1]									
10 + 3 X	2.502	0.814	1.492	5.880	5.944	5.975	2.08	0.845	1.523
10 + 3.5 X	2.457	0.788	1.456	5.834	5.855	5.886	2.035	0.819	1.487
10 + 4 X	2.412	0.763	1.420	5.788	5.766	5.797	1.99	0.794	1.451
15 + 3 X	2.480	0.792	1.470	5.858	5.922	5.975	2.08	0.845	1.523
15 + 3.5 X	2.435	0.766	1.434	5.812	5.833	5.886	2.035	0.819	1.487

TABLE A.18 (continued)

Simulations	Wheat-Export	Oats - Export	Barley-Export	Flaxseed-Export	Rapeseed-Export	Rapeseed - Processors	Wheat - Domestic	Oats - Domestic	Barley - Domestic
15 + 4 X	2.390	0.741	1.398	5.766	5.744	5.797	1.99	0.794	1.451
20 + 3 X	2.459	0.771	1.449	5.837	5.901	5.975	2.08	0.845	1.523
20 + 3.5 X	2.414	0.745	1.413	5.791	5.812	5.886	2.035	0.819	1.487
20 + 4 X	2.369	0.720	1.377	5.745	5.723	5.797	1.99	0.794	1.451
25 + 3 X	2.439	0.751	1.429	5.817	5.881	5.975	2.08	0.845	1.523
25 + 3.5 X	2.394	0.725	1.393	5.771	5.792	5.886	2.035	0.819	1.487
25 + 4 X	2.349	0.700	1.357	5.725	5.703	5.797	1.99	0.794	1.451
30 + 3 X	2.421	0.733	1.411	5.800	5.863	5.975	2.08	0.845	1.523
30 + 3.5 X	2.376	0.707	1.375	5.753	5.774	5.886	2.035	0.819	1.487
30 + 4 X	2.331	0.682	1.339	5.707	5.685	5.797	1.99	0.794	1.451

[1] Simulated combinations of increased delivery distance (D.D.) plus multiples of the statutory freight rate.

Note * 1977 domestic/local prices for other commodities: grain corn (feed) - $2.25/bushel, corn silage - $15/ton, alfalfa-grass - $40/ton, bromegrass - $35/ton, sunflowers (processors) - $3/bushel, grain corn (distillery) - $2.50/bushel. It was assumed that an increase in delivery distance and statutory freight rates would not affect the prices of these commodities.

TABLE A.19

1977 Commodity Prices Discounted by Simulated Grain Transportation Cost Increases ($ per bushel)
(Study Area 2: Birtle-Russell)

Simulations	Wheat-Export	Oats - Export	Barley-Export	Flaxseed-Export	Rapeseed-Export	Rapeseed - Processors	Wheat - Domestic	Oats - Domestic	Barley - Domestic
Base year (1977) Commodity Prices	2.713	0.947	1.667	6.096	6.33	6.105	2.26	0.97	1.524
Average Delivery Distance Increased to:									
10 miles	2.682	0.916	1.636	6.065	6.299	6.105	2.26	0.97	1.524
15 miles	2.660	0.894	1.614	6.043	6.277	6.105	2.26	0.97	1.524
20 miles	2.639	0.873	1.593	6.022	6.256	6.105	2.26	0.97	1.524
25 miles	2.619	0.853	1.573	6.002	6.236	6.105	2.26	0.97	1.524
30 miles	2.601	0.835	1.555	5.984	6.218	6.105	2.26	0.97	1.524
Statutory Rate Increased by:									
3.0 X	2.497	0.825	1.494	5.878	5.975	5.750	2.044	0.825	1.494
3.5 X	2.443	0.794	1.451	5.823	5.886	5.661	1.990	0.794	1.451
4.0 X	2.389	0.763	1.408	5.768	5.797	5.572	1.936	0.763	1.408
D.D. (miles) + Multiple of Crow[1]									
10 + 3 X	2.466	0.794	1.463	5.847	5.944	5.750	2.044	0.825	1.494
10 + 3.5 X	2.412	0.763	1.420	5.792	5.855	5.661	1.990	0.794	1.451
10 + 4 X	2.358	0.732	1.377	5.737	5.766	5.572	1.936	0.763	1.408
15 + 3 X	2.444	0.772	1.441	5.825	5.922	5.750	2.044	0.825	1.494
15 + 3.5 X	2.390	0.741	1.398	5.770	5.833	5.661	1.990	0.794	1.451

TABLE A.19 (continued)

Simulations	Wheat-Export	Oats - Export	Barley-Export	Flaxseed-Export	Rapeseed-Export	Rapeseed - Processors	Wheat - Domestic	Oats - Domestic	Barley-Domestic
15 + 4 X	2.336	0.710	1.355	5.715	5.744	5.572	1.936	0.763	1.408
20 + 3 X	2.423	0.751	1.420	5.804	5.901	5.750	2.044	0.825	1.494
20 + 3.5 X	2.369	0.720	1.377	5.749	5.816	5.661	1.990	0.794	1.451
20 + 4 X	2.315	0.689	1.334	5.694	5.723	5.572	1.936	0.763	1.408
25 + 3 X	2.403	0.731	1.400	5.784	5.881	5.750	2.044	0.825	1.494
25 + 3.5 X	2.349	0.700	1.357	5.729	5.792	5.661	1.990	0.794	1.451
25 + 4 X	2.295	0.669	1.314	5.674	5.703	5.572	1.936	0.763	1.408
30 + 3 X	2.385	0.713	1.382	5.766	5.863	5.750	2.044	0.825	1.494
30 + 3.5 X	2.331	0.682	1.339	5.711	5.774	5.661	1.990	0.794	1.451
30 + 4 X	2.277	0.651	1.296	5.656	5.685	5.572	1.936	0.763	1.408

[1] Simulated combinations of increased delivery distance (D.D.) plus multiples of the statutory freight rate.

Note * 1977 domestic/local prices for other commodities: alfalfa-grass - $40/ton, bromegrass - $35/ton. It was assumed that an increase in delivery distance and statutory freight rates would not affect the price of these two commodities.

APPENDIX B

STATISTICAL RESULTS

This appendix contains the following statistical results of the LP model farm simulations:

(a) Crop acreage trends under 1973 and 1977 commodity prices as transportation costs increase.

(b) Reduced cost under 1973 and 1977 commodity prices as transportation costs increase. Reduced cost is the profit adjustment on net farm income as one acre of a given crop is brought into the solution.

TABLE B.1

Crop Acreage Trends Under 1973 Prices as Grain Transportation Costs Increase
(Study Area 1: Red River Valley)

Crop Activity	Status Quo Base Year 1973	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
			- acres -				
Class 1							
Wheat - ST	140 UL	140	140	140	140	140	140
Wheat - F	34 UL	31 LL	31	31	31	34 UL	31 LL
Oats - ST	32 LL	32	32	32	32	32	32
Oats - F							
Barley - ST	26 BS	21.5 BS	21.5 BS	18 LL	18	18	18
Barley - F							
Flaxseed - ST	29 BS	33.5 BS	33.5 BS	38 BS	61 BS	70 BS	61 BS
Flaxseed - F				3 BS	3 BS		3 BS
Rapeseed - ST	44 UL	44	44	43 BS	20 BS	11 BS	20 BS
Rapeseed - F		3 BS	3				
Sunflowers - ST							
Grain Corn - ST	75 UL	75	75	75	75	75	75
Silage Corn - ST							
Alfalfa Grass - ST							
Bromegrass - ST							
Summerfallow	34 LL	34	34	34	34	34	34
Class 2							
Wheat - ST	29 UL	29	29	29	29	29	29
Wheat - F	7 UL	7	7	7	7	7	7

TABLE B.1 (continued)

Crop Activity	Status Quo Base Year 1973	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by:			Average D.D. 30 Miles + 4 X Crow
				3 X	3.5 X	4 X	
			- acres -				
Oats - ST	6 LL	6	6	6	6	6	6
Oats - F							
Barley - ST	20 BS	20	20	20			
Barley - F							
Flaxseed - ST					20 BS	20	20
Flaxseed - F							
Rapeseed - ST							
Rapeseed - F							
Sunflowers - ST							
Grain Corn - ST	15 UL	15	15	15	15	15	15
Silage Corn - ST							
Alfalfa Grass - ST							
Bromegrass - ST							
Summerfallow	7 LL	7	7	7	7	7	7
Class 3							
Alfalfa Grass - ST							
Bromegrass - ST							

Notation: D.D. - delivery distance, ST - stubble, F - summerfallow, BS - free in solution, UL - upper limit, LL - lower limit.

TABLE B.2

Crop Acreage Trends Under 1977 Prices as Grain Transportation Costs Increase
(Study Area 1: Red River Valley)

Crop Activity	Status Quo Base Year 1977	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
			- acres -				
Class 1							
Wheat - ST	63 LL	63	63	63	63	63	63
Wheat - F	31 LL	31	31	31	31	31	31
Oats - ST	32 LL	32	32	32	32	32	32
Oats - F							
Barley - ST	18 LL	18	18	18	18	18	18
Barley - F							
Flaxseed - ST							
Flaxseed - F							
Rapeseed - ST	44 UL	44	44	44	44	44	44
Rapeseed - F	3 BS	3	3	3	3	3	3
Sunflowers - ST	75 UL	75	75	75	75	75	75
Grain Corn - ST	75 UL	75	75	75	75	75	75
Silage Corn - ST							
Alfalfa Grass - ST	39 BS	39	39	39	39	39	39
Bromegrass - ST							
Summerfallow	34 LL	34	34	34	34	34	34
Class 2							
Wheat - ST	13 LL	13	13	13	13	13	13
Wheat - F	6 LL	6	6	6	6	6	6

TABLE B.2 (continued)

Crop Activity	Status Quo Base Year 1977	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
			- acres -				
Oats - ST	6 LL	6	6	6	6	6	6
Oats - F							
Barley - ST							
Barley - F							
Flaxseed - ST							
Flaxseed - F							
Rapeseed - ST	21 UL	21	21	21	21	21	21
Rapeseed - F	1 BS	1	1	1	1	1	1
Sunflowers - ST	15 UL	15	15	15	15	15	15
Grain Corn - ST	15 UL	15	15	15	15	15	15
Silage Corn - ST							
Alfalfa Grass - ST							
Bromegrass - ST							
Summerfallow	7 BS	7	7	7	7	7	7
Class 3							
Alfalfa Grass - ST							
Bromegrass - ST							

Notation: D.D. - delivery distance, ST - stubble, F - summerfallow, BS - free in solution, UL - upper limit, LL - lower limit.

TABLE B.3

Crop Acreage Trends Under 1973 Prices as Grain Transportation Costs Increase
(Study Area 2: Birtle-Russell)

Crop Activity	Status Quo Base Year 1973	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
				- acres -			
Class 1							
Wheat - ST	22 UL	22	22	22	22	22	22
Wheat - F	73 BS	73	73	73	73	73	73
Oats - ST	22 UL	22	22	22	22	22	22
Oats - F	4 LL	4	4	4	4	4	4
Barley - ST	30 UL	30	30	30	30	30	30
Barley - F	14 LL	14	14	14	14	14	14
Flaxseed - ST	9 UL	9	9	9	9	9	9
Flaxseed - F	6 UL	6	6	6	6	6	6
Rapeseed - ST	1 BS	1	1	1	1	1	1
Rapeseed - F							
Alfalfa Grass - ST							
Bromegrass - ST							
Summerfallow	97 LL	97	97	97	97	97	97
Class 2							
Wheat - ST	16 UL	16	16	16	16	16	16
Wheat - F	54 BS	54	54	54	54	54	54

TABLE B.3 (continued)

Crop Activity	Status Quo Base Year 1973	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
			- acres -				
Oats - ST	16 UL	16	16	16	16	16	16
Oats - F	3 LL	3	3	3	3	3	3
Barley - ST	21 UL	21	21	21	21	21	21
Barley - F	10 LL	10	10	10	10	10	10
Flaxseed - ST	6 UL	6	6	6	6	6	6
Flaxseed - F	4 UL	4	4	4	4	4	4
Rapeseed - ST	1 BS	1	1	1	1		
Rapeseed - F							
Alfalfa Grass - ST							
Bromegrass - ST							
Summerfallow	71 LL	71	71	71	71	72 BS	72 BS

Notation: D.D. - delivery distance, ST - stubble, F - summerfallow, BS - free in solution, UL - upper limit, LL - lower limit.

TABLE B.4

Crop Acreage Trends Under 1977 Prices as Grain Transportation Costs Increase
(Study Area 2: Birtle-Russell)

Crop Activity	Status Quo Base Year 1977	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
			- acres -				
Class 1							
Wheat - ST	8 LL	8	8	8	8	8	8
Wheat - F	35 BS	35	35	35	35	35	35
Oats - ST	14 LL	14	14	14	14	14	14
Oats - F	4 LL	4	4	4	4	4	4
Barley - ST	10 LL	10	10	10	10	10	10
Barley - F	14 LL	14	14	14	14	14	14
Flaxseed - ST							
Flaxseed - F	6 UL	6	6	6	6	6	6
Rapeseed - ST	8 UL	8	8	8			
Rapeseed - F	38 UL	38	38	38	38	38	38
Alfalfa Grass - ST	44 BS	44	44	44	52 BS	52	52
Bromegrass - ST							
Summerfallow	97 LL	97	97	97	97	97	97
Class 2							
Wheat - ST	6 LL	6	6	6	6	6	6
Wheat - F	25 LL	25	25	25	25	25	25

TABLE B.4 (continued)

Crop Activity	Status Quo Base Year 1977	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
			- acres -				
Oats - ST	10 LL	10	10	10	10	10	10
Oats - F	3 LL	3	3	3	3	3	3
Barley - ST	8 LL	8	8	8	8	8	8
Barley - F	10 LL	10	10	10	10	10	10
Flaxseed - ST							
Flaxseed - F							
Rapeseed - ST	6 UL	6	6	6	6	6	6
Rapeseed - F	33 UL	33	33	33	33	33	33
Alfalfa Grass - ST	25 UL	25	25	25	25	25	25
Bromegrass - ST	5 BS	5	5	5	5	5	5
Summerfallow	71 LL	71	71	71	71	71	71

Notation: D.D. - delivery distance, ST - stubble, F - summerfallow, BS - free in solution, UL - upper limit, LL - lower limit.

TABLE B.5

Reduced Cost Under 1973 Prices as Grain Transportation Costs Increase[1]
(Study Area 1: Red River Valley)

Crop Activity	Status Quo Base Year 1973	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
	-- dollars per acre --						
Class 1							
Wheat - ST	19.53	20.08	20.36	9.48	12.37	15.26	9.54
Wheat - F	0.62	- 0.44	- 0.98	- 3.60	- 0.72	2.16	- 3.49
Oats - ST	-14.65	-14.65	-14.65	-15.30	-17.70	-20.04	-17.37
Oats - F	-35.54	-37.16	-38.00	-30.00	-32.49	-34.93	-31.98
Barley - ST	- BS	- BS	- BS	- 1.60	- 4.21	- 6.81	- 4.14
Barley - F	-34.24	-35.86	-36.69	-28.64	-31.10	-33.56	-30.61
Flaxseed - ST	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Flaxseed - F	- 5.69	- 7.31	- 8.14	- BS	- BS	- BS	- BS
Rapeseed - ST	7.24	8.70	9.45	- BS	- BS	- BS	- BS
Rapeseed - F	- BS	- BS	- BS	- 2.41	- 2.40	- 2.39	- 2.41
Sunflowers - ST	-11.95	-11.95	-11.95	- 7.22	- 3.88	- 3.92	- 3.81
Grain Corn - ST	25.04	25.04	25.04	29.76	28.73	27.70	30.38
Silage Corn - ST	- BS	- BS	- BS	- 0.16	- 2.40	- 2.43	- 2.34
Alfalfa-Grass - ST	-33.53	-33.53	-33.53	-28.80	-29.83	-30.86	-28.18
Bromegrass - ST	-49.84	-49.84	-49.84	-45.11	-46.14	-47.17	-44.49
Summerfallow	-23.84	-23.84	-23.84	-19.11	-20.14	-21.17	-18.49
Class 2							
Wheat - ST	19.84	20.39	20.67	11.41	16.50	19.42	13.61
Wheat - F	10.57	10.00	9.54	0.49	3.40	6.32	0.57

TABLE B.5 (continued)

Crop Activity	Status Quo Base Year 1973	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
	-- dollars per acre --						
Oats - ST	-18.10	-18.10	-18.10	-16.93	-17.04	-19.28	-16.72
Oats - F	-29.52	-30.64	-31.40	-29.61	-31.98	-34.31	-31.48
Barley - ST	- BS	- BS	- BS	- BS	- 0.38	- 2.93	- 0.38
Barley - F	-24.13	-25.24	-26.00	-24.41	-26.82	-29.22	-26.40
Flaxseed - ST	- 3.94	- 3.94	- 3.94	- 2.17	- BS	- BS	- BS
Flaxseed - F	- BS	- 1.12	- 1.88	- BS	- BS	- BS	- BS
Rapeseed - ST	- 2.19	- 0.86	- 0.18	- 6.78	- 4.66	- 4.70	- 4.58
Rapeseed - F	- 0.36	- BS	- BS	- 7.52	- 7.56	- 7.60	- 7.49
Sunflowers - ST	-11.81	-11.81	-11.81	- 5.53	- BS	- BS	- BS
Grain Corn - ST	16.62	16.62	16.62	22.90	24.09	23.11	25.66
Silage Corn - ST	- 1.46	- 1.46	- 1.46	- BS	- BS	- BS	- BS
Alfalfa-Grass - ST	-38.41	-38.41	-38.41	-32.13	-30.94	-31.92	-29.37
Bromegrass - ST	-51.20	-51.20	-51.20	-44.92	-43.73	-44.71	-42.16
Summerfallow	-23.10	-23.10	-23.10	-16.82	-15.63	-16.61	-14.06
Class 3							
Alfalfa-Grass - ST	-19.40	-19.40	-19.40	-19.40	-19.40	-19.40	-19.40
Bromegrass - ST	-30.26	-30.26	-30.26	-30.26	-30.26	-30.26	-30.26

1. Reduced cost - for each additional acre of crop "x" brought into the solution, total farm net income would change ± dollars per acre.

Notation: D.D. - delivery distance, ST - stubble, F - summerfallow, BS - free in solution.

TABLE B.6

Reduced Cost Under 1977 Prices as Grain Transportation Costs Increase[1]
(Study Area 1: Red River Valley)

Crop Activity	Status Quo Base Year 1977	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
	-- dollars per acre --						
Class 1							
Wheat - ST	- 7.89	-10.10	-11.23	-13.26	-14.60	-15.94	-19.28
Wheat - F	-59.03	-61.29	-62.45	-56.75	-56.17	-55.59	-59.00
Oats - ST	-32.15	-32.15	-32.15	-38.74	-40.11	-41.43	-41.43
Oats - F	-84.06	-84.06	-84.06	-82.83	-82.25	-81.61	-81.61
Barley - ST	-18.15	-21.40	-23.07	-24.47	-26.05	-27.63	-27.63
Barley - F	-78.03	-80.75	-82.15	-75.56	-74.93	-74.31	-74.31
Flaxseed - ST	- 3.86	- 3.86	- 3.86	- 3.86	- 3.86	- 3.86	- 3.86
Flaxseed - F	-42.80	-42.80	-42.80	-35.03	-33.08	-31.13	-31.13
Rapeseed - ST	36.94	36.94	36.94	29.95	28.19	26.44	26.44
Rapeseed - F	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Sunflowers - ST	4.28	4.28	4.28	4.28	4.28	4.28	4.28
Grain Corn - ST	8.37	8.37	8.37	8.37	8.37	8.37	8.37
Silage Corn - ST	- 5.73	-11.36	- 5.73	- 5.73	- 5.73	- 5.73	- 5.73
Alfalfa-Grass - ST	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Bromegrass - ST	-19.61	-19.61	-19.61	-19.61	-19.61	-19.61	-19.61
Summerfallow	- 7.61	- 7.61	- 7.61	- 7.61	- 7.61	- 7.61	- 7.61
Class 2							
Wheat - ST	- 0.55	- 2.75	- 3.88	- 5.90	- 7.24	- 8.57	-11.90
Wheat - F	-47.27	-49.52	-50.68	-45.65	-45.23	-44.82	-48.23

TABLE B.6 (continued)

Crop Activity	Status Quo Base Year 1977	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
	-- dollars per acre --						
Oats - ST	-27.06	-27.06	-27.06	-33.33	-34.62	-35.88	-35.88
Oats - F	-74.65	-74.65	-74.65	-73.76	-73.28	-72.74	-72.74
Barley - ST	-11.04	-14.26	-15.92	-17.32	-18.89	-20.46	-20.46
Barley - F	-66.17	-68.89	-70.28	-64.36	-63.90	-63.44	-63.44
Flaxseed - ST	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Flaxseed - F	-34.52	-34.52	-34.52	-27.42	-25.64	-23.86	-23.86
Rapeseed - ST	33.16	33.16	33.16	26.80	25.21	23.62	23.62
Rapeseed - F	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Sunflowers - ST	11.29	11.29	11.29	11.29	11.29	11.29	11.29
Grain Corn - ST	8.48	8.48	8.48	8.48	8.40	8.48	8.48
Silage Corn - ST	- BS	- 5.55	- BS	- BS	- BS	- BS	- BS
Alfalfa-Grass - ST	- 0.21	- 0.21	- 0.21	- 0.21	- 0.21	- 0.21	- 0.21
Bromegrass - ST	-15.10	-15.10	-15.10	-15.10	-15.10	-15.10	-15.10
Summerfallow	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Class 3							
Alfalfa-Grass - ST	- 5.80	- 5.80	- 5.80	- 5.80	- 5.80	- 5.80	- 5.80
Bromegrass - ST	-18.26	-18.26	-18.26	-18.26	-18.26	-18.26	-18.26

1. Reduced cost - for each additional acre of crop "x" brought into the solution, total farm net income would change ± dollars per acre.

Notation: D.D. - delivery distance, ST - stubble, F - summerfallow, BS - free in solution.

TABLE B.7

Reduced Cost Under 1973 Prices as Grain Transportation Costs Increase[1]
(Study Area 2: Birtle-Russell)

Crop Activity	Status Quo Base Year 1973	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by:			Average D.D. 30 Miles + 4 X Crow
				3 X	3.5 X	4 X	
	-- dollars per acre --						
Class 1							
Wheat - ST	23.50	22.76	22.39	23.39	23.36	23.34	22.23
Wheat - F	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Oats - ST	6.29	7.37	7.93	5.56	5.35	5.15	6.78
Oats - F	-38.78	-36.52	-35.35	-38.99	-39.07	-39.16	-35.73
Barley - ST	9.41	10.49	11.05	7.93	7.58	7.22	8.86
Barley - F	-25.60	-23.33	-22.17	-26.82	-27.12	-27.42	-24.00
Flaxseed - ST	10.30	10.66	10.85	13.37	14.14	14.90	15.45
Flaxseed - F	2.67	3.87	4.48	6.14	7.00	7.86	9.67
Rapeseed - ST	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Rapeseed - F	- 8.05	- 7.38	- 7.03	- 9.07	- 9.34	- 9.60	- 8.58
Alfalfa-Grass - ST	- 2.64	- 2.63	- 2.62	- 2.59	- 2.57	- 2.51	- 0.87
Bromegrass - ST	-23.81	-22.73	-22.18	-18.63	-17.33	-16.03	-14.40
Summerfallow	-14.10	-13.02	-12.47	- 8.92	- 7.62	- 6.32	- 4.69
Class 2							
Wheat - ST	17.69	17.08	16.77	17.78	17.80	17.78	15.36
Wheat - F	- BS	- BS	- BS	- BS	- BS	- BS	- BS

TABLE B.7 (continued)

Crop Activity	Status Quo Base Year 1973	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
	-- dollars per acre --						
Oats - ST	6.22	7.21	7.72	5.59	5.41	5.20	5.20
Oats - F	-31.03	-29.03	-28.00	-31.40	-31.52	-31.64	-28.62
Barley - ST	5.88	6.88	7.38	4.72	4.45	4.12	4.12
Barley - F	-22.43	-20.43	-19.40	-23.53	-23.80	-24.06	-21.04
Flaxseed - ST	8.71	9.05	9.23	11.55	12.26	12.92	11.94
Flaxseed - F	5.21	6.25	6.78	8.21	8.95	9.69	11.26
Rapeseed - ST	- BS	- BS	- BS	- BS	- BS	- 0.05	- 1.55
Rapeseed - F	- 2.07	- 1.54	- 1.26	- 3.27	- 3.60	- 3.87	- 3.07
Alfalfa-Grass - ST	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Bromegrass - ST	-17.41	-16.41	-15.91	-12.65	-11.46	-10.31	-10.31
Summerfallow	- 7.10	- 6.10	- 5.60	- 2.34	- 1.15	- BS	- BS

1. Reduced cost - for each additional acre of crop "x" brought into the solution, total farm net income would change ± dollars per acre.

Notation: D.D. - delivery distance, ST - stubble, F - summerfallow, BS - free in solution.

TABLE B.8

Reduced Cost Under 1977 Prices as Grain Transportation Costs Increase[1]
(Study Area 2: Birtle-Russell)

Crop Activity	Status Quo Base Year 1977	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
	-- dollars per acre --						
Class 1							
Wheat - ST	-19.91	-21.72	-22.66	-25.20	-26.53	-27.85	-30.59
Wheat - F	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Oats - ST	-26.34	-26.34	-26.34	-33.37	-34.87	-36.37	-36.37
Oats - F	-22.34	-20.07	-18.91	-23.83	-23.92	-24.00	-20.57
Barley - ST	-22.32	-25.17	-26.63	-28.98	-30.64	-32.29	-32.29
Barley - F	- 8.83	- 9.92	-10.48	-10.06	-10.36	-10.65	- 7.22
Flaxseed - ST	-24.79	-25.51	-25.88	-26.90	-27.44	-27.97	-29.06
Flaxseed - F	5.16	6.36	6.98	8.64	9.50	10.36	12.17
Rapeseed - ST	5.57	4.49	3.93	0.39	- 0.91	- 2.21	- 3.85
Rapeseed - F	54.72	55.39	55.74	53.69	53.43	53.17	54.19
Alfalfa-Grass - ST	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Bromegrass - ST	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00
Summerfallow	-15.69	-15.69	-15.69	-15.69	-15.69	-15.69	-15.69
Class 2							
Wheat - ST	-16.88	-18.48	-19.30	-21.54	-22.71	-23.88	-26.30
Wheat - F	- 6.40	- 7.43	- 7.97	- 9.40	-10.14	-10.88	-12.45

TABLE B.8 (continued)

Crop Activity	Status Quo Base Year 1977	Average D.D. Increased to 20 Miles	Average D.D. Increased to 30 Miles	Statutory Freight Rate (Crow Rate) Increased by: 3 X	3.5 X	4 X	Average D.D. 30 Miles + 4 X Crow
	-- dollars per acre --						
Oats - ST	-19.70	-19.70	-19.70	-26.10	-27.46	-28.83	-28.83
Oats - F	-23.88	-22.92	-22.43	-28.42	-29.28	-30.15	-28.69
Barley - ST	-18.59	-21.12	-22.42	-24.51	-25.98	-27.45	-27.45
Barley - F	-14.13	-16.14	-17.17	-18.23	-19.24	-20.25	-18.80
Flaxseed - ST	-19.38	-20.03	-20.36	-21.29	-21.78	-22.26	-23.25
Flaxseed - F	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Rapeseed - ST	8.87	7.88	7.37	4.12	2.92	1.73	0.23
Rapeseed - F	47.33	46.82	46.56	43.13	42.08	41.04	40.28
Alfalfa-Grass - ST	6.22	6.22	6.22	6.22	6.22	6.22	6.22
Bromegrass - ST	- BS	- BS	- BS	- BS	- BS	- BS	- BS
Summerfallow	- 4.79	- 4.79	- 4.79	- 4.79	- 4.79	- 4.79	- 4.79

1. Reduced cost - for each additional acre of crop "x" brought into the solution, total farm net income would change ± dollars per acre.

Notation: D.D. - delivery distance, ST - stubble, F - summerfallow, BS - free in solution.

APPENDIX C

DETAILED ANLAYSIS

1. Grain Production Input Price Index (GPIPI)

The Grain Production Input Price Index (GPIPI) was designed to measure the movements of prices paid by western farmers for inputs into grain production. A price index is a ratio of current prices to a base period price. Its purpose is to show a percent change in price relative to a base period. The GPIPI was estimated from 1958 to 1977 by use of the Laspeyres price index formula. The index measures the impact of price change on the cost of purchasing a constant "basket" of inputs corresponding to the western region. The basket represents the annual rate of use of inputs in farm operations in Western Canada for the 1961 base year. The index is a price index reflecting only the direct impact of price change on the cost of purchasing the specified basket of farm operation inputs.

The farm input elements selected for the GPIPI were those elements having a minimal change in quantity used per acre over the 1958-77 period. Each cost element contributed to the index based on 1961 weights as established by Statistics Canada. The annual average price indexes for each item are calculated as unweighted averages of the four quarterly price indexes for each year.

A farm input was included in the price index if it was used in grain production 50 percent of the time or greater.

The index included all relevant inputs specifically related to crop production with the exception of fertilizer, chemicals and crop insurance. Fertilizer and chemicals changed not only in price but also in quantity used per acre over the 19 year period.

The GPIPI over the 1958-77 period was estimated in two stages. In stage 1, the following Laspeyres Index formula was used to estimate the index from 1961 to 1977.

$$I_t = \frac{\sum Wo\ (Pt/Po \times 100)}{\sum Wo}$$

Where I_t = price index in period t
Wo = base-year value weights for each item
Pt/Po x 100 = price for each item in time period "t" as a percent of price in base period "o".
$\sum$ = summation over items
t = 17 years (1961-1977)

In stage 1 the base year was 1961 with an index value of 100. In stage 2, to estimate the GPIPI for years prior to 1961 the 1935-39 base year indexes for years 1958, 1959 and 1960 were converted to the time base of the index weights (i.e. 1961). The conversion was made on an input item basis and then weighted using the Laspeyres Index formula to obtain an input price index for 1958, 1959 and 1960.

The 1935-39 base year index items and 1961 base year index items did not correspond in definition. It was necessary to consolidate some items and the respective index weights.

Sources: Statistics Canada, Farm Input Price Indexes (1961 = 100): Concepts, Sources and Methods, Catalogue Number 62-534 and Farm Input Price, Index Number 62-004.

2. LP Commodity Prices - Estimation Procedure

Study Area 1: Red River Valley

Average Farmgate Price (1973)

1. Wheat - export: Average realized price for No. 1 CWRS at Thunder Bay/Vancouver ($4.578/bus.) - average Manitoba freight rate ($.099/bus.) - average primary elevator handling tariff ($.0625/bus.) = $4.42/bushel. Grade distribution was not readily available to estimate a weighted average price. Source: 1973/74 CWB Annual Report.
2. Oats - export: average realized price for No. 1 Feed Oats ($1.719/bus.) - freight rate ($.056/bus.) - handling tariff ($.05/bus.) = $1.61/bushel. Feed oats represented 90% of oats. Source: same as number 1.
3. Barley - export: average realized price for No. 1 Feed ($2.592/bus) - freight rate ($.079/bus.) - handling tariff ($.0625/bus.) = $2.45/bushel No. 1 Feed represented 72.7% of barley. Source: same as number 1.
4. Flaxseed - export: total value of 1973 flax crop in Manitoba divided by total number of bushels produced = $9.55/bushel. Source: 1976 Manitoba Agriculture Yearbook, p.56.
5. Rapeseed - export: average Manitoba farm value at a shipping point = $5.84/bushel. Source: same as No. 4, p.68.

6. Rapeseed - processing: In study area 1 it was assumed that an average farmer would ship rapeseed about 50 miles to CSP Foods Ltd, Altona, Manitoba. The oilseed crushing plant at Altona priced rapeseed at about the same price as a farmer would receive at most primary elevators in the area. It was assumed that an average producer's trucking cost to the crushing plant would be about the same as if a farmer delivered to a local shipping point because CSP Foods covered additional trucking costs up to a distance of 100 miles from Altona. Therefore, the rapeseed processing price was set equal to the export price of $5.84/bushel.
7. Wheat - domestic: average realized price for No. 3 Canada Utility (feed wheat) at Thunder Bay/Vancouver ($3.906/bus.) - freight rate ($.099/bus.) - handling tariff ($.0625/bus.) = $3.74/bushel. Since grain was moving readily during this period it was assumed that quotas did not have a value, therefore the domestic feed market (i.e. feedmills and feedlots) was assumed to have paid the same price as a farmer would have received at a primary elevator.
8. Oats - domestic: It was assumed that since grain was moving readily during this period that feed oats sold to local markets would have been valued at the same price as oats exported from the area through a primary

elevator. Therefore, oats - domestic was set equal to oats - export at $1.61/bushel.

9. Barley - domestic: It was assumed that since grain was moving readily during this period that feed barley sold to local markets would have been valued at the same price as barley exported from the area through a primary elevator. Therefore, barley - domestic was set equal to barley - export at $2.45/bushel.

10. Corn (Grain) - domestic: The Manitoba average farm value for corn was estimated to be $2.80/bushel, slightly less than corn sold to the distillery.

11. Corn (Silage) - domestic: Manitoba average farm value was $12/ton. Source: 1976 Manitoba Agriculture Yearbook, p.72.

12. Alfalfa-Grass - domestic: Manitoba average farm value was 30/ton. Alfalfa - grass was priced at the same value as tame hay. Source: 1976 Yearbook, p.70 and Mr. D. Campbell, Forage Specialist, Manitoba Department of Agriculture (MDA).

13. Bromegrass - domestic: Average farm value for bromegrass was estimated at $25 per ton. Bromegrass price was estimated by discounting the alfalfa-grass price ($30) by $5 per tonne. Source: Mr. D. Campbell, MDA.

14. Sunflowers - processing: Average farm value of $.10/lb. x 30 lbs/bushel = $3.00 per bushel delivered to

CSP Foods Ltd., Altona. CSP's trucking allowance covered additional trucking costs incurred by producers. Normally, the mileage allowance covers about 72% of a producer's total trucking cost (e.g. CSP's pick up charge at 50 miles was $6.07/tonne as compared to the mileage allowance of $4.37 per tonne). Source: 1976 Yearbook, p.68 and Mr. M. Friessen, CSP Foods Ltd, Altona, December, 1978.

15. Corn (Grain) - distillery: It was assumed that corn sold for distilling brought a premium of about $.25 per bushel to corn sold for feed. Since the average feed value was $2.80/bus., distillery corn was priced at $3.05/bushel. Source: 1976 Yearbook, p.62.

Study Area 1: Red River Valley
Average Farmgate Price (1977)

1. Wheat - export: weighted average spring wheat price by grade at Thunder Bay ($2.954/bus.) - freight rate ($.099/bus.) - average primary elevator handling tariff ($.14125/bus.) = $2.713/bushel. Source: 1977/78 CWB Annual Report.
2. Oats - export: weighted average price by grade at Thunder Bay ($1.125/bus.) - freight rate ($.056/bus.) - handling tariff ($.1225/bus.) = $.947/bushel. Source: same as number 1.

3. Barley - export: weighted average price by grade at Thunder Bay ($1.889/bus.) - rail freight rate ($.079/bus.) - handling tariff ($.14/bus.) = $1.667/bushel. Source: same as number 1.
4. Flaxseed - export: Average price estimated at $6.10 per bushel. Source: 1978 Statistical Handbook, Canada Grains Council, p. 164.
5. Rapeseed - export: Average price estimated at $6.33 per bushel. Source: same as number 4.
6. Rapeseed - processing: $6.33 per bushel. Same basis as rapeseed - processing price in 1973.
7. Wheat - domestic: $2.26/bushel. Source: same as number 4.
8. Oats - domestic: $ .97/bushel. Source: same as number 4.
9. Barley - domestic: $1.52/bushel. Source: same as number 4.
10. Corn (Grain) - domestic: $2.25/bushel. Source: 1977 Manitoba Agriculture Yearbook, p. 15.
11. Corn (Silage) - domestic: $15/tonne. Source: 1977 Yearbook, p.72.
12. Alfalfa-Grass - domestic: $40/tonne. Source: 1977 yearbook, p. 17.
13. Bromegrass - domestic: $35/tonne. Source: D. Campbell, Forage Specialist, MDA.

14. Sunflowers - processing: \$3.00/bushel or \$ .10 per pound. Source: 1977 Yearbook, p.15
15. Corn (Grain) - distillery: \$2.50/bushel. Source: 1977 Yearbook p. 62.

Study Area 2: Birtle-Russell
<u>Average Farmgate Price (1973)</u>

1973 commodity prices for study area 2 were the same as the 1973 prices used in study area 1 except for rapeseed processing.

Item 6: Rapeseed - processing: Average Manitoba farm value at a shipping point (\$5.84/bus.) - trucking costs not covered by CSP Foods Ltd (\$.23/bus) = \$5.61/bushel. Shoal Lake was selected as a central point in study area 2 to truck rapeseed from an average farm to CSP Foods Ltd, Altona. The one-way distance from Shoal Lake to Altona was estimated to be 250 miles minus 100 miles covered by CSP Foods left a balance of 150 miles to be paid for by producers. Trucking cost for the 150 miles was estimated to be \$.23/bus. (i.e. \$1.50 per loaded mile for a 1000 bushel semi-trailer load). Source: John Enns, Cargill Ltd., Elm Creek Terminal, November, 1978.

Study Area 2: Birtle-Russell

Average Farmgate Price (1977)

1977 commodity prices for study area 2 were the same as the 1977 prices used in study area 1 except for rapeseed processing.

Item 6. Rapeseed - processing: Average Manitoba farm value at a shipping point ($6.33/bus.) - trucking costs not covered by CSP Foods Ltd. ($.23/bus.) = $6.10 per bushel.

Average Rail Freight Rate Used for Price Estimation

An average freight rate of 16.5¢ per cwt (average of two shipping points - 18¢ and 15¢ per cwt) was estimated and then the freight rate per bushel was calculated for wheat, oats and barley based on contract weights (ie. wheat - 60 lbs./bus., Oats - 34 lbs. per bus. and barley - 48 lbs. per bushel).

3. Crop Rotation Restraint - Upper and Lower Acreage Bounds

Study Area 1: Red River Valley

In Study Area 1 it is common practice to alternate broad leaf and cereal crops in a rotation to prevent the buildup of diseases. Special crops are not normally susceptible to the same diseases as cereal crops. Special crops such as rapeseed, flaxseed, sunflowers and other broad leaved crops should not follow each other in a rotation due to a possible carryover of pests and diseases. It is common practice to grow corn and sunflowers on land that would normally be used for summerfallow. Sunflower diseases such as leaf mottle and wilt are partially controlled by crop rotations of at least four years between sunflower crops.

Upper and Lower Acreage Bounds

Wheat

Total crop acres available	= 498
Average acreage %	= 36.75
Upper bound acreage %	= 50.86
Lower bound acreage %	= 22.64
% of wheat on Class 1	= 83.13
% of wheat on Class 2	= 16.87
% of wheat on stubble	= 66.60
% of wheat on fallow	= 33.40

Class	Wheat Upper Bounds	Wheat Lower Bounds
	- acres -	
1 ST	140	63
1 F	34	31
2 ST	29	13
2 F	7	6
Total	210	113

Notation: ST - Stubble, F - fallow, nb - no bounds

Oats

Total crop acres available	= 498
Average acreage %	= 14.74
Upper bound acreage %	= 21.75
Lower bound acreage %	= 7.73
% of oats on Class 1	= 83.13
% of oats on Class 2	= 16.87
% of oats on stubble	= 98.00
% of oats on fallow	= 2.00

Class	Oats Upper Bounds	Oats Lower Bounds
	- acres -	
1 ST	88	32
1 F	2	nb
2 ST	18	6
2 F	nb	nb
Total	108	38

Barley

Total crop acres available	= 498
Average acreage %	= 16.84
Upper bound acreage %	= 29.61
Lower bound acreage %	= 4.07
% of barley on Class 1	= 83.13
% of barley on Class 2	= 16.87
% of barley on stubble	= 90.48
% of barley on fallow	= 9.52

Class	Barley Upper Bounds	Barley Lower Bounds
	- acres -	
1 ST	111	18*
1 F	12	nb
2 ST	22	nb
2 F	2	nb
Total	147	18

* Three acres for class 2 ST was added to class 1.

Flaxseed

Total crop acres available	= 498
Average acreage %	= 13.61
Upper bound acreage %	= 26.21
Lower bound acreage %	= 0
% of flaxseed on Class 1	= 83.13
% of flaxseed on Class 2	= 16.87
% of flaxseed on stubble	= 93.29
% of flaxseed on fallow	= 6.71

Class	Flaxseed	
	Upper Bounds	Lower Bounds
	- acres -	
1 ST	101	nb
1 F	7	nb
2 ST	21	nb
2 F	1	nb
Total	130	nb

Rapeseed

Total crop acres available	= 498
Average acreage %	= 5.29
Upper bound acreage %	= 9.55
Lower bound acreage %	= 0
% of rapeseed on Class 1	= 83.13
% of rapeseed on Class 2	= 16.87
% of rapeseed on stubble	= 75.19
% of rapeseed on fallow	= 24.81

Class	Rapeseed	
	Upper Bounds	Lower Bounds
	- acres -	
1 ST	44	nb
1 F	15	nb
2 ST	9	nb
2 F	2	nb
Total	70*	nb

* Agricultural reprentative suggested that total rapeseed acres be increased from 48 acres to 70 acres.

Alfalfa-Grass and Bromegrass

It was assumed that an average farmer would grow perennial forage up to a maximum of one-third of sub-total (T) as shown in the Canadian Wheat Board quota permit book. In Study Area 1 one-third of sub-total (T) was 163 acres. A farmer would receive additional quota for each acre of perennial forage up to 163 acres but would receive no quota advantage for each acre over 163. Out of 163 acres, 90 acres was assigned to alfalfa-grass and 73 acres was assigned to bromegrass. The acreage distribution between Class 1 and 2 was based on information collected during the field survey. Class 3 farmland was primarily suited to perennial forage, therefore no acreage restrictions were applied.

Upper Bounds (alfalfa-grass)		Acres
Class 1	Stubble	75
Class 2	Stubble	15
Total		90
Upper Bounds (bromegrass)		
Class 1	Stubble	61
Class 2	Stubble	12
Total		73

There were no lower bounds applied to either alfalfa-grass or bromegrass.

Sunflowers

It was assumed that sunflowers were grown on the same stubble land once every five years. Total stubble land available was 449 acres or B_n. B_n represented total crop acres seeded to wheat, oats, barley, rye, flaxseed, rapeseed and miscellaneous crops. By dividing the 449 acres over five crop years, it was estimated that the average producer would have a maximum of 90 acres of sunflowers in any one year. The 90 acres of sunflowers were divided between Class 1 and 2 stubble in proportion to class 1 and 2 stubble acres to total stubble acres.

Upper Bounds (sunflowers)	Acres
Class 1 Stubble	75
Class 2 Stubble	15
Total	90

Lower Bounds (sunflowers) - No bounds

Corn (Grain and Silage)

Corn can precede or follow nearly any other crop, so there is no specific rotation requirement for disease control. The upper bound for corn was set at 90 acres to fit into the crop rotation with sunflowers. The division between Class 1 and 2 stubble was on the same basis as sunflowers.

Upper Bounds (corn)		Acres
Class 1	Stubble	75
Class 2	Stubble	15
Total		90

Lower Bounds (corn) - No bounds

Summerfallow

In Study Area 1 summerfallow acreage was 8.3% of total acres under crops plus summerfallow acres (based on 1976 data). The minimum level of summerfallow was estimated at 41 acres. The ten year average percentage was 14.4% with the upper acreage percentage at 21.5% and lower acreage percentage at 7.3%. The upper acreage percentage of 21.5% did not represent 1977-78 farming practice in the area, therefore the minimum acreage was set just within the lower acreage percentage of 7.3%. The 41 acres of summerfallow were divided between Class 1 and 2 farmland at 8.3% of the total acres in each class.

Upper Bounds (summerfallow) - No bounds

Lower Bounds (summerfallow)		Acres
Class 1	Stubble	34
Class 2	Stubble	7
Total		41

Study Area 2: Birtle-Russell

In Study Area 2 it is common practice to alternate broad leaf and cereal crops in a rotation to prevent the buildup of diseases. Rapeseed and flaxseed are not normally susceptible to the same diseases as cereal crops.

Upper and Lower Acreage Bounds

Wheat

Total crop acres available	= 480
Average acreage %	= 28.63
Upper bound acreage %	= 41.81
Lower bound acreage %	= 15.45
% of wheat on Class 1	= 57.92
% of wheat on Class 2	= 42.08
% of wheat on stubble	= 18.86
% of wheat on fallow	= 81.14

Class	Wheat	
	Upper Bounds	Lower Bounds
	- acres -	
1 ST	22	8
1 F	94	35
2 ST	16	6
2 F	69	25
Total	201	74

Oats

Total crop acres available	= 480
Average acreage %	= 8.48
Upper bound acreage %	= 10.53
Lower bound acreage %	= 6.43
% of oats on Class 1	= 57.92
% of oats on Class 2	= 42.08
% of oats on stubble	= 76.71
% of oats on fallow	= 23.29

Class	Oats	
	Upper Bounds	Lower Bounds
	- acres -	
1 ST	22	14
1 F	7	4
2 ST	16	10
2 F	5	3
Total	50	31

Barley

Total crop acres available	= 480
Average acreage %	= 16.62
Upper bound acreage %	= 24.52
Lower bound acreage %	= 8.72
% of barley on Class 1	= 57.92
% of barley on Class 2	= 42.08
% of barley on stubble	= 43.47
% of barley on fallow	= 56.53

Class	Barley	
	Upper Bounds	Lower Bounds
	- acres -	
1 ST	30	10
1 F	39	14
2 ST	21	8
2 F	28	10
Total	118	42

Flaxseed

Total crop acres available	= 480
Average acreage %	= 3.16
Upper bound acreage %	= 5.24
Lower bound acreage %	= 0
% of flaxseed on Class 1	= 57.92
% of flaxseed on Class 2	= 42.08
% of flaxseed on stubble	= 61.52
% of flaxseed on fallow	= 38.48

Upper Bounds (flaxseed)		Acres
Class 1	Stubble	9
Class 1	Fallow	6
Class 2	Stubble	6
Class 2	Fallow	4
Total		25

Lower Bounds (flaxseed) - No bounds

Rapeseed

Total crop acres available	= 480
Average acreage %	= 4.86*
Upper bound acreage %	= 9.4
Lower bound acreage %	= 0
% of rapeseed on Class 1	= 57.92
% of rapeseed on Class 2	= 42.08
% of rapeseed on stubble	= 32.17
% of rapeseed on fallow	= 67.83

* based on a 7 year average (1969-76)

Upper Bounds (rapeseed)		Acres
Class 1	Stubble	8
Class 1	Fallow	18
Class 2	Stubble	6
Class 2	Fallow	13
Total		45

Lower Bounds (rapeseed) - No bounds

Alfalfa-Grass and Bromegrass

As in Study Area 1 it was assumed that an average farmer would grow perennial forage up to a maximum of one-third of sub-total (T). In Study Area 2 one-third of sub-total (T) was 145 acres. The 145 acres was divided equally between alfalfa-grass and bromegrass.

The acreage distribution between Class 1 and 2 was based on information collected during the field survey. Class 3 farmland was assumed to be native pasture with insignificant income earning potential.

Upper Bounds (alfalfa-grass)	Acres
Class 1 Stubble	42.0
Class 2 Stubble	30.5
Total	72.5

Upper Bounds (bromegrass)	
Class 1 Stubble	42.0
Class 2 Stubble	30.5
Total	72.5

There were no lower bounds applied to either alfalfa-grass or bromegrass.

Summerfallow

In Study Area 2 summerfallow acreage was 35% of total acres under crops plus summerfallow acres (based on 1976 data). The minimum level of summerfallow was estimated at 168 acres. The ten year average acreage percentage was 39.75 with the upper acreage percentage at 45% and lower acreage percentage at 34.53%.

Upper Bounds (summerfallow) - No bounds

Upper Bounds (summerfallow)	Acres
Class 1 Stubble	97
Class 2 Stubble	71
Total	168