PRAIRIE GRAIN PRODUCER RESPONSE TO EXPORT CONSTRAINTS, 1970-80

by

TAMI-LEE REYNOLDS

A thesis
presented to the University of Manitoba
in partial fulfillment of the
requirements for the degree of
MASTER OF SCIENCE
in
AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

Winnipeg, Manitoba

February 1987

ISBN 0-315-37460-8

PRAIRIE GRAIN PRODUCER RESPONSE TO EXPORT CONSTRAINTS,

1970-80

BY

TAMI-LEE REYNOLDS

A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF SCIENCE

I hereby declare that I am the sole author of this thesis.

I authorize the University of Manitoba to lend this thesis to other institutions or individuals for the purpose of scholarly research.

TAMI-LEE REYNOLDS

I further authorize the University of Manitoba to reproduce this thesis by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research.

TAMI-LEE REYNOLDS

ABSTRACT

The thesis addresses the effects that constraints inherent to the Canadian grain transportation and handling system had on Prairie farm incomes from 1975 to 1980. System constraints affect gross margins[1] through the quantity of product marketed, the price received (specifically the domestic price), the use of variable inputs, and the allocation of land between crops as well as between competing agricultural usages.

A recursive simulation procedure is specified to analyze the effect of system constraints on producer decision behaviour. A historical simulation, replicating past behaviour, is compared to a production simulation estimating behaviour under an unconstrained system and a technology simulation predicting a more rapid adoption of crop technologies. The latter assumes producers have sufficient confidence in the system to increase fertilizer application rates and stubble cropping rates. To determine the total historical impact on income the differences in gross margins between the historical simulation and each of the unconstrained simulations are added together for each year between 1975 and 1980. The Canadian Savings Bond rate was used to account for the loss or gain in interest income.

---

[1] Gross margin is defined as sales revenue minus operating expenses. Fixed costs are assumed to be similar between simulations.

Producers are estimated to have lost income because of constraints affecting behaviour from 1975 to 1980. Given adequate capacity, the compounded annual difference in producer gross margins is forecasted to increase by an additional $1.1 million by 1980. Based on the compounded annual difference in gross margin between the technology and historical simulations, producers would have an additional $3.1 billion by 1980 if they responded to adequate capacity by farming more intensively.

A build up of grain stocks in 1979-80 caused the historical income to exceed the unconstrained estimates of income. The gross margins increased above historical simulated levels in both capacity simulations in all years except 1979-80. Adequate capacity resulted in more grain sales occurring from 1976 to 1978 and in 1980 because of either increased production or a shift in production to favour higher valued grains such as wheat. However, in 1979-80 these production changes are estimated to provide insufficient production to compensate for the historical build up in grain inventories available for export from 1978-79.

Producers are predicted to respond to the removal of constraints by increasing the area seeded. Average annual seeded area is predicted to increase from 18.4 million hectares in the historical simulation to 18.8 million hectares in the production simulation and to 22.4 million in the technology simulation. The increase in seeded area in the production simulation is primarily due to reduced summer fallowing; however, production is predicted to decline in some years because of the lower yield obtained on stubble seedbeds and increased production of lower yielding crops such as wheat and canola. In the technology simulation, the additional area from reduced summer fallow and reduced area seeded to the non-principal crops is forecasted to be sufficient to offset the production decrease brought about by the factors noted previously. Farming more intensively is estimated to benefit secondary industries such as fertilizer and chemical companies by an additional $270 million ($1980) in the production simulation and by an additional $3.5 billion ($1980) in the second simulation.

The results suggest several major implications from providing adequate capacity during the seventies. Prairie farm management practises would have to change to allow more intensive farming. Agricultural policies affecting adoption rates would have to be reviewed in terms of providing incentive to producers to accelerate the continuous cropping practises and fertilizer use.

Producers are expected to further specialize in wheat production which would increase the vulnerability to negative price movements against wheat, climatic changes, insects and disease.

An adequate transportation capacity fully paid for by producers would benefit producers only if they responded by accelerating adoption rates. The $3.1 billion compounded gross margin generated in the third simulation is forecasted to exceed the $2.0 billion shortfall previously absorbed by the governments and railways as well as the $600 million cost required to market the additional exports. However, producers are predicted to be worse off if adoption rates remain unchanged. Producer losses are estimated to be approximately $1.0 billion after covering the existing transportation cost shortfall and added transportation cost of $80 million.

In summary, the study indicates that producer gross margin was foregone during the latter part of the seventies because of system constraints. System participants should review policies which affect the system capacity and adoption rates to minimize losses to agriculture, related industries and governments.

ACKNOWLEDGEMENTS

I am indebted to many for this thesis; however a few special notes of appreciation are in order.

The excellence of this work is due to the constructive criticisms and suggestions provided by my graduate committee: Drs. D.F. Kraft, H. Bjarnason and R. Harris. In particular Dr. Kraft's guidance has encouraged the development of research skills that can be applied to any problem.

Miss Cathy Watt's decision to type the rough drafts and countless revisions facilitated the completion of this thesis.

The academic and support staff, and fellow students provided support, encouragement, and the essential element of humour to the entire process. The ladies in the main office are extended an extra word of appreciation for their encouragement.

Two exceptional friends, Valerie Fields and Sandra Craven Ignasjewski, deserve special thanks for their respective blend of optimism and enthusiasm as well as faith in the completion of this thesis.

Finally, my family especially Gordon, Dallis, Pat and Jack are owed a special debt for their patience, understanding and encouragement.

CONTENTS

Chapter I

INTRODUCTION

A general perception exists that transportation constraints limited Prairie grain producers' ability to sell cereal grains to international buyers. The Canadian Wheat Board[2] (CWB) estimated that insufficient transportation capacity caused $1.1 billion of sales to be lost or deferred in 1972, 1978 and 1979. A lost sale; however, has a significantly different impact on producers' financial situation than a deferred sale. A lost sale means that the revenues are foregone while deferred sales can result in an increase, decrease or no change in income because of the interyear changes of grain prices and storage costs.

According to Harvey,[3] deferred sales become foregone sales. Production plans are scaled down as producers pay excessive storage costs due to stock accumulation. This relationship is hypothesized, but has yet to be tested.

---

[2] Jean-Luc Pepin, Minister of Transport, in an address to Saskatchewan Wheat Pool's 1980 Annual Meeting of Delegates, Regina, November 20, 1980.

[3] David R. Harvey, Christmas Turkey or Prairie Vulture? An Economic Analysis of the Crows Nest Pass Grain Rates, (Montreal: The Institute for Research on Public Policy, 1980), p. 83.

[4] Colin Carter, Neil Hamilton and Om P. Tangri, The Impact of Transportation System on Producers' Grain Revenue, (a report prepared for the Research Branch, Canadian Transport Commission, February 1982), pp. 21-23.

Carter et al.[4] argued that transportation capacity restricted the movement of grain in 1973/74, 1974/75, 1977/78 and 1978/79. They suggested that producers benefited from these inefficiencies as long as the stored product was subsequently sold at a price in the following year which exceeded storage and interest costs. The Carter study estimated the gain or loss in revenue given historical production but did not determine the accurred net effect on producer revenues or any change in production plans.

United Grain Growers[5] argued that grain movement was hindered only in 1978/79. Based on an analysis of actual and potential performance of the grain fleet, United Grain Growers came to the following conclusion:

> For the three years 1973-74 to 1975-76 production was simply not great enough to sustain rail movement at the high levels of 1971-72 and 1972-73 . . . There is, however, no evidence to suggest that boxcar shortages consistently inhibited movements in 1976-77 or 1977-78 . . . Only in 1978-79 did the actual use once again climb into the calculated range of fleet capacity as it did in the 1971-73 period and hence only for the 1978-79 period is there evidence that lack of rolling stock was a constraint.

The above studies and presentations identified years affected by constraints and in some cases, estimated the revenue effects. Direct effects such as lost or foregone sales as well as revenue losses or gains were noted without detailing the accompanying effects on the type of crop produced and rate of technological adoption. To determine the dynamic impact of the constraints requires identifying when the events occurred and how farmers adjusted to higher grain inventories. Only after these impacts have been identified and the adjustment measured, is it possible to determine the farm income lost.

[5] United Grain Growers, "Dimensions of the Box-Car Shortage," Appendix C, United Grain Growers 73rd Annual Report, (Winnipeg: United Grain Growers, 1979), pp. 49-52.

1.1 CEREAL GRAIN MARKETING CONSTRAINTS

This study focuses on the impact of domestic marketing constraints[6] on grain and oilseed exports. For the five principal grain and oilseed crops,[7] exports account for approximately 55 percent of net farm disposition. By comparison, 21 percent of net farm disposition is sold to domestic users while the remaining 24 percent is utilized on farms. The impact of marketing constraints on exports has even greater significance assuming that one of the grain industry's objectives is to increase sales to foreign buyers.

The cumulative impact of all domestic marketing constraints are examined in this study rather than the impact of a particular constraint. Research usually has focused on one domestic marketing constraint in isolation of the effect of other concurrent constraints. For example, substantial research[8] has focused on the inefficiencies of moving Prairie grain under statutory rates, ceteris paribus. However, marketing constraints of various forms have simultaneously affected the commercial grain marketing system. The cumulative effect of these constraints will have the greatest impact on producer behaviour.

---

[6] Constraints are reviewed in terms of the impact of the physical capacity of the entire transportation and handling system (all components).

[7] Canada Grains Council, <u>Prospects for the Prairie Grain Industry 1990</u>, (Winnipeg: Canada Grains Council, 1982), pp. 119-124.

[8] An overview of transportation problems in western Canada, as well as reference to several related articles is published in the following report: W.W. Wilson and E.W. Tyrchniewicz, "The Role of Transportation In the Development of Western Canadian Agriculture," (a report prepared for the Canada West Foundation Task Force on the Role of Agriculture in the Economic Development of Western Canada, Department of Agricultural Economics, University of Manitoba, Winnipeg, Manitoba, January 1980).

Although all constraints are considered, only the effect of marketing system constraints are deemed to be the result of business behaviour. Constraints are defined as system or natural depending on the source of the constraint. System constraints are derived from the marketing environment and include factors such as social and economic policies, and management-labour disputes. Natural constraints are generated by nature and consist of weather related influences such as droughts and frosts. Both types of constraints can vary in duration and impact; however, only system constraints are considered within the grain system's ability to mitigate.

Cereal marketing constraints as defined above seriously affected Prairie exports in six crop years between 1970-71 and 1980-81.[9] Exports were limited in three crop years (1972-73, 1973-74, and 1974-75) largely due to inadequate supplies caused by natural constraints. Three additional years (1975-76, 1977-78, and 1978-79) were influenced primarily by system constraints.

1.2 IMPACT OF MARKETING CONSTRAINTS

Marketing system constraints prevent the movement of cereal grains to export position thereby creating a domestic surplus. This surplus is either stored, marketed into the domestic market or consumed on farms. In the case of storage, stocks accumulate on farms as the Canadian grain storage system has evolved at the farm level. In the other cases, cereal grain is sold based on open market prices for use in processing or for livestock feed. The surplus grain entering the domestic market de-

[9] Please refer to Chapter II for a more detailed discussion of crop years influenced by constraints.

presses regional prices and, depending on price elasticities, increases domestic usage.

Producers adjust to the lower price and higher inventory conditions by reallocating resources to maximize their net return. The share of each crop seeded is likely to be affected as well as the total area seeded. Historically, land has been shifted between crops as a reaction to price movements. Land is reallocated towards the relatively higher valued grains such as wheat and crops least affected by constraints. Producers are also expected to farm less intensively by reducing usage of variable inputs such as fertilizers and chemicals as well as increasing area fallowed.

Resources also are shifted to favour increased domestic usage of feed grains to take advantage of depressed domestic prices. The livestock sector is expected to take advantage of lower priced feed grains; however, the supply response of each subsector is dependant upon livestock prices, institutional constraints and expectation of long- versus short-term constraints. The oilseed crushing industry is expected to increase production as farmers diversify by growing more rapeseed.

The rate of technological adoption also could be reduced in response to domestic marketing constraints depending on the relative income changes. Constraints may lower the combined export and domestic revenue to levels below those obtained in the absence of constraints. As a result, producers may delay incorporating a new innovation because the cost exceeds the expected revenue.

1.3 PURPOSE, METHOD AND APPROACH

The objectives of this study are as follows:

1. to estimate the farm gate gross margins of Prairie cereal grain producers from the 1970-71 to 1980-81 crop years;
2. to determine the effect of Prairie producers' responses, in terms of gross to a constraint-free marketing environment from 1974-75 to 1980-81, ceteris paribus; and
3. to simulate gross margins in a constraint-free environment with an accelerated rate of adoption, ceteris paribus.

An understanding of the producer decision-making process is necessary to estimate gross margins[10] at the farm gate. Producer behaviour is hypothesized and empirically tested using a series of analytical models culminating in a model estimating gross margins. A key model estimates the supply and disposition relationships for the five principal crops and requires information on expected prices and yields, and area seeded. This model simulates domestic and export sales, and area seeded which are used to estimate the revenue and cost components of gross margin.

A simulation procedure is followed to measure the influence of domestic marketing constraints on gross margins. In the first scenario, a historical simulation is used to evaluate the ability of the analytical models to explain actual relationships and estimate a historical stream of gross margin. It is also used as a benchmark for comparison with the second scenario.

---

[10] Gross margin is defined as the receipts less variable production costs with the fixed costs assumed to be similar between scenarios. For more information, please refer to Chapter II.

In the second scenario, two simulations are used to estimate the gross margin resulting from the production and technology adoption responses of producers to the removal of system constraints. The production simulation estimates the gross margin derived from the new crop mix and corresponding production resulting from lower grain and oilseed stocks. The technology adoption simulation generates the crop production due to a higher rate of adoption than was observed historically combined with the production response to minimum carryovers. The accelerated adoption rate involves expanding the use of fertilizer more rapidly and reducing the area summer fallowed at a greated rate than historically occurred.

The net gross margin impact of marketing constraints is evaluated based on the accrued differences between the three simulations. For each year, the gross margin obtained in Scenario One is subtracted from the gross margin obtained in each of the Scenario Two simulations. The two sets of annual differences in gross margin are compounded to 1980 to allow a comparison between the two time streams of revenue.

The compounded difference in gross margin reflects the opportunity costs arising from marketing system constraints from 1975 to 1980. The difference in gross margin derived from the first and second simulations is the revenue available for investment as a result of an altered production mix and level. The accrued net difference between the first and last simulation is the revenue obtained from incorporating new innovations at a faster rate as well as altering the production mix and level. A priori, the net revenue gain or loss resulting from economic constraints is difficult to predict. Gross margin losses in constrained years may have been greater than, equal to or less than gross margin gains in years without constraints depending on the relative intertemporal price relationships.

The remaining chapters provide a more detailed discussion and analysis of the problem introduced in this chapter. Chapter II presents the background theory, framework, assumptions and related studies as they apply to this analysis. The empirical procedures including model specifications, statistical techniques, data and information sources are presented in Chapter III. Chapter IV contains the empirical results while Chapter V presents a brief summary of the thesis as well as major conclusions and recommendations.

Chapter II

BACKGROUND

The working hypothesis of this study is that domestic marketing system constraints reduced producer gross margins during the seventies. The theoretical framework from and within which the analysis is developed is presented in this chapter. Support for the above hypothesis is developed by relating the theoretical framework to observed historical events. This is followed by a brief discussion of the basic assumptions necessary to conduct the study and a review of relevant research and literature.

2.1 THEORETICAL FRAMEWORK

Based on pure competition market theory, Prairie producers are assumed to be rational, profit maximizers operating in a pure competitive input and output market. As a result, producers attempt to maximize the difference between total revenue and total costs.[11] Total revenue is given by the quantity (q) sold multiplied by the fixed price (p) received. Total cost is derived by multiplying the quantity of input (r) purchased by the price of the input plus the cost of the fixed inputs (b):

$$\pi = p_1 q_1 - (r_1 x_1 + r_2 x_2 + b) \qquad (2.1)$$

---

[11] J.M. Henderson and R.E. Quant, Microeconomic Theory: A Mathematical Approach, 2nd Edition (McGraw-Hill: New York, 1971), pp. 55-75.

This relationship is reworked to reflect the change in income obtained from two alternative sets of cereal grain production given the same set of resources. The fixed cost components of the income relationships cancel because the same level of fixed inputs are used in all simulations. The equation is reduced to the change in revenue minus the change in variable costs associated with production and is expressed as gross margin:

$$GR = ((pq)_2 - (pq)_1) - ((r_1 x_1 + r_2 x_2)_2 - (r_1 x_1 + r_2 x2)_1) \qquad (2.2)$$

A causal relationship is hypothesized to exist between marketing system constraints and both revenues and production costs. Marketing system constraints are hypothesized to reduce crop revenues by lowering the price received for a given quantity. Constraints which prevent the movement of cereal grains to export positions cause producers to either store or sell the grain domestically. Storage and incidental storage costs reduce revenues obtained if grain is stored and subsequently sold for a price equal to or lower than the original export price. The revenue obtained by selling the product domestically is also lower due to a surplus of grain entering the open market or sold through livestock (feed grains only). In both the storage or the domestic sale situation, realized crop revenue is lower than revenue derived from an optimum combination of domestic and export sales without marketing system constraints.

This non-optimum pricing environment causes a reallocation of resources with respect to primary agriculture production. Some producers may maintain their production decisions because they view the constraints as short-term or they have complete confidence in the marketing institutions' ability to move the excess grain. However, many cereal grain producers are likely to modify their planting intentions by redistributing seeded area between crops and farming less intensively. While seed area is reduced, area cultivated traditionally has not varied due to constraints. Land is reallocated towards the higher valued grains (to offset potential storage costs), grains with the lowest relative on-farm inventory and forages. Marginal land could be reassigned to livestock production in the case where the cost of cropping the land exceeds the expected revenue. Therefore, cereal grain producers have the option of altering the seeded area and reassigning land to other agricultural uses.

The production mix within the agriculture sector is shifted towards increased regional processing due to the non-optimum pricing environment. Lower domestic prices are likely to encourage producers to substitute or increase the percentage of Prairie feed grains in their ration mix. In the long-run, total livestock production is expected to increase as producers take advantage of lower production costs. Hog production, in particular, may increase over and above the increase in other forms of livestock production as hog producers can take advantage of the shorter production period for hogs. Poultry and dairy sectors are expected to maintain production levels as both industries have supply-oriented marketing boards with production quotas.

The production increase in the livestock sectors is expected to be modified by the following factors: price of livestock, the point in time in the production cycle, the position in the cycle of culling or building up of herds, tariffs, export quotas, export restrictions, interest rates and the perceived duration of constraints (i.e., short- or long- term). The livestock industry's response to changing feed grain prices is empirically difficult to estimate by isolating these factors. Available studies[12] require substantial alteration to be incorporated into this analysis. It is felt that the time required to develop a suitable model would be better spent focusing on grain producers as the primary focus of this study is grain producers. Therefore, although there are important impacts on livestock producers due to marketing system constraints, livestock demand remains at historical levels in the analysis with demand unaffected by removing system constraints.

As traditional crops are likely to be constrained, producers are expected to increase production of non-traditional crops. In particular, producers are likely to increase rapeseed production which will cause crushers to increase production as producers will sell their product at lower prices. Oilseed crushers are likely to increase their production capacity as a result of the increase in crushing margin.

The non-optimum pricing environment would also affect the rate of technological adoption within the agriculture sector and within the cereal grain subsector in particular. At the most basic level, producers would have less capital to invest in agricultural innovations. The depressed price for a particular crop may be low enough for it to be uneconomical to incorporate the new technology. This reduction in the rate of technological innovation is costly to both the individual and society as the postponement of a profitable innovation is a foregone ec-

[12] See Quarterly Canadian Feed Grains Forecasting Model, Version 1, Working Paper, (Ottawa: Agricultural Canada Policy, Planning and Economics Branch, 1979); Christmas Turkey or Prairie Vulture? An Economic Analysis of the Crow's Nest Pass Grain Rates, D.R. Harvey, (Montreal: Institute for Research on Public Policy, 1980).

onomic benefit.

2.2 HISTORICAL PRESENCE OF DOMESTIC CONSTRAINTS

Domestic constraints are indicated by the historical presence of producer responses and price changes based on theoretical expectations. System constraints cause the following changes:

1. an increase in on-farm carryovers (as well as an increase in demurrage charges);
2. an increase in the share of the transportation system allocated to higher valued grains relative to lower valued grains;
3. a decrease in domestic prices;
4. an increase in hog production; and
5. an increase in canola crushing.

The crop years 1969-70 to 1980-81 are examined for these conditions to determine the existence of domestic system system constraints. The crop year, 1969-70, is included in the analysis as occurrences in that crop year affect stock levels in 1970-71. Where appropriate, wheat, oats and barley are used as examples.

The level of on-farm grain inventories is the first indicator used to identify constraints. On-farm stocks reflect constraints to a greater extent than commercial stocks as Canada's grain storage has evolved at the farm level. As stock levels may increase because of higher production levels as well as marketing system constraints, several additional indicators are used to determine the cause of the increases.

Total grain stocks were high in two periods during the seventies as indicated in Table 2.1.

Table 2.1

Total March On-Farm Grain Stocks for the Five Principle Grains, Prairie Provinces 1969-1981

Year	Total Stocks
	- 000 tonnes -
1969	23,803
1970	23,164
1971	25,847
1972	24,935
1973	19,323
1974	18,517
1975	15,323
1976	15,180
1977	21,292
1978	23,952
1979	26,221
1980	21,899
1981	18,419

Source: Statistics Canada, _Field Crop Reporting Series_, Cat. No. 22-002.

High stock levels existed from March 1969 to March 1972 with grain inventories in excess of 20 million tonnes. Grain inventories peaked at 33 million tonnes in 1970 then steadily declined to a low of 15 million tonnes in March 1976. Grain inventories returned to levels in excess of 20 million tonnes during the second period; from March 1977 to March 1980, with a high of 26 million tonnes in 1979. Based on the level of March grain inventories, the two periods require further review to determine if domestic constraints caused the increase in stocks.

The first period of stock increases (March 1969 to March 1972) was a period of relatively high production (see Table 2.2) and slow growth in demand for exports (see Table 2.3). The March 1970 increase was preceded by a bumper crop year with production increases for all crops. The surplus was stored as world demand grew slowly in this period due to a reasonably good harvest world wide, particularly for wheat. The Lower Inventories for Tomorrow (LIFT) program was introduced in 1970 to remove land from production in an attempt to lower inventories. The intended effect of LIFT was partially offset in 1971 due to a significant increase in yields obtained from summer fallowing land. The surplus was stored as relatively good crops worldwide reduced world demand from 1969-70 to 1971-72.

Table 2.2

Production for the Five Principal Grains, Prairie Provinces

1968-1980

Year	Wheat	Oats	Barley	Rapeseed	Flaxseed	Total
			- 000 tonnes -			
1968	17,240	3,900	6,700	400	500	28,740
1969	17,830	4,200	7,700	800	700	31,230
1970	8,560	4,300	8,500	1,600	1,200	24,160
1971	13,970	4,500	12,600	2,200	600	33,870
1972	14,030	3,700	10,800	1,300	500	30,330
1973	15,700	4,300	9,800	1,200	500	31,500
1974	12,710	3,100	8,400	1,200	400	25,810
1975	16,370	3,600	9,000	1,800	400	31,170
1976	22,810	4,100	10,100	800	280	38,090
1977	18,900	3,600	11,400	2,000	650	36,550
1978	20,620	2,800	9,900	3,500	580	37,400
1979	16,360	2,100	7,900	3,400	820	30,580
1980	18,400	2,200	10,700	1,800	940	33,540

Source: Statistics Canada, Grain Trade of Canada, Cat. No. 22-2001.

Table 2.3

Total(a) Production and Exports for the Major Producing Countries

1969-1980

Year	Production Total	Production Wheat	Exports Total	Exports Wheat and Wheat Flour
	- million tonnes -			
1969	488	306	56	47
1970	495	315	62	49
1971	541	349	66	51
1972	531	343	83	70
1973	579	372	78	64
1974	561	357	77	65
1975	543	356	86	72
1976	645	421	77	64
1977	600	384	97	80
1978	680	447	95	79
1979	630	424	112	94
1980	652	443	115	99

(a) All Wheat, Oats, Barley.

Source: <u>Canada Grains Industry Statistical Handbook</u>, Tables 15, 17 and 29.

High stocks also occurred from March 1977 to March 1980. Carter et al[13] compared carryover-to-production ratios and market shares for Canadian wheat and barley and American wheat and corn. Their analysis suggested that the build up of inventories during 1977-78 and 1978-79 was primarily due to marketing system constraints. The large increases in Canadian carryover-to-production ratio could not be explained by either production or world market conditions.

This analysis of constraints is supported by examining demurrage charges for wheat, oats and barley as indicated by Table 2.4. Demurrage charges increased by $20 million between 1976-77 and 1977-78 and remained high in 1978-79. The cost per tonne for wheat increased from $0.12 in 1976-77 to $1.06 in 1977-78 and reached $1.92 in 1978-79. The combination of the high demurrage costs indicating ships were waiting for loading, and both production and carryover levels suggest that the marketing system was unable to provide adequate supplies at export positions.

Transportation constraints also are likely to cause a shift in the share of the transportation system to favour higher valued grains relative to lower priced grains. The percentage share of bulk exports for the five crops is used to calculate an annual crop ratio relative to wheat (see Table 2.5).

---

[13] Colin Carter, Neil Hamilton and Om P. Tangri, <u>The Impact of Transportation System on Producers' Grain Revenues</u>, (a report prepared for the Research Branch, Canadian Transport Commission, February 1982).

Table 2.4

Demurrage Charges for CWB Grains

1973-74 to 1980-81

Crop Year	Total	Wheat	Oats	Barley	Wheat	Oats	Barley
	dollars	......cost/tonne.....			....cost/bushel.......		
1973-74	17,102,725	0.79	0.00	0.68	0.02	0.00	0.01
1974-75	4,937,745	0.31	0.00	0.44	0.01	0.00	0.01
1975-76	3,308,731	0.79	0.00	0.24	0.01	0.00	0.01
1976-77	2,164,390	0.12	0.00	0.09	0.00	0.00	0.00
1977-78	22,131,500	1.06	0.00	1.22	0.03	0.00	0.03
1978-79	13,145,617	1.92	13.80	1.44	0.05	0.21	0.03
1979-80	5,137,464	0.56	0.35	0.95	0.02	0.01	0.02
1980-81	2,226,982	0.23	0.00	0.06	0.01	0.00	0.00

Source: CWB, CWB Annual Report, 1970-71 to 1980-81 issues.

Table 2.5

Shares of Bulk Exports Relative to Wheat

1969-70 to 1980-81

Crop Year	Percentage of Bulk Export Share Wheat	Oats	Barley	Canola	Flax-seed	Oats /Wheat	Barley /Wheat	Canola /Wheat	Flaxseed /Wheat
1969-70	75	0.6	16	4	4	0.01	0.21	0.06	0.05
1970-71	65	1.2	22	6	3	0.02	0.34	0.09	0.05
1971-72	65	0.8	24	5	3	0.00	0.37	0.08	0.05
1972-73	73	0.5	17	5	2	0.00	0.23	0.08	0.03
1973-74	73	0.1	17	6	3	0.00	0.23	0.08	0.04
1974-75	73	0.1	20	4	2	0.00	0.27	0.05	0.03
1975-76	68	1.6	24	4	1	0.02	0.35	0.06	0.01
1976-77	69	2.7	20	5	2	0.04	0.29	0.07	0.03
1977-78	75	0.4	16	5	1	0.00	0.21	0.07	0.01
1978-79	67	0.1	19	9	3	0.00	0.28	0.13	0.04
1979-80	70	0.5	18	8	2	0.01	0.26	0.11	0.03
1980-81	73	0.2	15	6	2	0.00	0.21	0.09	0.03
AVERAGE	71	0.7	19	6	2	0.01	0.27	0.08	0.03

Source: Canadian Grain Commission, Canadian Grain Exports.

Wheat movement would be favoured at the expense of oats and, to some extent, barley within the framework of CWB sales commitments. As indicated in Table 2.5, the share of the system allocated to oats was zero in both 1977-78 and 1978-79. Sufficient stocks appeared to be available as available supplies were relatively high in 1977-78 though available supplies declined in 1978-79. In addition, demurrage charges for 1978-79 suggest that vessels were waiting for oats for extended time periods (see Table 2.4). The combination of low stocks and demurrage charges suggest inadequate supplies contributed to reduce exports rather than domestic constraints in 1978-79. Although this information appears to support restricted marketings in 1977-78, a definite conclusion is difficult to draw without additional information concerning CWB sales intentions. The CWB may have been marketing wheat and/or barley more aggressively, but, oats sales are often small and erratic, and the volume available for export is relatively small.

A similar situation exists when barley shares are considered. Barley's 0.21 ratio relative to wheat in 1977-78 was tied with the lowest ratio in the 13 years examined, despite having available supplies in excess of the previous four years. In the following year, the barley/wheat ratio rose to 0.28 while available supply was above the 1977-78 level. Barley sales may have deferred until 1978-79; however, sales information necessary to substantiate this conclusion is unavailable.

Additional evidence for constraints affecting barley is provided by comparing Canadian and American prices ($Canadian) for barley as established by the CWB, the Winnipeg Commodity Exchange (WCE) and the Minneapolis Duluth Exchange (MDE).[14] Both American domestic prices and Cana-

[14] Colin A. Carter, Allister B. Hickson and Daryl F. Kraft, "Export Con-

dian export prices are higher than Canadian domestic prices if Canadian domestic constraints cause a localized surplus of barley. Table 2.6 indicates that the 1977-78, 1978-79 and 1980-81 crop years contained lower prices for barley traded on the WCE than traded on the MDE or handled by the CWB.

The relationship reported by Martin[15] between pork supply and grain stocks were also examined. Grain producers dispose of surplus grain stocks either by selling the stocks to feed mills and feed lot operators or increasing their own production of livestock. Figure 2.1 shows that pork supply increased in the two periods identified as having surplus grain stocks.

The number and capacity of oilseed crushers is also examined to determine if capacity increased during the two periods of constraints. As indicated in Table 2.7, capacity increased from 1972 to 1979, while the number of crushers also generally increased except in 1976. During the same time, total production including seed, oil and meal was quite variable. Based on this information, oilseed crushing capacity cannot be conclusively related to stock levels.

---

straints and Canadian Feed Grain Policy," (unpublished paper, University of Manitoba, 1982), p. 5a.

[15] Larry Martin, "Economic Intervention and Regulation in the Beef and Pork Sectors," Economic Council of Canada.

Table 2.6

Average Prices Received For Feed Barley

($Canadian)

Crop year	CWB(a)	WCE(b)	Duluth(cd)
........................dollar per bushel........................			
1974-75	121.28	123.57	120.85
1975-76	108.96	108.80	114.45
1976-77	95.55	91.88	103.28
1977-78	93.09	77.30	87.02
1978-79	96.13	82.73	101.10
1979-80	110.36	117.22	116.17
1980-81	158.21e	145.85	143.45
1981-82	144.43e	122.13	121.61

a The CWB Annual Reports, Statement of Operations and Surplus for Distributuion to Producers On the Crop Year Pool Account-Barley Period August 1 to October 31, Winnipeg, Canada.

b Average cash price, Winnipeg Commodity Exchange basis Thunder Bay.

c Grain Market News, Agriculture Marketing Service, USDA, Washington, D.C. Weekly Summaries 1970-1980.

d US-Canadian dollar exchange rates were from Bank Review, Bank of Canada, Ottawa, Canada.

e Sales to July 31 only and is comparable to the previous number but not equivalent to prices received by farmers because pool prices were from two crop years ending July 31.

Table 2.7

Number and Capacity of Oilseed Crushers

	Number	Capacity	Rapeseed Production
		tonnes	million tonnes
1970	3	10,300	1,600
1971	3	10,300	2,200
1972	3	11,200	1,300
1973	4	22,200	1,200
1974	5	47,000	1,200
1975	6	63,000	1,800
1976	5	67,100	800
1977	7	86,500	2,000
1978	8	91,600	3,500
1979	8	95,000	3,400
1980	8	95,000	1,800

Source: Canadian Grain Commission, Licensed Elevator and Statistics Canada, Cat. No. 32-006.

In summary, the crop years 1969-70 to 1980-81 were reviewed to identify the existence of domestic marketing system constraints. On-farm carryover was used to identify two periods, 1968-69 to 1971-72 and 1976-77 to 1979-80 as having surplus stock caused by either a lack of export demand or transport capacity. The first high stocks resulted from a combination of good crops and relatively slow demand. The second high stocks were due largely to domestic constraints as evidenced by carryover-to-production level, demurrage charges, domestic barley prices, and pork supply.

2.3 ASSUMPTIONS

Analytical models are used to simulate producer response to domestic constraints. As with all models attempting to simulate real world relationships, certain boundaries are drawn to make the study more manageable. The following assumptions[16] are required to simplify the modeling process.

World demand is assumed to be sufficient to absorb the increase in Canadian exports resulting from the removal of constraints. This assumption is reasonable to a certain extent; however, there has been a trend towards importing countries decreasing their reliance on imports by increased self-sufficiency. In addition, the recent United States embargo against Russia caused importers to seek "security of supply" by limiting the amount of grain purchased from an individual country.

Canada is assumed to be a price taker in the world grain market and as a result, world prices would be unaffected by a change in the level of Canadian exports. This assumption is reasonable as the United States is the dominant exporter in the wheat, coarse grain and oilseed markets.

In conjunction with the above assumption, Prairie producers are assumed to allocate seeded area between crops on the basis of world prices reflected through Canadian marketing institutions. Any deviation between exports and domestic prices is explained by domestic constraints. Producers use the lower domestic price as a decision factor in cropland allocation for oats and barley during times of constraints due to the greater probability of selling the product into domestic markets. Once constraints are removed, the prices equalize at the higher export price.

---

[16] The acceptability of several key assumptions are further discussed in Section 4.2.1.

Annual growing conditions are assumed to be accounted for in the year to year variations of actual grain yields. As either actual yields or estimated yields based on actual yields are used in the scenarios, the effect of weather is indirectly included in the analysis.

Historical growth of fertilizer usage is assumed to have been greater if grain stocks were at minimal levels throughout the seventies. Minimum stocks imply that demand and therefore prices, were sufficient to clear surplus production. Producers would be expected to respond to these demand signals by increasing crop production through greater usage of variable inputs. In particular, fertilizer application rates are assumed to reach recommended rates[17] by 1985.

The historical reduction of summer fallow is assumed to have been greater if grain stocks were at minimal levels throughout the seventies. As in the above assumption, producers would be expected to increase crop production by reducing summer fallow. Producers have tended to increase summer fallow in response to high stock levels because under the current quota system, producers are able to deliver grain based on summer fallow and seeded area. Producers also have increased summer fallow area in response to programs such as Lower Inventories For Tomorrow.

On-farm stocks are set at the minimum level observed in each province for each grain during the seventies. For a variety of reasons, producers are unwilling to draw stocks lower than 2.9 million tonnes despite open quotas. The minimums are used as an estimate of the level of inventory producers would have been willing to carryover if they were able to export their excess supply.

[17] Manitoba Department of Agriculture, 1985 Field Crops Production Recommendations for Manitoba, (Manitoba Agriculture, Winnipeg, Manitoba, 1985).

Inventory calculations require regional information concerning contributions to commercial grain inventories and exports that are unavailable from statistical sources. Commercial grain inventories are assumed to be drawn from the Prairie provinces, i.e., all grain held as commercial inventories in Canada is from the Prairies. As the majority of cereal grain production and consequently grain destined for storage originates on the Prairies, the margin of error introduced by this assumption is relatively small.

Domestic consumption is assumed to remain at historical levels despite the removal of marketing system constraints. Though consumption levels would likely be affected, this study focuses on the export effect of constraints. In addition, current analytical domestic consumption models require substantial modifications to be incorporated into this analysis.

Fixed costs are assumed to remain at historical levels throughout the analysis. Fixed costs are not explicitly included in the study because of data, information and modeling difficulties encountered. The quality of the data makes it questionable to interpret annual changes in fixed assets for provincial farms in western Canada. The error introduced by this assumption should be small due to the level of excess capacity that existed during the seventies.[18]

The marketing system for western Canada is assumed to operate at 95 percent of peak efficiency. The operational capacity of each provincial marketing system is allocated a share of the total Prairie system based on historical percentages. The five percent leeway allows for some

---

[18] Daryl F. Kraft, "The Impact of Expanding Grain Production on Farm Structure," (a paper presented to the Canada Grains Council Annual Meeting, Winnipeg, Manitoba, April 7, 1981).

slippage in the grain marketing system once a peak has been set.

Forecast errors generated by the simulation model are assumed to be random and will cancel over time.

2.4 RELATED STUDIES

As the simulation of area seeded is a major component of the analysis, studies dealing with this area of research are reviewed. Lam[19] briefly discussed the evolution of many of the empirical models developed by agricultural economists relating to acreage analysis for western Canada. The discussion noted the objectives, explanatory variables, techniques, and performance of each of the research efforts. The review concluded that Colman`s[20] model provided the best forecasting performance based on economic considerations and relationships.

Colman analyzed the acreage response for the five major crops in the Prairies using models to constrain the sum of the acreage for the five major crops to a predetermined total acreage. The multinominal logit acreage allocation model incorporating the Zellner seemingly unrelated regression (ZSUR) estimation method was used to account for the interrelationship of the relationship between crop acreage in allocation. An independent equations model was also estimated using ordinary least squares (OLS). Both approaches generally resulted in good statistical and reasonable predictive properties though the independent equations model performed slightly better than the multinominal logit acreage al-

---

[19] Su-Yi Lam, "A Regional Crop Forecasting Model for the Canadian Prairies," (M.Sc. Thesis, University of Manitoba, 1984), pp. 8-27.

[20] D. Colman, Prairie Grain and Oilseed Acreage Response In North America, (Working Paper No. 7, Agriculture Canada, Policy, Planning and Economics Branch, November 1979).

location model.

Acreage response equations were specified for each of the five crops based on statistical fit and were expressed in a linear form in the independent equations model. The same specifications were expressed in an exponential form in the multinominal acreage allocation model. Wheat acreage was a function of a weighted expected price of wheat, the CWB initial payment for wheat, the Lift program, April-May rainfall and excess supply of wheat. Oats acreage was explained by a time trend, rainfall, and the difference between the expected return for oats and barley. Barley acreage was expressed as a function of land payment arrears, numbers of sows, three year average yield of barley, a dummy variable for the LIFT program, and the difference between the expected return for barley and the average expected return from all five crops. The rapeseed acreage equation included the lagged ratio of rapeseed price to average barley selling price, wheat stocks, a LIFT dummy, and a structural shift variable after 1969. Flaxseed acreage was estimated using the lagged relative price of flaxseed to rapeseed, wheat stocks, and the LIFT program. Equations were also developed for summer fallow acreage and aggregated acreage for the five crops. Barley acreage was chosen as the residual in the multinominal logit acreage allocation model.

Lam[21] further developed Colman's work by disaggregating acreage by province and seedbed. These modifications were incorporated to account for regional variations in cropping patterns and to more accurately reflect producers' decisions in allocating crops between fallow and stubble seedbeds. The changes reduced the aggregation errors associated

[21] Lam, op. cit., pp. 28-46.

with the analysis and improved the within-estimation period forecasting powers of the multinominal acreage allocation model.

The same modeling and estimation methods incorporated by Colman were used to estimate acreages of wheat, oats, barley, rapeseed, flaxseed and sunflower by province in western Canada. The results from the multinominal logit acreage allocation model generally compared favourably to results from a naive model. Reasonable statistical properties were obtained with the exception of total crop area sown on stubble seedbed. The errors in estimating the total area seeded on stubble seedbed were reflected in estimations of area seeded to each of the five crops.

A set of six exponential acreage functions were developed in Lam's analysis. The cropland allocation was specified to be a function of expected relative returns between crops, inventories of the cereal grains, total area of cropland, the LIFT program and rapeseed adoption. Area seeded to each crop by province was estimated from 1961 to 1981 and forecasts were generated for 1982 and 1983. The analysis demonstrated that production responses differ in acreage allocation between fallow and stubble seedbeds, and among the three Prairie provinces.

2.5 SUMMARY

The working hypothesis is that domestic economic constraints reduced producer gross margins in western Canada during the late seventies. This hypothesis is supported by historical events which were observed based on theoretical expectations. Producer gross margins are defined as the quantity sold times price received in export and domestic markets less the variable production costs. Both the revenue received and the variable costs depend on the area seeded. A review of empirical models suggests that the most appropriate means of estimating area seeded is using a simultaneous, constrained equation specification. The specification utilized by Lam should be relevant to explain changes in area seeded and ultimately farm gross margins between 1975-76 and 1980-81.

Chapter III

SIMULATION PROCEDURE, MODEL SPECIFICATION AND DATA

A simulation procedure is used to estimate the influence of marketing system constraints on Prairie producer behaviour. Producer behaviour is simulated using a series of models estimating price expectations, yields, supply and disposition, and gross margins. The supply and disposition model is the major analytical component which receives information determined in other models and from which information is supplied to the gross margin model. A brief discussion of the simulation procedures, analytical models and the necessary data is presented in this chapter.

3.1 SIMULATION PROCEDURE

The key relationships within the analytical models are presented in Fiqure 3.1 and are described in the next section. Based on these relationships, cereal grain marketings are simulated from 1970 to 1980 using a recursive system employing grain inventories. Data from 1969 is used to provide start-up information for the Scenario One simulation with data from 1974 used to initialize the Scenario Two simulations.

Scenario One (benchmark simulation) simulates historical relationships and uses historical prices, yields, rate of technological change and capacity of the grain marketing system. As a result, estimated grain inventories, marketings and gross margins should closely match actual values.

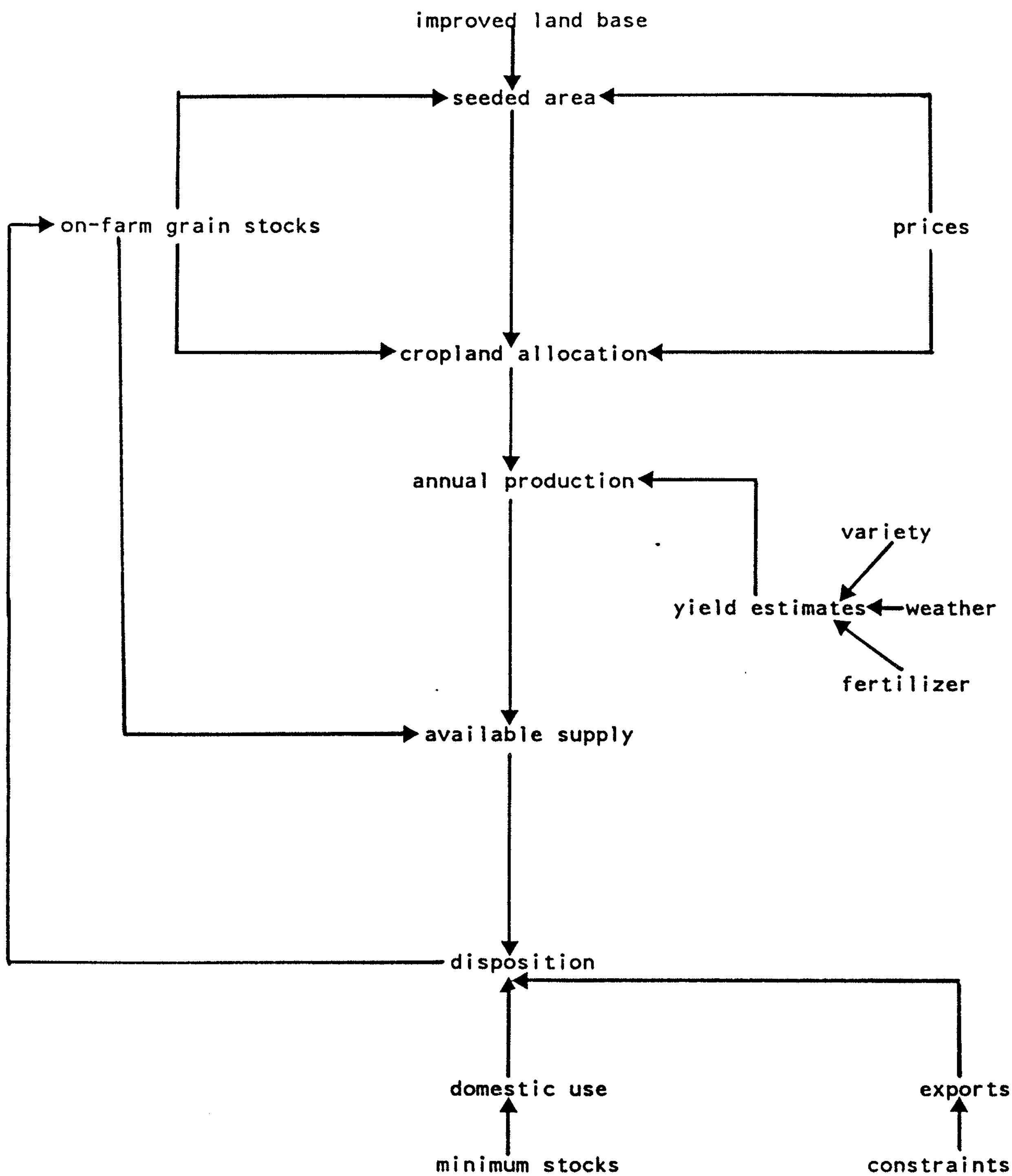


Figure 3.1: Model Diagram

Scenario Two (production and technology simulations) is used to estimate producer response to the removal of marketing constraints. In this case, the capacity of the marketing system is set high enough to allow the clearance of all grain in excess of domestic requirements. Producers respond by drawing on-farm grain inventory down to the minimum level that they are willing to hold. As indicated in Chapter 1, producers will also respond by altering production patterns and incorporating new or existing technology in an attempt to maximize their expected net return.

The production and technology responses are estimated in different simulations to determine the effect of reducing inventories given certain producer behaviour assumptions. In the production simulation, producers are expected to alter the production mix to favour crops with the highest relative return as production costs are similar between crops and grain inventory levels are now a relatively minor decision factor. In the technology simulation, producers are assumed to incorporate technology at a higher rate by increasing fertilizer usage and reducing area fallowed. Production is expected to increase due to increased area seeded and higher yields. The crop mix should also shift towards the higher valued crops.

3.2 MODEL SPECIFICATION

3.2.1 Price Expectations Model

The price expectations model is used to formulate expected harvest prices given information available to producers at seeding time. Producers use this information as well as information concerning excess grain inventories and area available for seeding to determine their production plans. Expected prices influence planting decisions through the relative expected income between cropping alternatives. Assuming production costs are similar between crops,[22] the relative profitability of crop i is determined by the ratio of the expected price times the expected yield of crop i to crop j. This relationship is discussed in greater detail in the supply and disposition model.

The CWB has sole exporting authority to market wheat, oats and barley into international markets and establishes a pooled export market price for each grain. Price expectations for grains marketed through the CWB are based on the most recent initial and final prices paid by the CWB as illustrated in the following equation:

$$P = PI_{-1} + PF_{-2} \qquad i = \text{wheat, oats and barley} \qquad (3.1)$$

where:

P = expected CWB price of crop i, basis Thunder Bay, \$ per tonne.
PI = initial CWB price of crop i, basis Thunder Bay, \$ per tonne.
PF = final CWB price of crop i, basis Thunder Bay, \$ per tonne.

[22] W.J. Craddock, "Economics of Oilseed Production", (paper presented to the Oilseed and Pulse Crops in western Canada Symposium, 1975), p. 684.

The most recent initial price is the price from the previous crop year as the initial price for the current crop year is announced in April. The interim payments are added to the initial price. The most recent final price is from two crop years previous as the final price for the previous crop year is not announced until six months after the close of a crop year.

The Winnipeg Commodity Exchange (WCE) establishes prices for wheat, oats and barley traded domestically and for oilseeds traded in domestic and international markets. The estimated WCE harvest price is based on the average cash price, six months prior to seeding (October to March) for the appropriate grade and port.

Historical marketing patterns[23] are used to indicate the appropriate price expectation for grains handled by both institutions. The CWB price best reflects price expectations for wheat producers because the majority of wheat is marketed by the CWB. The opposite is true for oats for which approximately 7 percent of the marketings of oats are handled by the CWB versus 93 percent by the WCE and farm markets. A similar situation exists for barley although the marketing pattern is not as decisive. Approximately 44 percent of net Prairie farm disposition for barley is handled by the CWB while 55 percent moves through the domestic market.

Barley price expectations are based on both CWB and WCE prices because of policy changes affecting the domestic marketing structure. Responsibility for marketing barley has been held by the CWB (1969-74), the WCE (1974-76) and by both agencies (1976-present). Price expecta-

---

[23] Canada Grains Council, Prospects for the Prairie Grain Industry 1990, (Winnipeg: Canada Grains Council, 1982), pp. 119-124.

tions are based on CWB prices from 1969-1973 and on WCE prices from 1974-1980. The latter price expectation estimate is used because the WCE price is more reflective of the price producers were likely to receive or price grain by given historical grain marketing patterns.

The price expectation estimates for both the CWB and the open market are similar to the form used by Lam[24] however, the basis for the estimates are different for two grains in this analysis. Barley price expectations are based on both CWB and WCE prices rather than solely on CWB prices to reflect policy changes in the barley marketing environment as well as historical marketing patterns. Oats price expectations are based on WCE prices instead of CWB prices because of the significantly larger marketing share of the open market.

3.2.2 Yield Acceleration Model

This model is used to simulate yields resulting from increased incorporation of fertilizers over the period identified as constrained, ceteris paribus. Higher yields are used in the second simulation in Scenario Two as a means of quantifying producer response to the removal of constraints. Yield increases as well as increased continuous cropping are used to simulate a higher rate of adoption.

The following linear relationship is used to determine the fertilizer application rates by major nutrient:

$$\widehat{NUTRi} = NUTRi + \Delta\, NUTRi \qquad i = \text{nitrogen, phosphorous} \qquad (3.2)$$

where:

$\widehat{NUTR}$ = estimated nutrient application rates by seedbed, kg per ha.

[24] Lam, op. cit., pp. 40-44.

ΔNUTRi = change in nutrient application rates required to reach recommended rates by 1985, by seedbed, kg per ha.

Actual and estimated nutrient application rates are in Table A.18 Appendix A. The estimated nutrient application rate is used to develop estimated yields using the following form:

$$\widehat{YIELD} = YIELD + (b* \widehat{NUTRi} - NUTRi/NUTRi) \qquad (3.3)$$

where:

$\widehat{YIELD}$ = estimated yield by crop, by seedbed in each Prairie province, tonnes per hectare.
YIELD = historical yield by crop, by seedbed in each Prairie province, tonnes per hectare.
b = yield elasticity includes fertilizer effect and improved weed control.
where: b = 0.18 for fallow seedbed
b = 0.20 for stubble seedbed

Estimated yields are a function of actual yields and change in yield derived from increasing fertilizer application rates.

The estimated yields affect producer decisions regarding the allocation of area available for seeding between crops. Allocation decisions are altered because the relative profitability between seedbeds is changed. Relatively more fertilizer is required on stubble seedbeds to bring the application rates to recommended levels compared to fallow seedbeds. The greater yield response that occurs on stubble seedbeds may make it relatively more profitable to seed stubble versus fallow seedbeds despite increased fertilizer costs due to the higher elasticity of stubble.

Producers must also decide on a marketing plan for the excess production generated by a higher yield from a given seeded area. Assuming a fully supplied domestic market and adequate world prices, producers are expected to sell their excess production into world markets.

3.2.3 Supply and Disposition Model

The purpose of this model is to simulate export and domestic marketings for the Prairie provinces. This enables the calculation of the gross margin directly attributable to export and domestic marketings from the Prairies. The simulation requires an estimation of the land base available for seeding, the distribution of the available land base between crops and the disposition of the resulting supply.

3.2.3.1 Land Base

The area seeded to the principal crops is estimated using a multinominal logit approach incorporating simultaneous estimation procedures first developed by Colman (1979) and later modified by Lam (1983). This type of approach accounts for the simultaneous interrelationships involved in the allocation of crop area and ensures the area seeded is positive by restricting the percentage shares of crops to a sum of one. The actual model consists of a system of five equations estimated by using Zellner's Seemingly Unrelated Regression (ZSUR) estimation method. This generalized least squares estimation method is used to account for the correlation among disturbance terms across equations.

The total land base is defined as the area under cultivation plus the area summer fallowed. Total land base fluctuates as new land is cleared and land is removed from production. The area cleared in the current year is assumed to be available for seeding in the following year. The total cultivated land base consists of the area seeded on fallow and stubble seedbeds. The area seeded on fallow in the current year is assumed to be the area summer fallowed in the previous year. The total cultivated land base is generated by the following equation:

$$TOT = STUB + SF_{-1} - RYE_{-1} + LC_{-1} \quad (3.4)$$

where:

TOT = total available land base, for cultivation, 000 ha.
STUB = stubble seedbed, 000 ha.
SF = area summer fallowed in the previous year; fallow seedbed in the following year, 000 ha
RYE = area seeded to fall rye in the previous year, 000 ha.
LC = change in total land base from the previous year, 000 ha.

The land seeded to crop production increased as a share of total land available throughout the 1960's and latter 1970's. This growth in crop land resulted from decreased summer fallowing and, to some extent, the clearance and cultivation of new land. The change in stubble relative to the total cropland over time is estimated by a logistic function that is specified in the following linear form:

$$\ln \frac{STUB/TOT_{-1}}{K-(STUB/TOT_{-1})} = a + b * TREND + c * LIFT + d * POST70 + e * POST75 + f * EXCESS \qquad (3.5)$$

where:

STUB = area seeded on stubble seedbed, 000 ha.
TOT = total area of non-forage crops, 000 ha.
TREND = time variable, year.
LIFT = a dummy variable for the LIFT program, if TREND = 1970 THEN LIFT = 1, otherwise LIFT = 0.
POST70 = dummy variable for a shift in the function, if TREND ≥ 1970 then POST70 = 1970 otherwise POST70 = 0.
POST75 = a dummy variable for a shift in the function, if TREND ≥ 1975 then POST75 = 1, otherwise POST75 = 0, (for scenario one only).
EXCESS = a dummy variable for periods of excess supply.
K = maximum level of stubble to cropland ratio where:
K = 0.93 in Manitoba
K = 0.71 in Saskatchewan, and
K = 0.76 in Alberta.

and

$$STOC = \ln \frac{STUB/TOT_{-1}}{K-(STUB/TOT_{-1})}$$

where:

STOC = stubble to cultivated area ratio.

The TREND variable is used to determine the rate of adoption or adjustment to minimum levels of summer fallow. The rate of adoption is affected by programs such as LIFT and influences such as grain inventories.

The first two variables in Equation 3.5 account for the direct and indirect effects of the LIFT program. This program was intended to reduce grain inventories in the short-term by taking land out of production for one year. The LIFT dummy variable is used to account for the increase in summer fallow area in 1970 as a direct result of this program. The POST70 dummy variable is used to account for the indirect effect of the LIFT program on cropping patterns in years following LIFT. The rationale for the practise of fallowing was reinforced partly due to the increased yield response in 1971. As a result, a cyclical pattern of increasing and decreasing area seeded occurred from 1971 to 1975. Prior to this period and immediately after this period, stubble area seeded increased as a share of total cultivated area.

The POST75 dummy variable is used to shift the function to a higher rate of adjustment allowing the minimum levels of summer fallow to be reached earlier than under historical rates of change. This variable is used to account for the accelerated rate of adoption resulting from the removal of marketing system constraints. It is included in Equation 3.5 during the second simulation in scenario one.

The EXCESS variable is defined as total cereal grain available to market (once domestic requirements are fulfilled) in excess of the capacity of the grain marketing system. This variable is defined to be equal to the estimated value if the value is positive and by definition, equal to zero if the value is negative or zero. The derivation is illustrated in the following equation:

$$EXCESS = AMKT - EXC \qquad (3.6)$$

where:

EXCESS = the sum of excess cereal grain inventories for the five crops, million tonnes.
AMKT = cereal grain available to market, million tonnes.
EXC = cereal grain marketing capacity, million tonnes.

The stubble area available for seeding is specificed by rearranging Equation 3.5 and solving for the stubble area:

$$STUB = (STOC * K * TOT_{-1} + LC_{-1})/(1 + STOC) \qquad (3.7)$$

A linear regression is used to determine the stubble area seeded to the five principal crops. The intercept is suppressed for Manitoba and Saskatchewan as it was insignificant:

$$STUB5 = a + b * STUB \qquad (3.8)$$

where:

STUB5 = stubble area seeded to the five crops, 000 ha.

As the total cultivated area and the area seeded on stubble are known, rearranging Equation 3.4 and solving for summer fallow area gives the following equation:

$$SF = (TOT_{-1} + LC_{-1}) - STUB \qquad (3.9)$$

The area summer fallowed in the current year is seeded in the following year giving rise to the next equation:

$$FAL5 = SF_{-1} \qquad (3.10)$$

The following exponential function[25] is used to determine the area allocated to each crop:

$$Ai = e^{f_i(I_{ij}, Z, e_i)} \quad i = \text{wheat, oats, barley, rapeseed, and flaxseed} \quad j = 1, 2, \ldots n \; j \neq 1 \qquad (3.11)$$

where:

Ai = area of each crop i.
fi = linear function of I_{ij} and Z in unknown parameters.
Iij = vector of expected return from crop i relative to competing crop j.
Z = all other factors affecting producer decisions in land allocation.
eij = random disturbance term for crop i.

The actual functional specification is based on both theoretical considerations and statistical significance with a similar form used for both fallow and stubble seedbeds. The linear functions for each crop relative to the base crop flaxseed are expressed as follows:

$$\ln(W/FL) = a + bIWFL + bIBFL + bIRFL + bIFLO + bIWB + bIWO + bIWR + bGIFL + bGIW + bGIR + bGIB + bLIFT + e \qquad (3.12)$$

$$\ln(B/FL) = a + bLLBFL + bIWFL + bIBFL + bIRFL + bIFLO + bIWB + bIWO + bIBO + bIBR + bGIFL + bGIW + bGIR + bGIB + e \qquad (3.13)$$

$$\ln(R/FL) = a + bIWFL + bIBFL + bIRFL + bIFLO + bIBR + bIRO + bIWR + bGIFL + bGIW + bGIR + bGIB + bTRDRP + e$$

$$\ln(O/FL) = a + bIWFL + bIBFL + bIRFL + bIFLO + bIWO + bIBO + bIROB + bGIFL + bGIW + bGIR + bGIB + e \qquad (3.14)$$

---

[25] For a more detailed discussion of the approach and method used, please refer to: S. Lam, "A Regional Crop Forecasting Model for The Canadian Prairies", (M.Sc. thesis, University of Manitoba, 1984), pp. 29-39.

where:

Iij = expected return I from crop i / expected return from crop j, i.e., IWFL = expected return from wheat/ expected return from flaxseed (W = wheat, O = oats, B = barley, R = rapeseed, and F = flaxseed)
GIi = March 31, on-farm grain inventory of crop i.
LIFT = dummy variable for Lower Inventories For Tomorrow.
TRDPR = trend variable for canola.
LLij = the natural logarithm of the ratio of crop i to crop j, from the previous year, i.e., LLBFL = the natural logarithm of the ratio of barley to flaxseed from the previous year.

The crops are estimated relative to a common denominator. Flaxseed is used because of the relative small area seeded and the absence of a discernible trend in share of seeded area. These characteristics enable the area seeded estimations to be unbiased and the small size of the acreage does not restrict the variations in acreage ratios.

Relative expected returns are included based on simple profit maximization principles which theorize that producers will allocate production resources based on relative prices and costs. Expected price returns are used as a proxy for expected revenue because Craddock (1975) has argued production costs for alternative crops are known to the producer and the difference between average costs for alternative crops is insignificant.

The usage of price returns in a ratio form accounts for the competitiveness among crops for limited resources and is calculated as a three year moving average of yield times the expected price. Yields are included to incorporate the production advantages of each crop relative to all other cropping alternatives. The yields are derived by aggregating yields weighted by crop district to the provincial level.

March 31st grain inventories for wheat, flaxseed, rapeseed and barley are included in both fallow and stubble equations. Inventories influence the distribution of area seeded between crops because a build up of stocks cause producers to allocate resources towards crops with relatively small inventories, ceteris paribus. Wheat has the largest annual area of all principal crops and consequently, wheat inventories are the most influential in terms of affecting area seeded to alternative crops. Although flaxseed inventories are relatively minor, they are included because flaxseed is used as the common denominator. Rapeseed and barley inventories are included as these crops are major cropping alternatives to wheat depending on the level of grain inventories and expected returns. A simultaneous system of equations makes it difficult to eliminate variables based solely on significance; however, inventories for oats and sunflowers[26] were excluded due to the relatively small area seeded and level of statistical insignificance.

A dummy variable, LIFT, is included in the wheat equations for both seedbeds to account for the removal of wheat area from production in 1970 in response to the Lower Inventories for Tomorrow program. This one year program was specific to wheat and resulted in a large increase in fallow area. For example, the area fallowed in Saskatchewan during 1970 was almost greater than the area cropped.

A TRDPR variable is a zero one trend variable included in rapeseed area estimation equations for both seedbeds. Prior to 1970, rapeseed can be considered a relatively new crop. After 1970, expertise and skills in rapeseed management and production were sufficiently widespread for most producers to consider canola/rapeseed as a viable crop-

[26] The acreage of sunflowers is estimated in both the Lam (1983) analysis and this analysis to assist in estimating the allocation of area seeded on stubble to the principal crops in Manitoba. However, sunflowers are excluded from the supply disposition model as sunflowers are primarily grown for domestic consumption.

ping alternative.

A variable, FAL, was included in the Alberta equations to account for the significance of total fallow area in the estimation process. The area fallowed influences the rotation choices available to producers as well as increasing the choice of land use. This variable had a large degree of significance attached to it in the estimation results.

The lagged acreage of wheat on fallow, LLWFLF, was included in equations where it was felt that the area seeded to wheat in the previous year influenced the land allocation. Total area was removed from all equations because year to year changes are relatively small. Therefore, the net change in area available for seeding will not influence the producer decisions in any particular year. In addition, this variable was relatively insignificant in all equations.

Specific cost differences and associated risk in management and production decisions are attributed to the error term in the equations as these influences are difficult to quantify. Technological changes, management skills and weather effects are accounted for by actual yields used in the relative expected return ratios.

The land base derivation is similar to a previous research derivation used by Lam[27] with the following modifications:

1. The total land base and therefore, the cultivated land base (Equation 3.4) is allowed to fluctuate as land is brought into production or removed from production. The previous analysis held the land base equal to the land base available in the year used to initialize the simulation.

---

[27] Lam, op. cit., pp. 29-46.

2. The cultivated area available in Equation 3.4 is assumed to be based on stubble plus last year's summer fallow rather than stubble plus last year's summer fallow and area seeded to rye. This derivation is used as the area seeded to rye is unavailable for seeding to one of the principal crops.
3. The EXCESS dummy variable in Equation 3.5 is redefined to be consistent with the definition of excess inventories used in this analysis. In Lam's analysis, the EXCESS variable is defined as the amount of expected supply (inventory plus expected production) greater than expected disappearance while in this analysis, it is defined as cereal grain in excess of both domestic requirements and the capacity of the grain marketing system.
4. Several of the explanatory variables in Equations 3.12 to 3.14 decisions have been modified. Variables remaining the same in both analyses are the relative return ratios, grain inventories for wheat and flaxseed, the dummy variable for LIFT and the trend variable for adoption of rapeseed management and production skills. Explanatory variables added to the equations include grain inventories for flaxseed, rapeseed and barley to all equations, Alberta area fallowed in the fallow equations, and the lagged area seeded to barley and wheat where appropriate. One variable, total fallow or stubble seedbed, has been excluded as it was statistically insignificant.

3.2.3.2 Supply and Disposition

The market clearing identity for the supply and disposition structural relationship is expressed in the following manner:

AS + TDISP = 0 (3.15)

where:

AS = available supply, 000 tonnes.
TDISP = total disposition, 000 tonnes.

Based on this identity, statistical information on the supply and disposition of cereal grains for western Canada is available using the following structural relationships:

AS = (YIELD x AREA) + FCO (3.16)

where:

YIELD = yield, kg. per hectare.
AREA = area seeded, 000 ha.
FCO = on-farm carryover, August 1, 000 tonnes.

and:

TDISP = MKT + SEED + FWD + FECO (3.17)

where:

MKT = commercial marketings, 000 tonnes.
SEED = seed requirement, 000 tonnes.
FWD = feed, waste and dockage.
FECO = on-farm ending carryover, July 31, 000 tonnes.

The information provided at the provincial level includes commercial marketings but does not distinguish between export or domestic marketings. This reflects the difficulty of tracing a homogenous product which is aggregated for ease of transportation from the point of origin to the point of export. As this analysis focuses on exports, both exports and domestic consumption are estimated in the following equations using several of the assumptions presented in Chapter II.

The available supply equation is expanded to include commercial grain inventories as it is assumed that commercial inventories are drawn from western Canada. Available supply is expressed as the following modified function:

$$AS = (YIELD \times AREA) + FBC + CBC \qquad (3.18)$$

where:

CBC = commercial cereal grain beginning carryovers, August 31, 000 tonnes.

Total disposition also requires several modifications. Ending commercial carryovers are added to the equation to maintain the structural relationship. Feed, waste and dockage is disaggregated to separate feed requirements from waste and dockage. In addition, marketings are disaggregated into exports and domestic sales with domestic consumption including shipments of western cereal grains to eastern Canada. Shipments to the east originate from either the CWB or the open market. Total disposition is redefined in the following manner:

$$TDISP = EX + CWB + OM + FEED + SEED + WD + FECO + CECO \qquad (3.19)$$

where:

EX = western Canada exports, 000 tonnes.
CWB = shipments by the Canadian Wheat Board to eastern Canada, 000 tonnes.
OM = shipments by the open market to eastern Canada, 000 tonnes.
FEED = feed requirement, 000 tonnes.
WD = waste and dockage, 000 tonnes.
CECO = ending commercial grain inventories, July 31, 000 tonnes.

Substituting Equations 3.18 and 3.19 into Equation 3.15 and solving for exports results in the following equation:

$$EX = [(YIELD \times AREA) + FBC] - [(CWB + OM + FEED + SEED$$

$$WD + FECO)] + (CBCO - CECO) \qquad (3.20)$$

Export marketings are calculated as a residual once domestic and inventory requirements are met. As seeded area is simulated provincially and aggregated regionally, marketings are aggregated from the Prairie provinces with British Columbia supply and disposition subtracted from western Canada data. Provincial cereal grain available for sale is defined as grain in excess of provincial requirements for feed, seed and minimum acceptable carryovers and is derived by crop:

$$AMKTi = ASi - SEEDi - FEEDi - WDi - MECOi \quad i = \text{six principal grains} \qquad (3.21)$$

where:

AMKT = cereal grains available for marketing by crop, 000 tonnes.
MECO = minimum ending on-farm carryover by crop, July 31, 000 tonnes.

The volume of grain physically marketed outside each province is affected by the capacity[28] of the provincial commercial marketing system. Total grain in excess of the physical capacity of the system is added to minimum on-farm carryover with available marketings subsequently reduced by an equivalent amount, and the waste and dockage estimate adjusted accordingly. Each crop is allocated a share of the commercial system based on its proportion of the total cereal grain available to market. In the case where total grain available to market is less than or equal to the provincial capacity, provincial marketings are equal to the amount of grain available to market. Otherwise provincial marketings are equal to the capacity of the marketing system:

$$SUR = \Sigma \ AMKTi - EXC \qquad (3.22)$$

$$AMKTi = (SUR * STAi) \qquad (3.23)$$

[28] Refer to Section 2.3 for the assumption concerning the system capacity and Section 3.2.3.1 for a discussion of the EXCESS variable.

where:

$$STAi = \frac{AMKi}{\Sigma AMKi} \tag{3.24}$$

$$MKTi = AMKTi - RMKTi \tag{3.25}$$

where:

SUR = volume of grain in excess of the capacity of provincial marketing system, 000 tonnes.
EXC = capacity of the commercial marketing system by province, 000 tonnes.
STA = share of commercial system by crop and is the crop share of total marketings.

Once provincial marketings by crop are determined, western Canadian exports by crop are estimated using a modified form of Equation 3.20:

$$WCEXi = \Sigma MKTi - WDUi - CWBi - OMi + (CBCOi - CECOi) \tag{3.26}$$

where:

WCEX = western Canadian exports by crop, 000 tonnes.
MKT = provincial marketings by crop, 000 tonnes.
WDU = western Canada domestic requirements, 000 tonnes.

Western Canadian exports by crop as defined in Equation 3.26 may have a positive or a negative value. Exports are positive when the sum of the provincial grain marketings exceed domestic requirements and shipments to the east; for example, wheat. Exports are negative when the sum of the provincial grain marketings is less than domestic requirements; for example, oats in some years. Negative exports are actually imports necessary to meet a deficit supply situation.

The possibility of positive or negative exports requires two definitions for western Canadian domestic consumption. When exports are positive, domestic consumption is defined as the sum of the provincial marketings minus exports:

$$\Sigma WCDOMi = XMKTi - WCEXi \quad (3.27)$$

When provincial exports are negative, domestic consumption is defined as exports plus western Canadian domestic requirements plus shipments to the east plus change in commercially held inventories:

$$WCDOMi = WCXi + WDUi + CWBi + OMi + (CBCOi - CECOi) \quad (3.28)$$

Total exports and domestic marketings are the sum of the respective marketings for the five principal crops.

$$EX = \Sigma WCX \quad (3.29)$$

$$DOM = \Sigma WCDOM \quad (3.30)$$

3.2.4 Gross Margin Model

The purpose of this model is to calculate an accurate gross margin gain or loss associated with market constraints for Prairie cereal grain producers. This requires the following steps:

1. a simulation of the revenue and cost flows associated with export and domestic marketing during the seventies with historical marketing system constraints in place (benchmark simulation);
2. an estimation of the revenue and cost flows from total marketings during the seventies without historical marketing system constraints (Scenario Two-simulation one);
3. an estimation of the revenue and cost flows from total marketings during the seventies without historical marketing system constraints and with an increased rate of adoption of technology (Scenario Two-simulation two); and

4. a means of comparing the revenue and cost streams.

Based on the theoretical framework introduced in Chapter II, income is specified in the following manner:

$$I = (MKT \times PR) - VC - FC \tag{3.31}$$

where:

I = income, $billion.
MKT = marketings of crop i, 000 tonnes.
PR = price received for crop i, $ per tonne.
VC = variable costs associated with crop i, $ per tonne.
FC = fixed costs associated with crop i, $ per tonne.

Prairie marketings for the simulations are derived from the supply and disposition model. The corresponding revenue and cost flows are based on the assumption that fixed production costs between crops and between provinces within a simulation are assumed to be the same for all scenarios. The only change in costs between the simulations is the variable costs associated with increased production. As it is the change in gross margin resulting from the removal of constraints that is important, the income equation from scenario one is subtracted from the benchmark equation to form Equation 3.32 and is reduced to Equation 3.33.

$$\Delta I = (MKT * (PR) - VC - FC)_2 - (MKT * (PR) - VC - FC)_1 \tag{3.32}$$

$$GM = (MKT * (PR) - VC)_2 - (MKT * (PR) - VC)_1 \tag{3.33}$$

where:

GM = gross margin, $billions.

The price received, PR, is specified in one of the two forms depending on the agencies that market the cereal grains. The price received for grain sold by the CWB is equal to the initial price reduced by handling and transportation costs plus the interim and final prices. Grain delivered to the private trade is priced net of handling and transportation costs. The domestic price for oats and barley is equal to the WCE price in the benchmark simulation and set equal to the CWB price in the Scenario Two simulations. CWB prices are used in the second scenario because domestic prices are assumed to equal export prices once the marketing constraints no longer exist. The two pricing equations used in the benchmark simulation are expressed as follows:

$$PR = PI - EC - TC + PIT + PF \tag{3.34}$$
$$PR = P$$

where:

PR = price received, $ per tonne.
PI = CWB initial price, $ per tonne.
EC = elevation charges, $ per tonne.
TC = transportation charge, $ per tonne.
PIT = CWB interim price, $ per tonne.
PF = CWB final price, $ per tonne.
P = WCE street price, $ per tonne.

Fertilizer costs are used as one measure of variable costs associated with production. The net fertilizer cost is disaggregated by seedbed and by province to reflect differences in fertilizer application rates. Costs will change between simulations due to changes in type of area seeded (either fallow or stubble seedbed), total area seeded and application rates.

The remaining costs are calculated by multiplying the Farm Price Index for Western Canada Crop Products, (1981=100) by the costs by province, crop and seedbed obtained for 1984.[29] Variable costs are calculated for each province by seedbed and crop using the following equation:

[29] Daryl F. Kraft and Valerie J. Fields, Influence of Technological Change on Prairie Grain Farms Between 1971 and 1984, (a report prepared for the Grains Group, CP Rail, November 1985).

$$VC_y = \frac{I_y}{I_{1984}} \times VC \qquad y = 1975 \text{ to } 1980 \qquad (3.35)$$

where:

VC = variable costs.
I = Farm Price Index for Western Canada Crop Products (1981-100).

For example, the variable production cost per ha for Manitoba wheat seeded on stubble was calculated as \$13.93 with I_{1975} = 70.6, I_{1984} = 122 and VC_{1975} = 24.08 (see Table 3.1). The variable costs per hectare for 1984 include cost of fuel and lubricants, repairs, fertilizer, chemicals and seed and exclude cost associated with custom charges, interest on operating capital, machinery insurance, labour taxes, overhead and miscellaneous costs. The latter are excluded because these costs are incurred regardless of production level.

Table 3.1

1984 Variable Cost Per Hectare, Prairie Provinces
($1 ha)

	Manitoba	Saskatchewan	Alberta
Wheat			
Stubble	24.08	24.22	23.48
Fallow	20.24	19.49	18.80
Oats			
Stubble	24.79	26.25	23.98
Fallow	25.10	26.20	24.68
Barley			
Stubble	24.11	24.84	23.58
Fallow	24.77	25.24	23.82
Flaxseed			
Stubble	21.16	22.36	22.08
Fallow	22.21	22.45	21.97
Canola			
Stubble	23.54	25.09	22.63
Fallow	23.95	24.94	22.24

Source: Daryl F. Kraft and Valerie J. Fields, "Influence of Technological Change on Prairie Grain Farms Between 1971 and 1984," (a report prepared for the Grains Group, CP Rail, November, 1985).

The result of Equation 3.33 is an estimation of the annual change in gross margin caused by constraints in the marketing system. The aggregate values of this revenue stream would give the net financial impact of the constraints. The annual values are compounded to bring the stream of revenues into 1980 dollars for comparison purposes:

$$GM = GM(1 + i)^{n} \qquad (3.36)$$

where:

GM = gross margin as of year 1980; end value.
GM = gross margin as of year zero; initial value.
i = annual rate of interest expressed in decimals.
n = number of years compounded, 1.

Canada Savings Bonds are used as a proxy for a reasonable rate of return available on investment as these bonds are a comparatively safe investment vehicle.

3.3 DATA

3.3.1 Price Expectations Model

This model requires cereal grain prices established by the CWB and private trade. Initial and final prices, F.O.B. Thunder Bay for No. 1 Red Spring Wheat, No. 1 Feed Oats and No.1 Canadian Feed Barley are taken from the CWB Annual Reports. Average cash prices, six months prior to seeding (October to March) for grains and oilseeds traded on the WCE are collected from Statistics Canada: Grains and Oilseed Review, (cat. no. 22-007), Canadian Grain Commission, Grain Statistics Weekly, and the WCE Commodity Reports. Prices are recorded for No. 1 Feed Oats, No. 1 Feed Barley and No. 1 Canadian Flaxseed, basis Thunder Bay. No. 1 Canadian Canola is recorded basis Vancouver.

3.3.2 Yield Acceleration Model

This model uses elasticities derived from field experiments and farm data to determine yields under increased fertilizer usage. Yields by crop, seedbed and province are obtained from Statistics Canada: Field Crop Reporting Series (FCRS), (cat. no. 22-002). Nutrient application rates by seedbed and by province, are obtained from Kraft and Fields.[30]

---

[30] Daryl F. Kraft and Valerie J. Fields, "Fertilizer Demand In The Prairie Provinces," (unpublished paper, University of Manitoba, 1981).

3.3.3 Supply and Disposition Model

Calculation of the area seeded to the five crops by seedbed and province requires several data sources. March on-farm grain inventories are obtained from Statistics Canada: Stocks of Canadian Grain as of March 31, FCRS (cat. no. 22-002). Total area of land available for seeding is taken from Statistics Canada: Quarterly Bulletin of Agricultural Statistics (cat. no. 21-003) and is revised on the basis of census data. Total area of summer fallow available for seeding is equal to the fallow area less the area seeded to fall rye. Stubble area is equal to the total area minus the fallow area. Annual fallow and stubble areas by crop and yields by seedbed are collected from Statistics Canada: FCRS (cat. no. 22-002).

Supply and disposition data are obtained from the Board of Grain Commissioners Annual Report and Statistics Canada: Supply and Disposition of Major Grains. March and July on-farm grain inventories are taken from Statistics Canada: Stocks of Canadian Grain as of March 31 and Stocks of Canadian Grain as of July 31, FCRS (cat. no. 22-002).

While complete supply and disposition data are available regionally and nationally, only production, on-farm grain inventories and deliveries to the primary elevator system are available provincially from the Board of Grain Commissioners Annual Report. As a result, seed and feed, waste and dockage are calculated. Seed is calculated based on recommended seeding rates (for the most widely seeded variety of interest to this analysis) in Manitoba Agriculture: Field Crop Recommendations for Manitoba. Feed, waste and dockage are calculated as the residual component from available supply minus seed requirements and ending inventories. Provincial export marketings are reduced by western domestic marketings to eastern markets. Shipments by the CWB and the open market are obtained from Statistics Canada: Grain Trade of Canada (cat. no. 22-201) from 1966-1973, directly from the CWB for 1974-1975 and from Kraft[31] from 1975 to 1980.

3.3.4 Gross Margin Model

This model requires data on prices received by producers in Manitoba, Saskatchewan and Alberta, elevation and transportation charges, variable production costs and Canada Savings Bond rates. Producers receive the initial price paid by the CWB less handling and transportation charges when they deliver their grain to the primary elevator system. The price received is increased by interim and final prices at a later date. The CWB prices are collected from the CWB Annual Report for No. 1 Red Spring Wheat, No. 1 Feed Oats and No. 1 Canadian Feed Barley, F.O.B. Thunder Bay. The inital price is reduced by handling charges collected from Agriculture Canada: Canadian Grain Commission Annual Report and by transportation charges recorded by Statistics Canada: Grain Trade of Canada (cat. no. 22-201) for each of the three provinces. The average annual price for flaxseed and rapeseed is collected for Manitoba from Manitoba Agricultural Yearbook and reflect handling, transportation and marketing charges. These prices are calculated for Saskatchewan and Alberta by reducing Manitoba prices by the respective transportation charge.

Total revenue is reduced by the variable production costs. The Farm Price Index for western Canada (Crop Products, 1981=100) is obtained from the Manitoba Agriculture Yearbook. Variable costs by province,

---

[31] Daryl F. Kraft, (unpublished paper, University of Manitoba, 1981).

crop and seedbed for 1984 are obtained from Kraft and Fields.[32]

This model also uses Canada Savings Bonds as a measure of a reasonable rate of return on investment. The long-term Canada Saving bond rate is taken for the Bank of Canada Review.

[32] Daryl F. Kraft and Valerie J. Fields, Influence of Technical Change on Prairie Grain Farms Between 1971 and 1984, (a report prepared for the Grains Group, CP Rail, November 1985).

Chapter IV

EMPIRICAL RESULTS AND DISCUSSION

This chapter reviews the results of the econometric models established in Chapter III for the two scenarios. The results from the benchmark simulation are evaluated for forecasting performance and compared to production and technology simulations to measure the effects of producer behaviour assumptions. Several key components are examined including area seeded, production, on-farm carryover, marketings and gross margin. The majority of the components are discussed in aggregate for the five principal crops for the Prairie provinces with some elaboration for each crop where appropriate. The review concludes with a brief summary of the results and the implications of the analysis.

4.1 VALIDATION OF THE BENCHMARK SIMULATION - SCENARIO ONE

The results from Scenario One are used as a measure of the ability of the empirical relationships to track historical occurances by evaluating the difference between predicted and actual values of the dependent variable. The benchmark simulation is judged on the accuracy of the forecasts and the ability to predict the direction of change (turning points).[33] The forecast accuracy is measured with Theil's inequality coefficient where a small value for the inequality coefficient (i.e., U

---

[33] A. Koutsoyiannis, "Testing the Forecasting Ability Power of a Model," Theory of Econometrics, An Introductory Exposition of Econometric Methods, (London and Basingstoke: The Macmillan Press Ltd., 1973), pp. 480-487.

< 1) suggests that the forecasting performance of the empirical relationships is reasonably good.

All aggregate forecasts are reasonably accurate as the inequality coefficients are less than one (see Table 4.1). Crop production forecasts are reasonably accurate except for oats and flaxseed which had inequality coefficients greater than one. The accuracy of the oats forecast is affected by the relatively small and fluctuating volume of oats produced. Flaxseed forecasts are less accurate because flaxseed seeded area is defined as the residual necessary to make the sum of the predicted area seeded to the five crops equal the total area seeded. The accuracy of the aggregate production forecast is good despite the relative inaccuracy of oats and flaxseed forecasts because of the comparatively small contribution to total production and the cancelling of prediction errors.

All aggregate forecasts have three or less turning point errors. The component forecasts have slightly more turning point errors with approximately four or less incorrect changes in direction. This suggests that the simulation is generally able to account for direction changes in aggregate with directional errors cancelling between individual crops.

Table 4.1

Forecasting Performance of Benchmark Simulation

	Thiel's Coefficient	Turning Points Missed	Turning Points Forecasts
Area Seeded	0.55	3	-,-,+
Fallow Area Seeded	0.23	4	+,-,+,-
Stubble Area Seeded	0.78	3	+,+,+
Production	0.32	2	+,-
Wheat	0.48	2	
Oats	1.12	2	
Barley	0.67	2	
Rapeseed	0.62	4	
Flaxseed	1.03	0	
Carryover	0.42	2	+,+
Total Marketings	0.70	3	-,-,-
Export Marketings	0.51	1	+
Gross Margin	0.39	1	+

Both the accuracy and number of turning point errors in the area seeded forecasts ultimately affect supply and disposition forecasts. Area seeded forecasts should be accurate with few turning point errors, particularly from 1975 to 1980, as these years are re-estimated in Scenario Two assuming adequate capacity.

Total area seeded to the five principal crops equals the area seeded on fallow and stubble seedbeds. As indicated in Figure 4.1, three turning point errors for total seeded area occurred with the simulation incorrectly predicting a negative change in direction in 1976 and 1978, and a positive change in 1980. Forecasted total area is without a clear estimation bias because estimation errors in stubble area are usually cancelled by estimation errors in fallow area (see Figure 4.2).

The error for total seeded area in 1976 is due to the inaccuracy of fallow and stubble seeded area forecasts. The decrease in fallow area is overestimated while the increase in stubble area is underestimated. As less fallow and stubble area is seeded, predicted total seeded area declined when actual area increased.

A turning point error in forecasted seeded fallow area caused an incorrect directional change in total seeded area in 1978. The simulation incorrectly forecasted a decrease in seeded fallow area while underestimating the seeded stubble area. Predicted total seeded area declined as less fallow and stubble area is seeded than actually occurred.

The turning point error for 1980 total seeded area is due to a an error in the stubble area forecast. Stubble area is incorrectly predicted to increase causing an increase in forecasted total seeded land. By comparison, historically seeded land decreased.

Figure 4.1
Area Seeded to the Five Principal Crops in Western Canada
1970-71 to 1980-81, '000,000,000 hectares

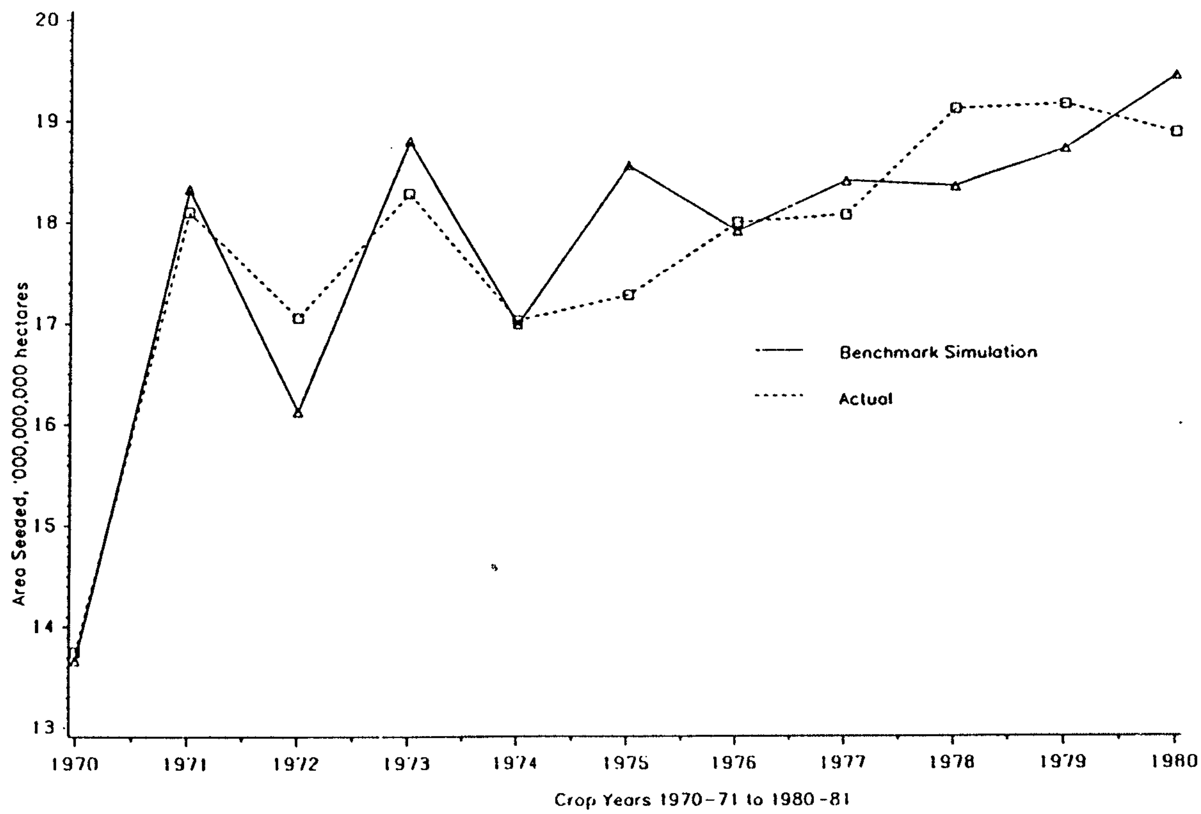
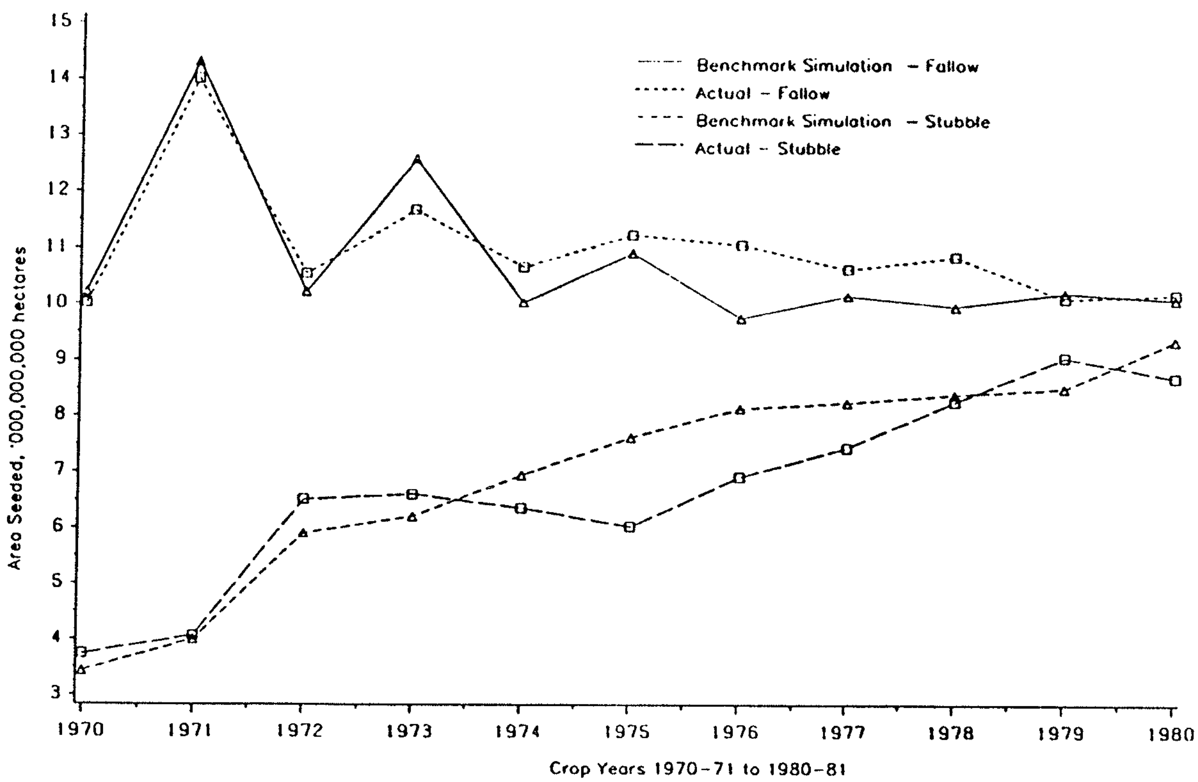


Figure 4.2
Area Seeded on Fallow and Stubble Seedbed
For the Five Principal Crops in Western Canada
1970-71 to 1980-81, '000,000,000 hactares



Although errors occurred in both fallow and stubble forecasts in years other than 1976, 1978 and 1980, the addition of the two seedbeds cancelled the error's effect on the direction of change of total seeded area. The turning point errors for both seedbeds are primarily caused by overestimation of total seeded area.

For fallow[34] in 1977, the total area is overestimated and stubble seeded area is underestimated in comparison to actual values. This results in more land allowed to rest than historically occurred in 1977 and 1979.

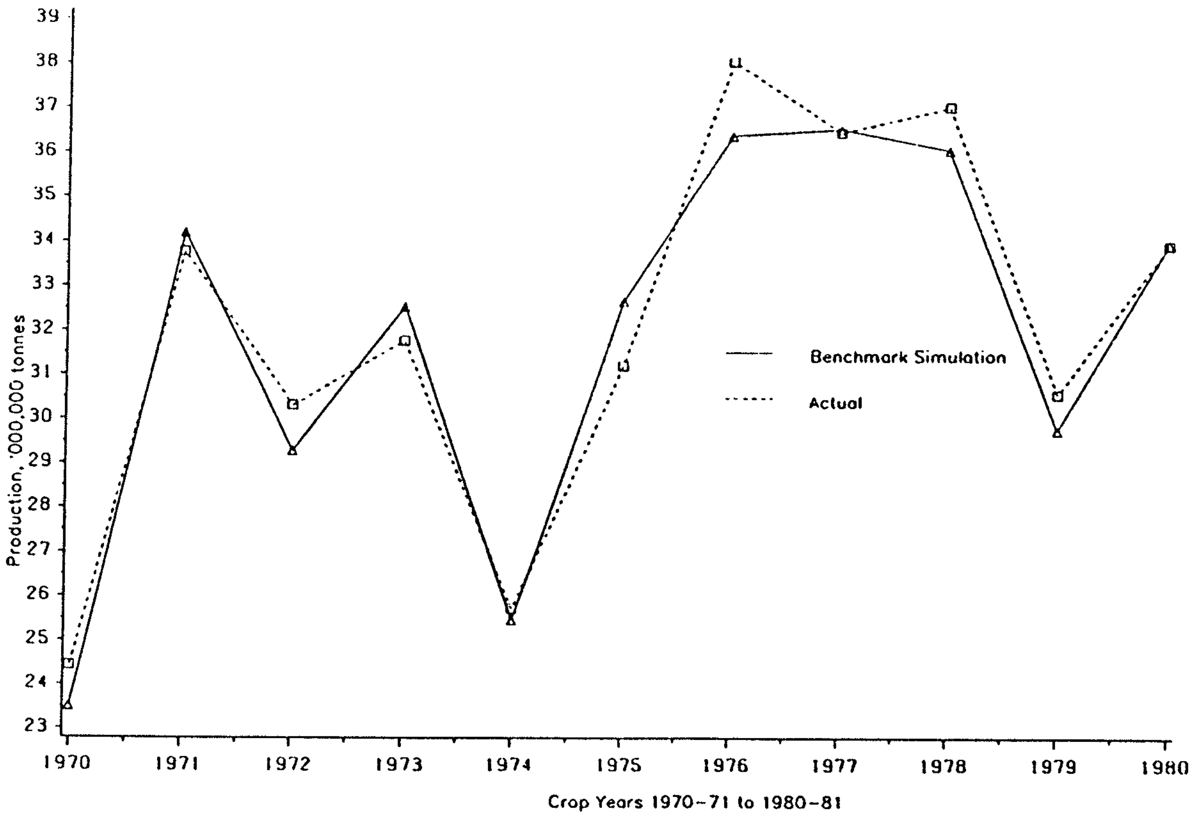
The turning point errors for total seeded area caused errors in forecasting fallow area seeded in 1978 and 1980. The total area seeded in 1976 and 1980 is incorrectly predicted to decrease and the predicted stubble seeded area is underestimated in 1977 and 1979. As a result, fallow seeded area is forecasted to decrease because less land is available for seeding.

Changes in direction are incorrectly forecasted for total production largely because of turning point errors on fallow seeded area (see Figures 4.1 to 4.3). As production equals predicted area seeded times historical yields by seedbed, the negative change in fallow area in 1977 results in less seeding of higher yielding fallow land with a corresponding decrease in production. Similarly, production rose in 1978 although total seeded area is underestimated because of increased cultivation of higher yielding fallow land.

---

[34] Fallow area is defined as a function of total area from two years previous and stubble area from the previous year.

Figure 4.3
Total Production for the Five Principal Crops in Western Canada
1970-71 to 1980-81, '000,000 tonnes



The remaining seedbed turning point errors caused either an over- or underestimation of production rather than incorrect changes in production. This is due to shifts in the share in total cultivated area between seedbeds given historical yields. For example, total production increased in 1976 but the level of production is underestimated because the increase in lower yielding stubble area is insufficient to offset the loss in production from a decrease in higher yielding fallow area.

In addition to differences in share of cultivated land by seedbed, the area seeded to each crop affected production because of the difference in yields between crops. The mix of crops is briefly discussed because of crop mix changes in Scenario Two simulations. Turning point errors are identified in Table 4.2 but are not explicitly analyzed as the simultaneous allocation of land makes it impossible to identify the source of the error. Predicted and actual crop production are indicated in Figures 4.3.1 to 4.3.5.

Table 4.2

Turning Point Errors in Benchmark Crop Production Forecasts

	Year	Predicted Direction of Change
Wheat	1972, 1978	-,-
Oats	1976	-
Barley	1976, 1978	-,+
Rapeseed	1971, 1973, 1974, 1979	-,+,+,+
Flaxseed	--	

Figure 4.3.1
Total Wheat Production in Western Canada, by Crop
1970-71 to 1980-81, '000,000 tonnes

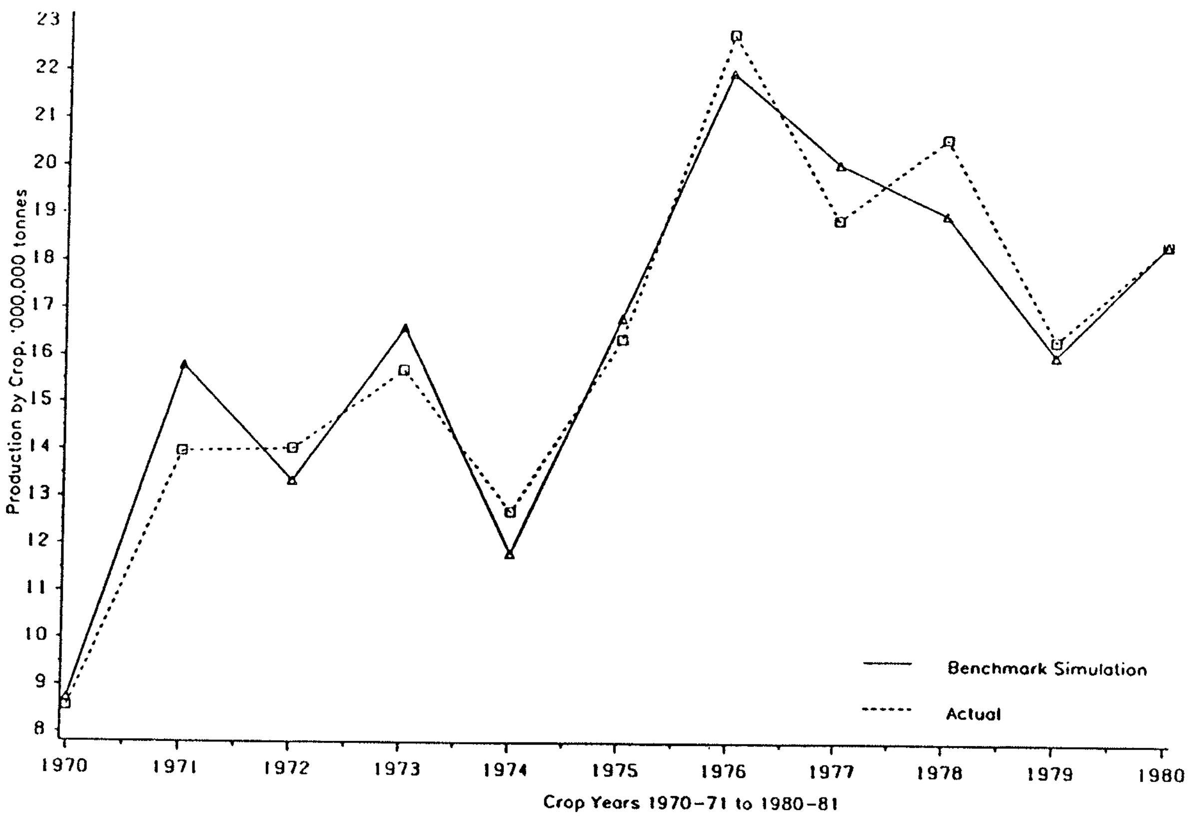


Figure 4.3.2
Total Oats Production in Western Canada, by Crop
1970-71 to 1980-81, '000,000 tonnes

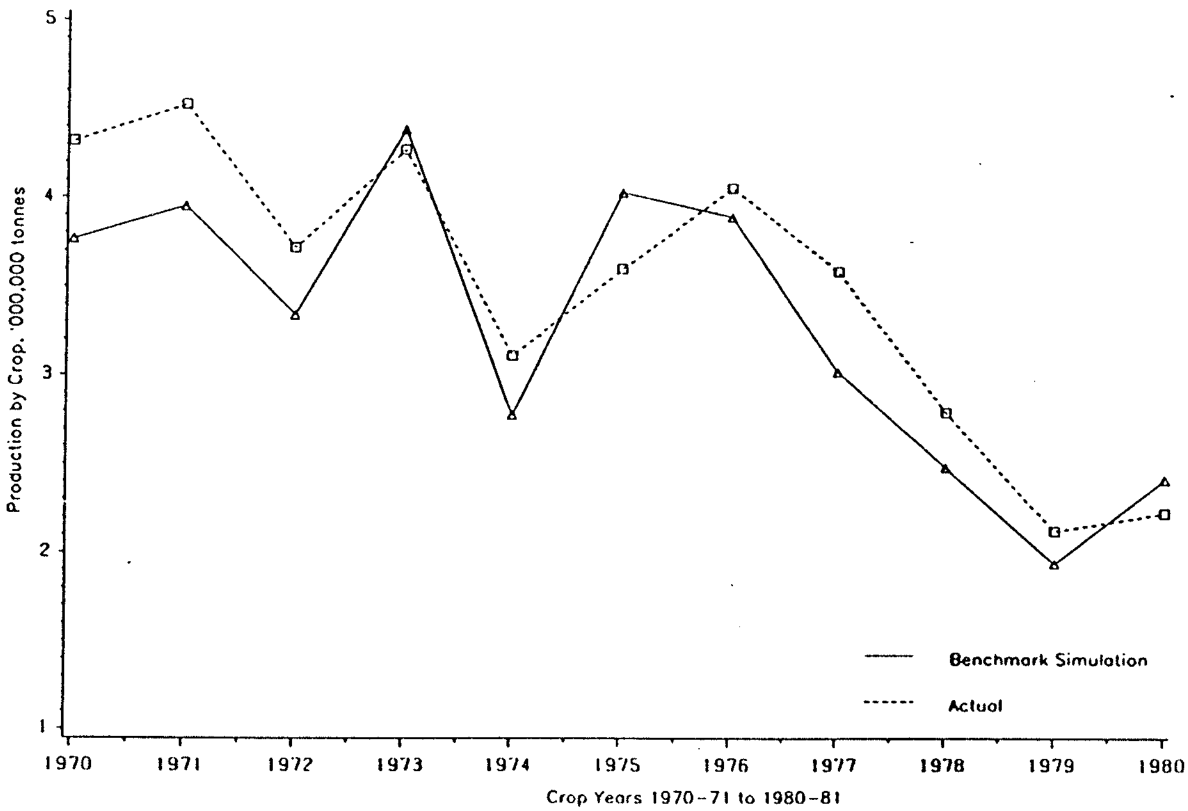


Figure 4.3.3
Total Barley Production in Western Canada, by Crop
1970-71 to 1980-81, '000,000 tonnes

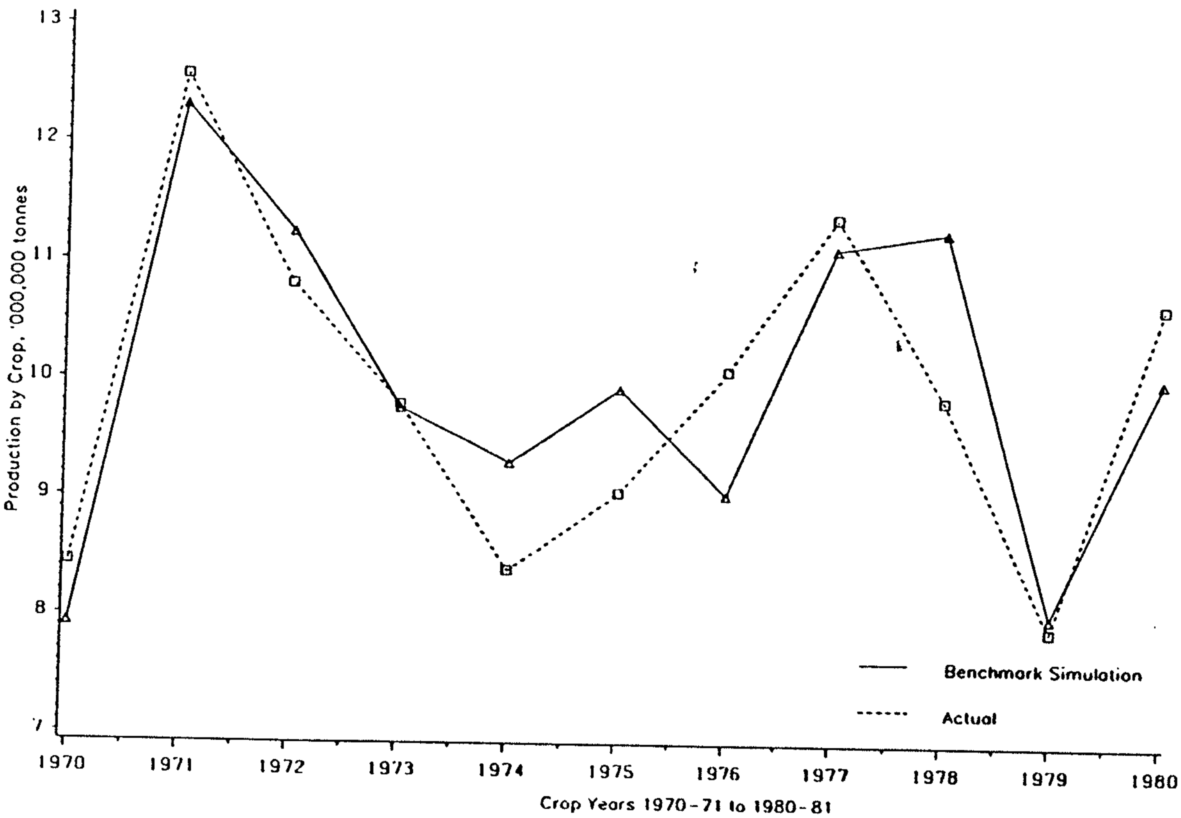


Figure 4.3.4
Total Rapeseed Production in Western Canada, by Crop
1970-71 to 1980-81, '000,000 tonnes

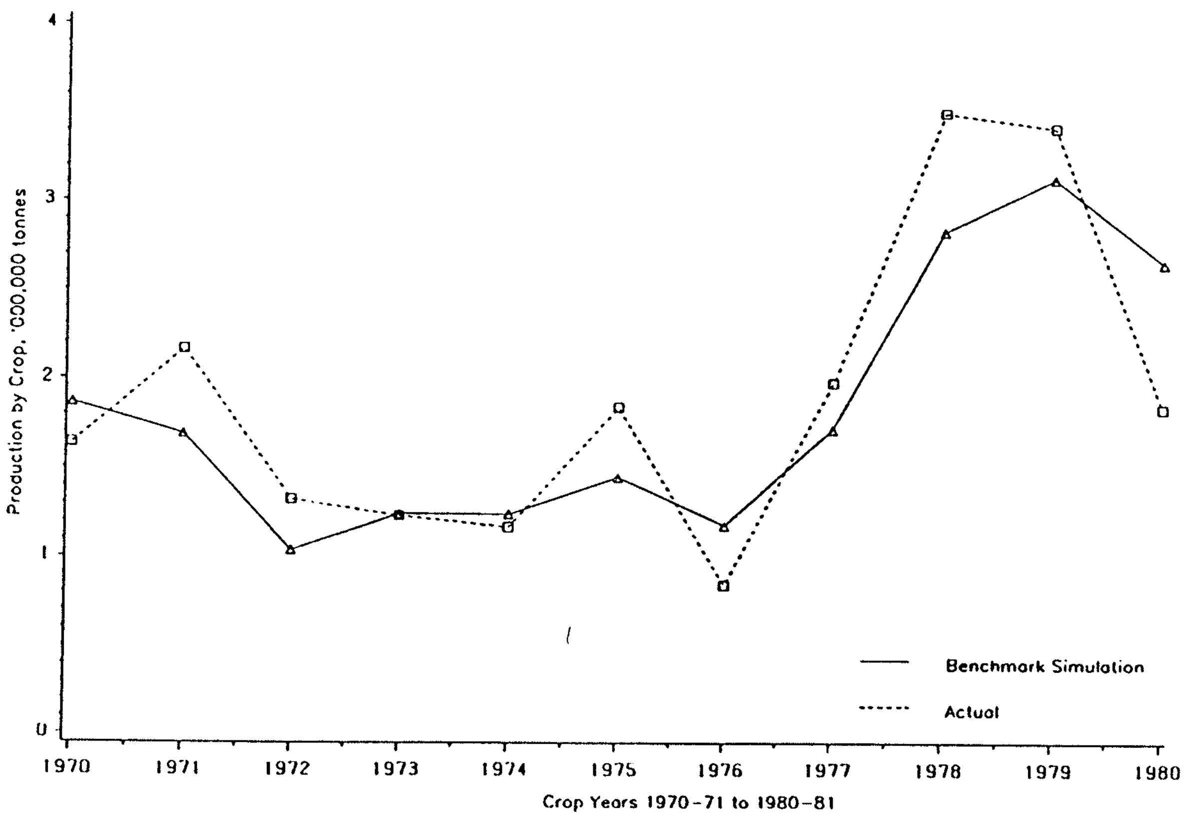
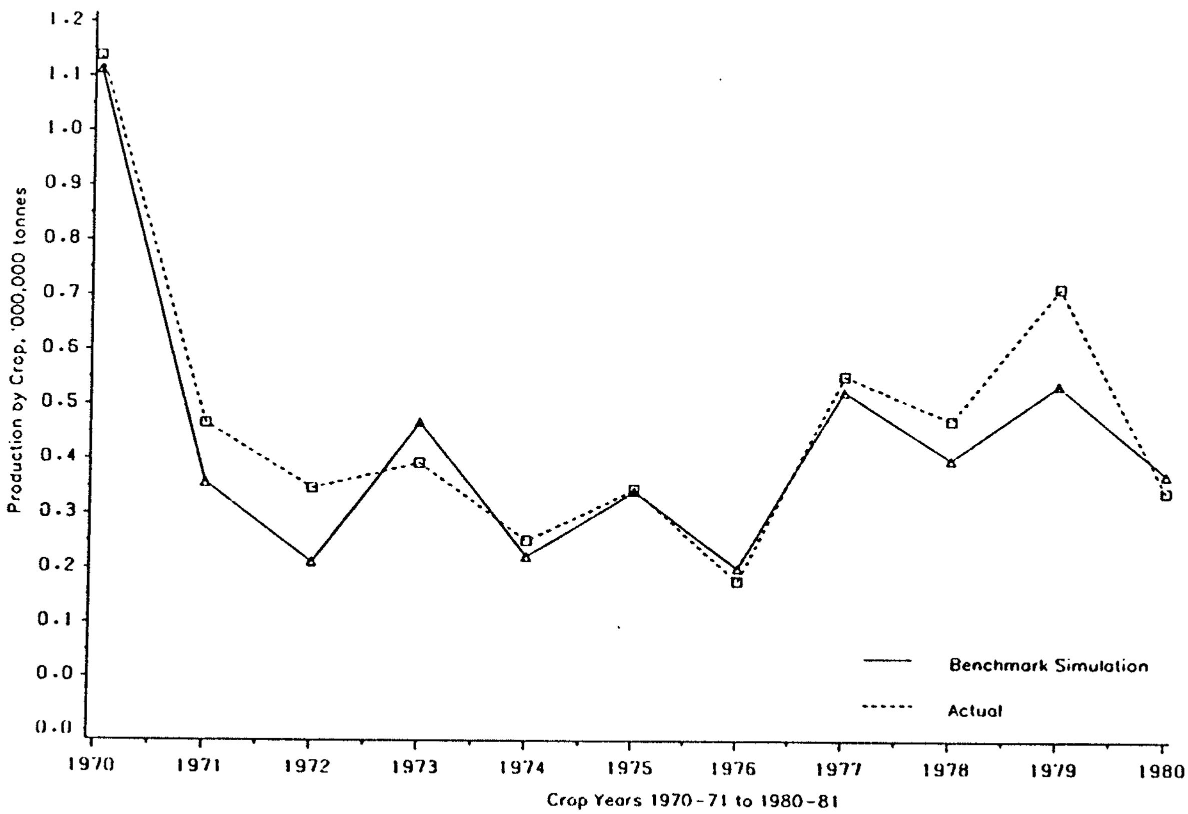


Figure 4.3.5
Total Flaxseed Production in Western Canada, by Crop
1970-71 to 1980-81, '000,000 tonnes



Production forecasts affect carryover and exports because both are derived from production. The minimum inventory producers are willing to carryover, domestic consumption, and seed and dockage are subtracted from production plus August 1 carryovers to give the volume of grain available for export. Exports are defined to be equal to the capacity of the market system if the volume of grain available to export is greater than or less than the system capacity. Grain in excess of the capacity is stored on farms. Alternatively exports are equal to the available supply if grain available for export is less than the system capacity.

As shown in Figure 4.4, the direction of change in carryover is correctly predicted in all years except 1972 and 1974. In both years the turning point error is largely due to an overestimation of production as marketings are close to actual levels. Production is overestimated because total seeded area is overestimated. As a result, the forecasted excess is stored causing on-farm carryovers to increase at a time when actual carryovers declined. Although carryovers tended to be overestimated from 1972 to 1976, no major bias existed in the latter seventies.

Two out of three incorrect changes in direction for total marketings are between 1975 and 1980. Total marketings are predicted to decrease in 1972, 1976 and 1978 as indicated in Figure 4.5. The errors in the first two years are caused by an underestimation of available supply. Available supply is underestimated primarily because production is underestimated in both years. In 1980, the error is due to an underestimation of system capacity as available supply is close to actual values.

Except for 1973, export marketings are correctly forecasted as shown in Figure 4.6. The positive increase in export marketings is caused by

Figure 4.4
August 1 Carryover for the Five Principal Crops in Western Canada
1970-71 to 1980-81, '000,000 tonnes

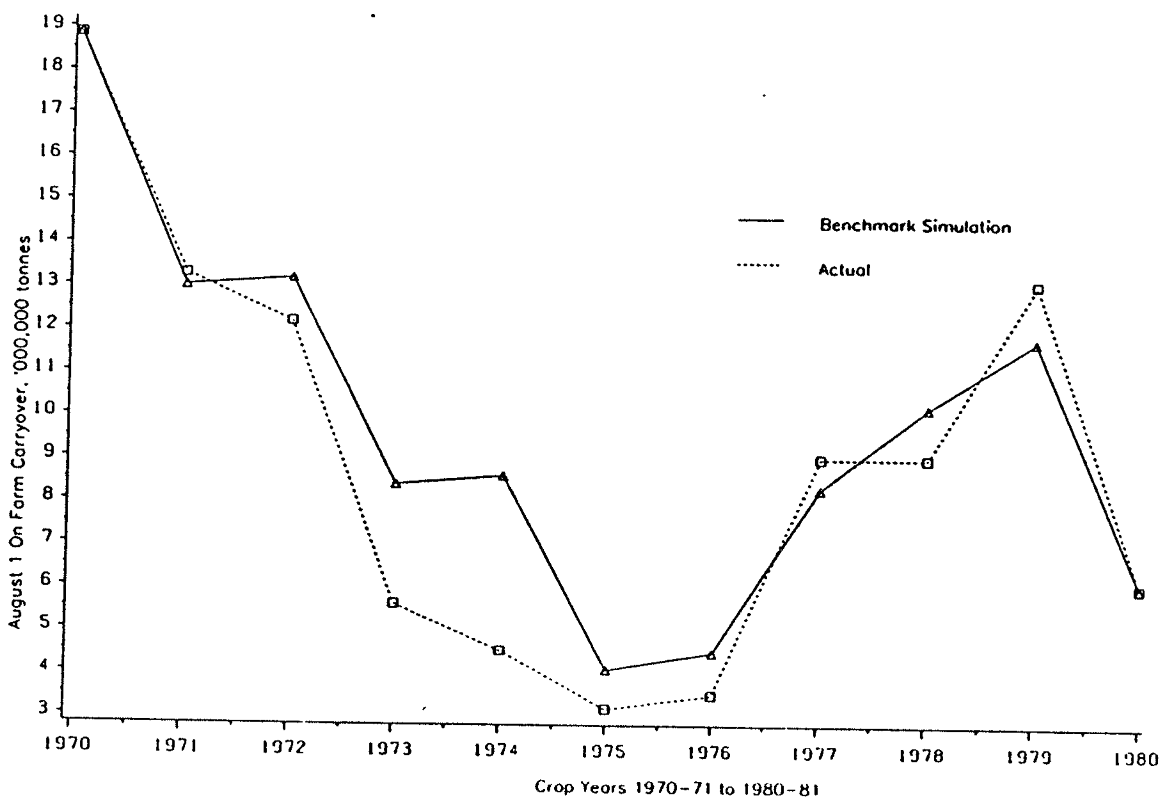


Figure 4.5
Total Marketings for The Five Principal Crops in Western Canada
1970-71 to 1980-81, '000,000 tonnes

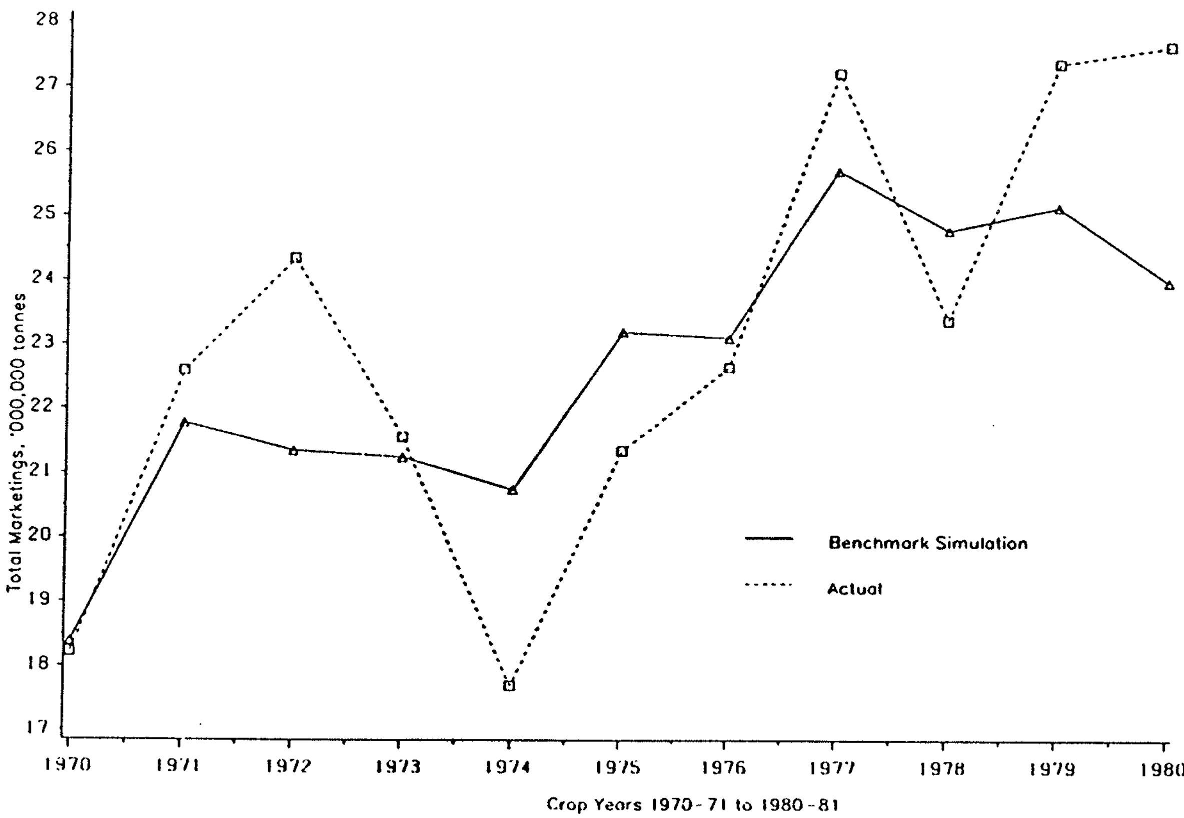
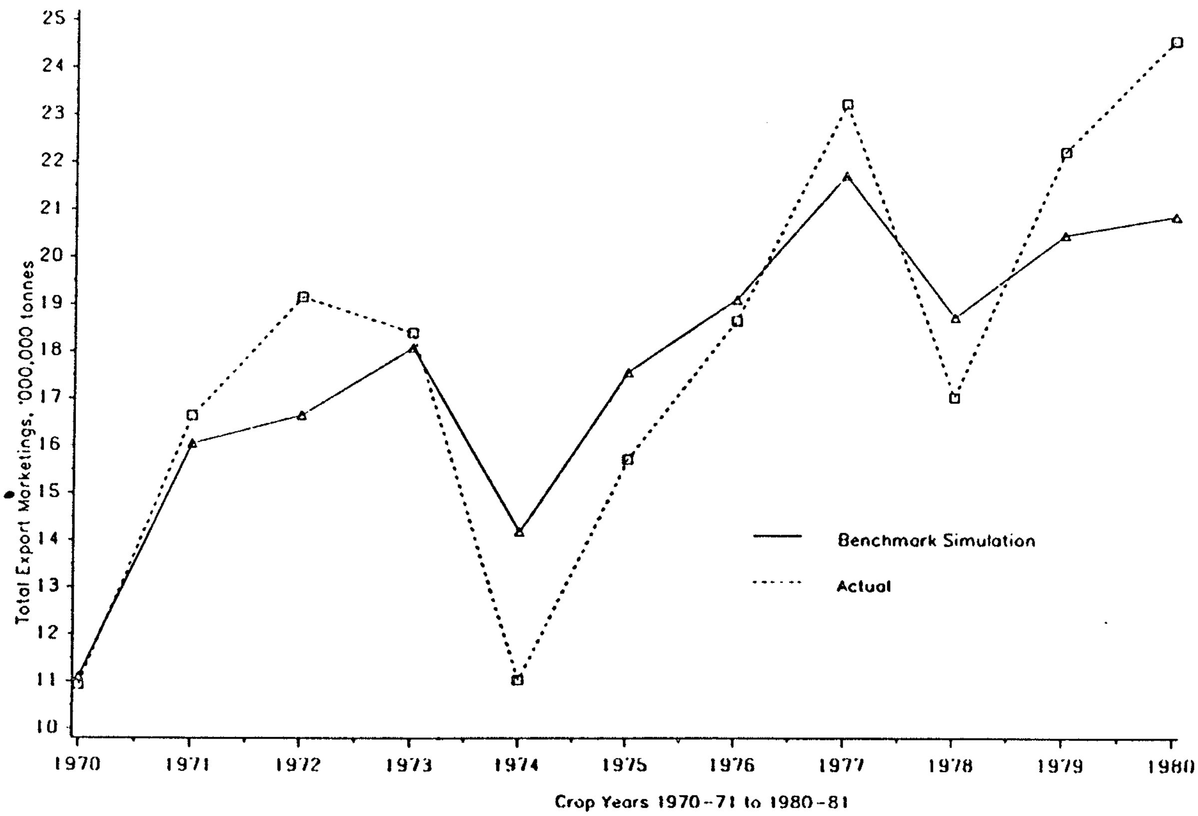


Figure 4.6
Total Export Marketings for The Five Principal Crops in Western Canada
1970-71 to 1980-81, '000,000 tonnes



an overestimation of production. This inflated both exports and carryovers as domestic requirements are held at historical levels. There is no clear estimation bias or turning point errors from 1975 to 1980.

Turning point errors occurred in only the 1978 forecast of gross margin (see Figure 4.7). Gross margin incorrectly increased because revenue is overestimate due to overestimated grain exports, and variable costs are underestimated as less land is seeded. Simulated gross margins are quite accurate (U=0.39) with little bias in estimation.

In summary, the forecasting performance of the econometric models used in Simulation One, Scenario One is satisfactory. The accuracy of the simulation as measured by Theil's inequality coefficient is in an acceptable range for all major components. The econometric models are able to correctly predict the realized direction of change in most years. Incorrect changes in direction are explained by the predictive performance of relevant components of the econometric models. Based on this review, the forecasting performance of the econometric models is sufficiently acceptable that the benchmark simulation is used to measure the impact of changes in producer behaviour in the production and benchmark simulations in Scenario Two.

4.1.1 Comparison of Production and Benchmark Simulations

In the production simulation, system capacity is set at a sufficiently high enough level from 1975 to 1980 to clear excess availability supply. As a result, grain inventories decrease to and remain at the minimum levels producers are willing to carryover (see Figure 4.8). The most significant impact is expected in 1979 as the stock decrease is greater than in any other year (approximately nine million tonnes).

Figure 4.7
Gross Margin for The Five Principal Crops in Western Canada
1970-71 to 1980-81, $ billions

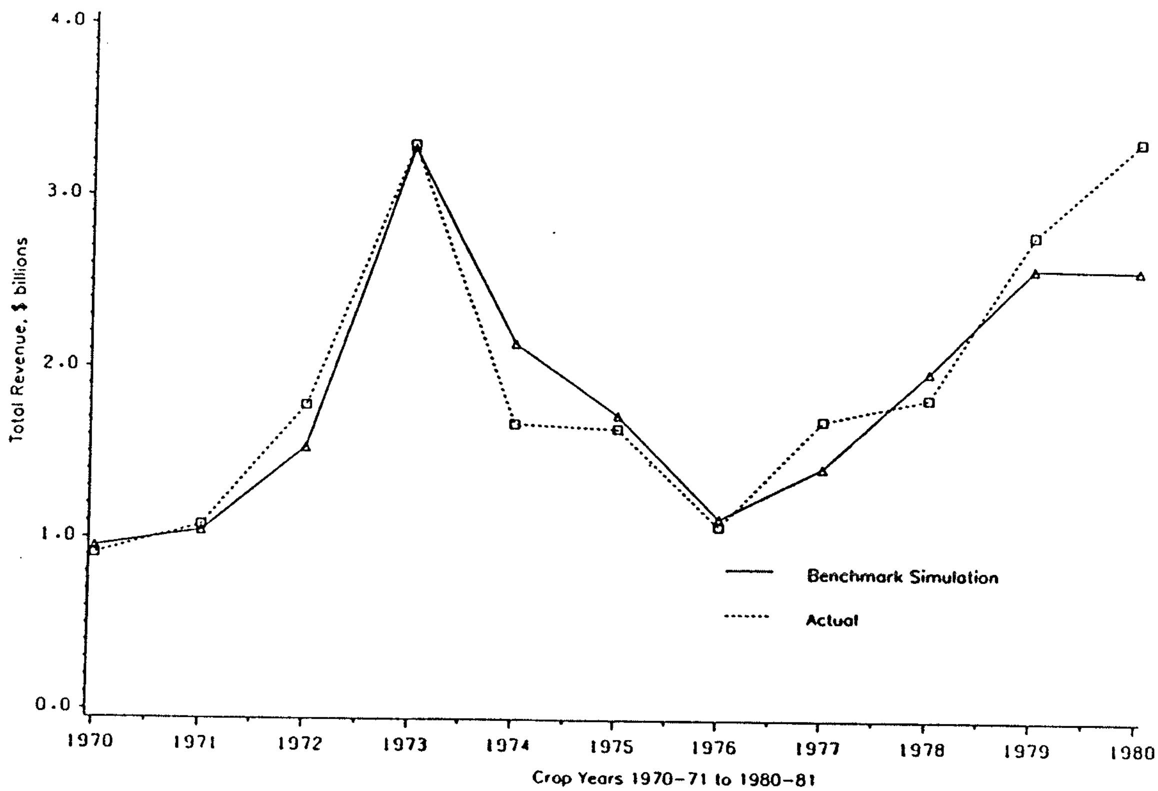
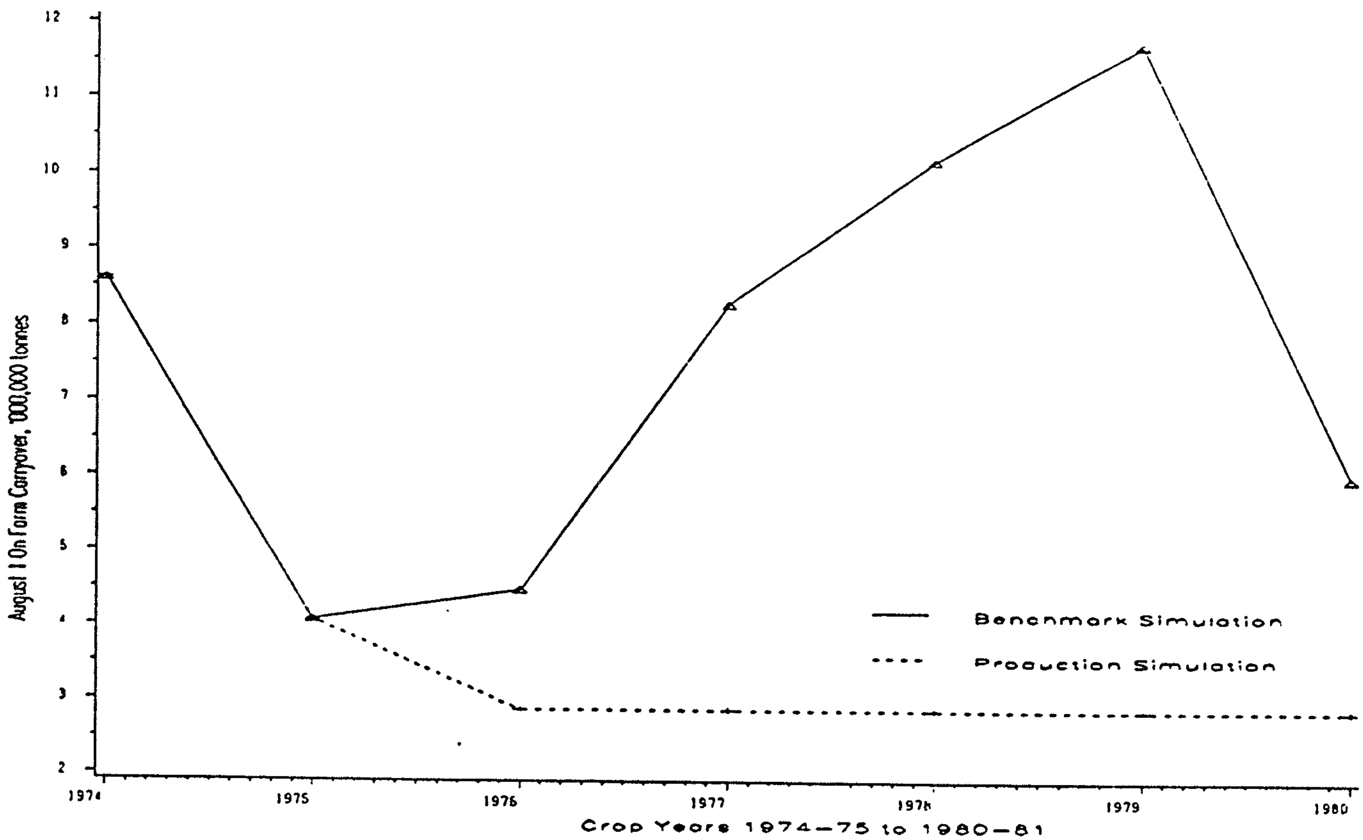


Figure 4.8
August 1 Carryover for the Five Principal Crops in Western Canada 1974-75 to 1980-81, '000,000 tonnes



The impact of reducing grain inventories is reflected in the total area seeded to the five principal grains as shown in Figure 4.9. Predicted total area seeded followed the same general trend as historical area except in 1980, but is above benchmark levels in all years. Total area seeded is forecasted to peak at 19.5 million hectares in 1980. This is approximately 60 thousand hectares above the corresponding benchmark level.

The size of the decrease in grain carryover proportionately affected the increase in area seeded. For example, the largest decrease in grain inventories occurred in 1979 with the largest increase in area seeded occurring in the same year (an additional 730 thousand hectares). Conversely, the incremental increase in predicted area seeded is relatively slight in 1980 as a relatively small excess inventory existed.

The changes in simulated area seeded on fallow and stubble occurred as anticipated (see Figure 4.10). The area seeded on stubble seedbed increased above benchmark levels at an increasing rate until 1980. As noted earlier, the size of the increase in stubble area is related to the size of the decrease in carryover. The area seeded on fallow declined at an increasing rate throughout the time period. More land is predicted to be continuously cultivated and additional land (previously used to grow other crops) is being seeded to the five principal crops, as the increase in stubble area seeded is greater than the decrease in fallow area seeded in all years.

The change in cultivation plans results in seeded stubble area reaching the highest level in 1980. Seeded stubble area is forecasted to reach 10.2 million hectares compared to a benchmark level of 9.4 million hectares. Seeded fallow area is correspondingly predicted to fall to 9.3 million hectares from a benchmark level of 10.1 million hectares.

Figure 4.9
Area Seeded to the Five Principal Crops in Western Canada
1974-75 to 1980-81, '000,000,000 hectares

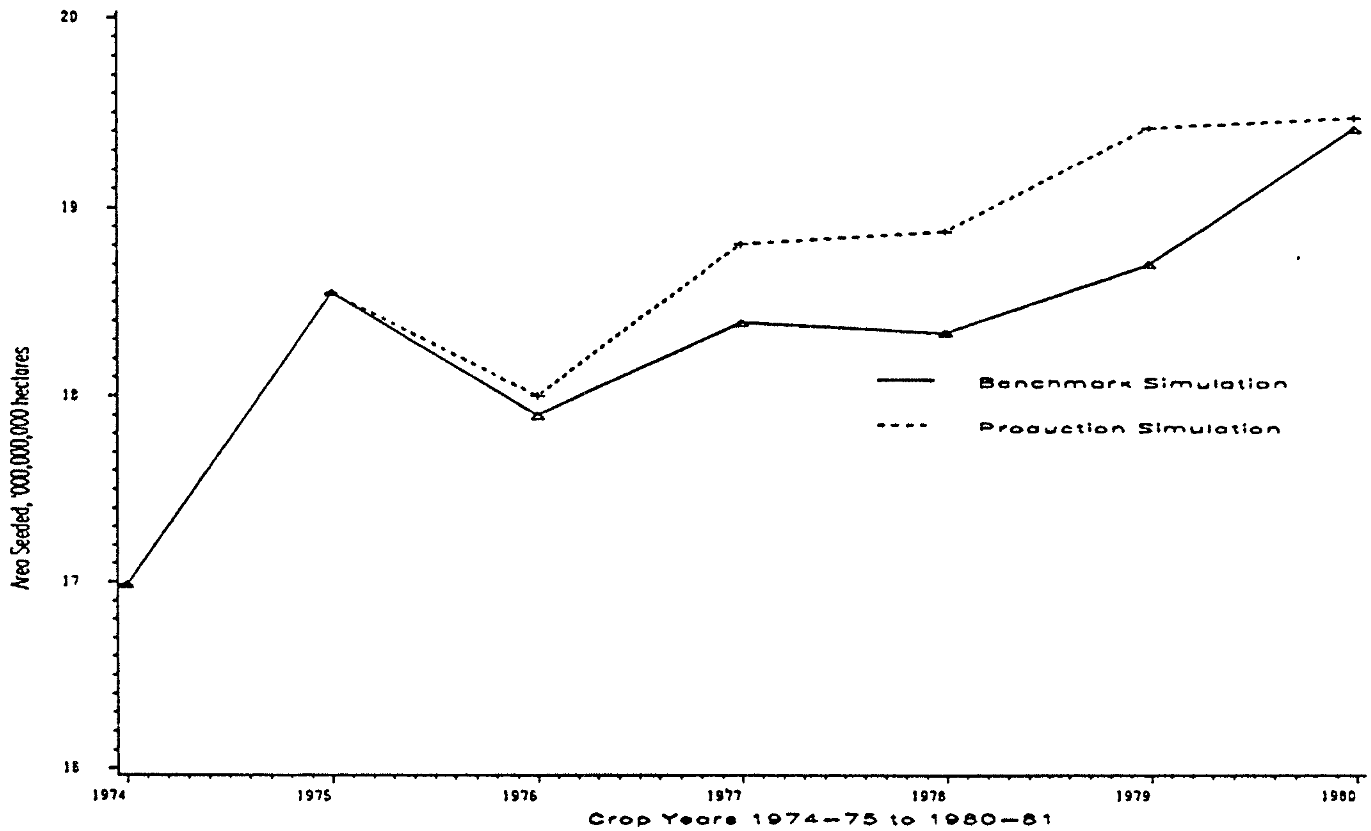
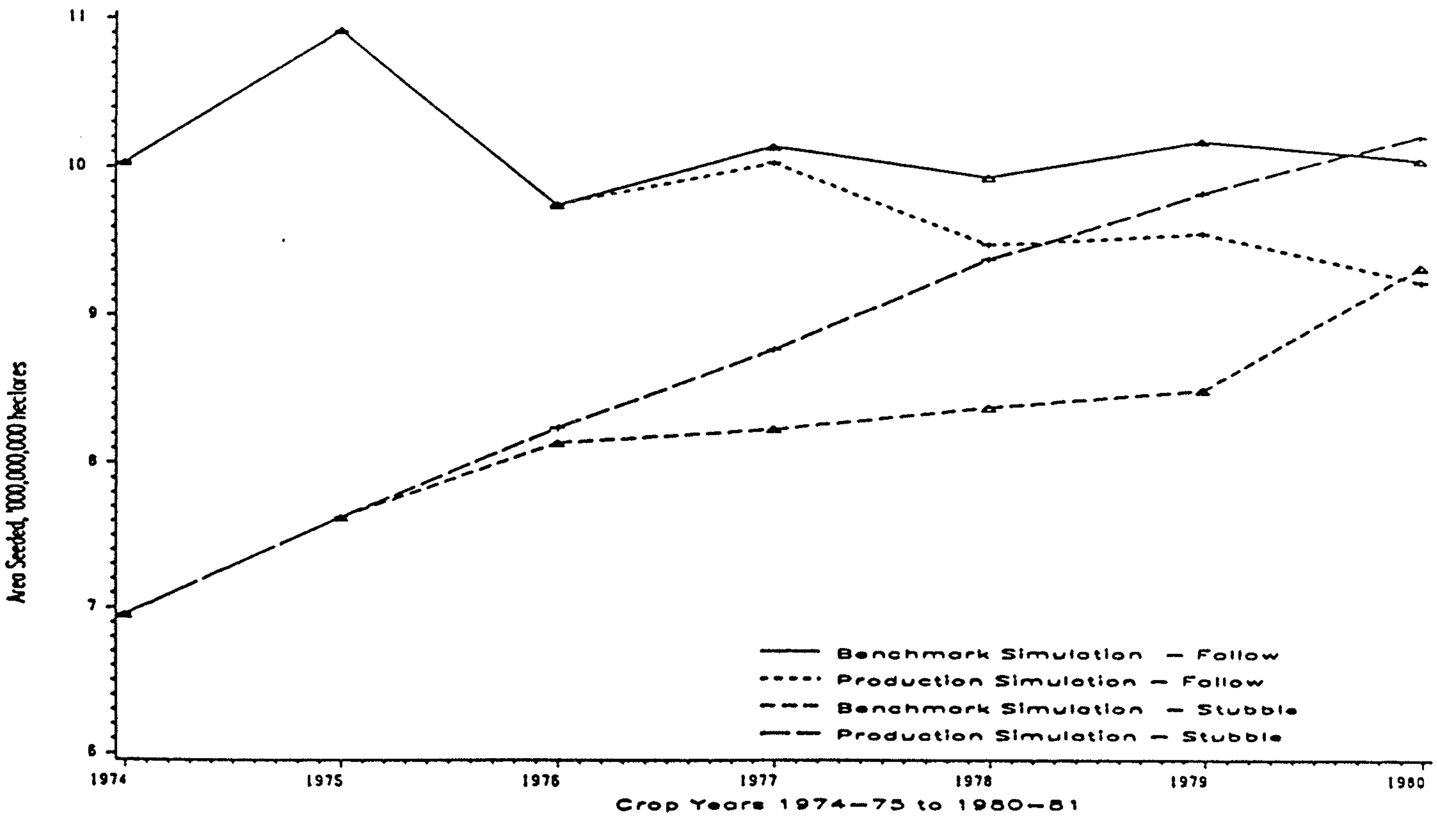


Figure 4.10
Area Seeded on Fallow and Stubble Seedbed
For the Five Principal Crops in Western Canada
1974-75 to 1980-81, '000,000,000 hectares



Although predicted total area seeded increased in all years, forecasted production is less than benchmark production in 1975, 1976 and 1980 and greater than benchmark production from 1977 to 1979 (see Figure 4.11). The decrease in total production is primarily due to the relative changes in area seeded by crop given historical yields (see Table 4.2). In both 1975 and 1980, rapeseed accounted for the largest increase in predicted area seeded while barley area seeded experienced the largest decrease. Aggregate production fell in both years as rapeseed yields are approximately half of barley yields. Similarly, aggregate production is reduced in 1976 because the increase in production due to more area seeded to lower yielding wheat is insufficient to offset the decrease in production from less area seeded to higher yielding barley.

Change in the area seeded, given historical yields, is also the reason predicted production increased above benchmark levels from 1977 to 1979. Wheat and barley production increases are more than sufficient to offset the production decrease in the other three crops for 1977. In the following two years, wheat and oats accounted for production increases above the benchmark level.

Table 4.3 also shows the change in crop mix that is predicted to occur relative to the benchmark. In most years, wheat area seeded is forecasted to increase while barley area is predicted to decrease. Area seeded to oilseeds is predicted to increase at the beginning and end of the period and decrease from 1977 to 1979. Oats area is forecasted to fluctuate considerably over the six years. The change in mix suggests that producers diversified by growing more barley and oilseeds during periods of high carryovers. Removal of these constraints results in further specialization in wheat.

Figure 4.11
Total Production for the Five Principal Crops in Western Canada 1974-75 to 1980-81, '000,000 tonnes

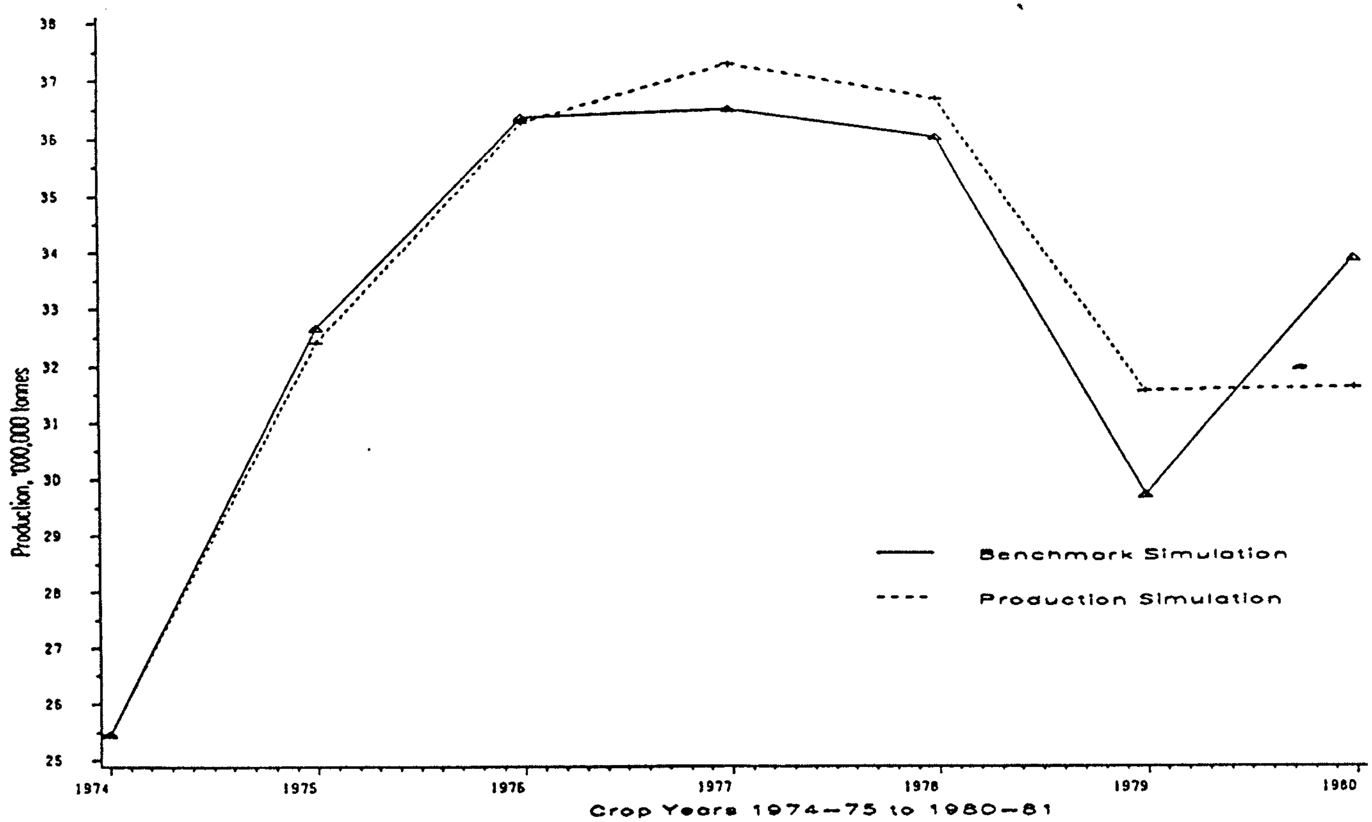


Table 4.3

Change in Area Seeded and Absolute Yields by Crop
Production Minus Benchmark Simulation

1975-1980

Year	Wheat	Oats	Barley	Rapeseed	Flaxseed	Total
			Change in Area Seeded - 000 hectares -			
1975	- 20	- 30	- 240	240	30	- 20
1976	280	220	- 510	110	20	120
1977	500	- 30	80	- 40	-90	420
1978	650	80	- 220	- 30	-80	400
1979	1,230	500	- 200	- 800	-60	670
1980	840	-270	-1,940	1,300	90	20
			Weighted Yields - kg. per hectare -			
1975	1,800	1,900	2,100	1,000	790	
1976	2,000	2,100	2,400	1,200	850	
1977	1,900	2,100	2,500	1,400	1,100	
1978	2,000	2,000	2,400	1,200	1,100	
1979	1,600	1,900	2,200	1,000	870	
1980	1,700	2,000	2,400	1,200	800	

(a) Actual yields are used in both simulations.

This tendency is reflected in total marketings and exports as illustrated in Figures 4.12 and 4.13. As the mix of crops is shifted to favour export crops, particularly wheat and in some years rapeseed, export marketings and consequently total marketings are predicted to increase above the respective benchmark value with the exception of 1979 and 1980. Both export and total marketings fell substantially in 1979 despite production increases relative to the benchmark. Marketings declined because of the substantial reduction in available supply caused by the reduction in on-farm carryovers that occurred with the removal of system constraints. Predicted export and total marketings are approximately equal to the benchmark marketings in 1980 due to decreases in both aggregate production and on-farm carryover.

Total marketings are predicted to peak in 1977 with the lowest level of marketings two years later. Forecasted marketings reach 28.3 thousand tonnes in 1977 and decline to 22.1 thousand tonnes in 1979. By comparison, benchmark marketings are 25.7 and 25.1 thousand tonnes.

The changes in predicted total marketings are reflected in the gross margin (see Figure 4.14). Predicted gross margin exceeded benchmark gross margin in all years except 1979 because of increased production of higher valued grains, such as wheat, and increases in overall production. The 1979 decrease in gross margin reflects the decrease in total and export marketings caused by the lower available supply noted earlier.

It should be noted that the decrease in production and exports for 1980 is predicted to result in a higher gross margin than occurred in the benchmark simulation. This is due to a shift in mix of crops produced to favour the relatively more profitable grains as production is close to benchmark levels.

Figure 4.12
Total Marketings for The Five Principle Crops in Western Canada
1974-75 to 1980-81, '000,000 tonnes

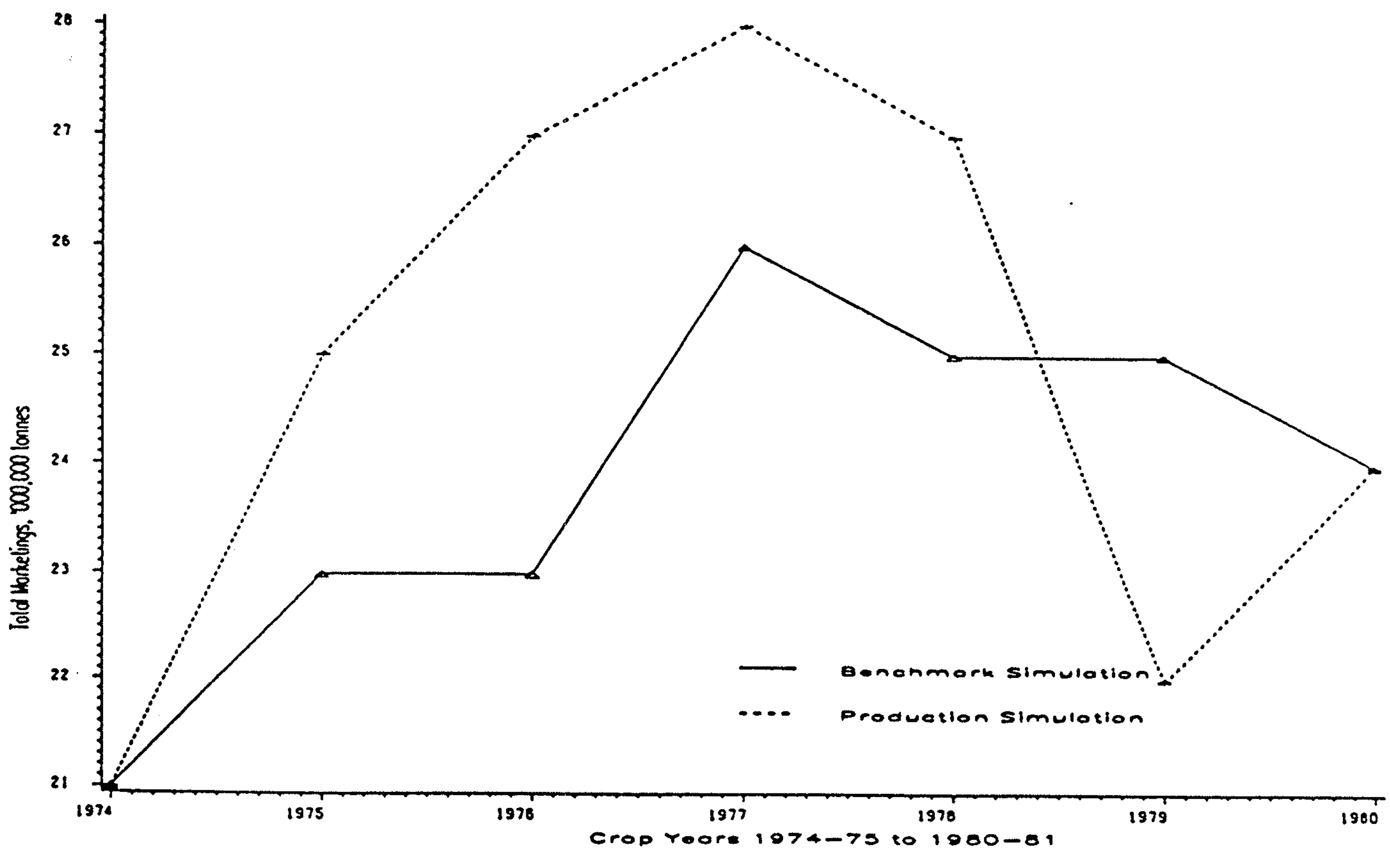


Figure 4.13
Total Export Marketings for The Five Principal Crops in Western Canada
1974-75 to 1980-81, '000,000 tonnes

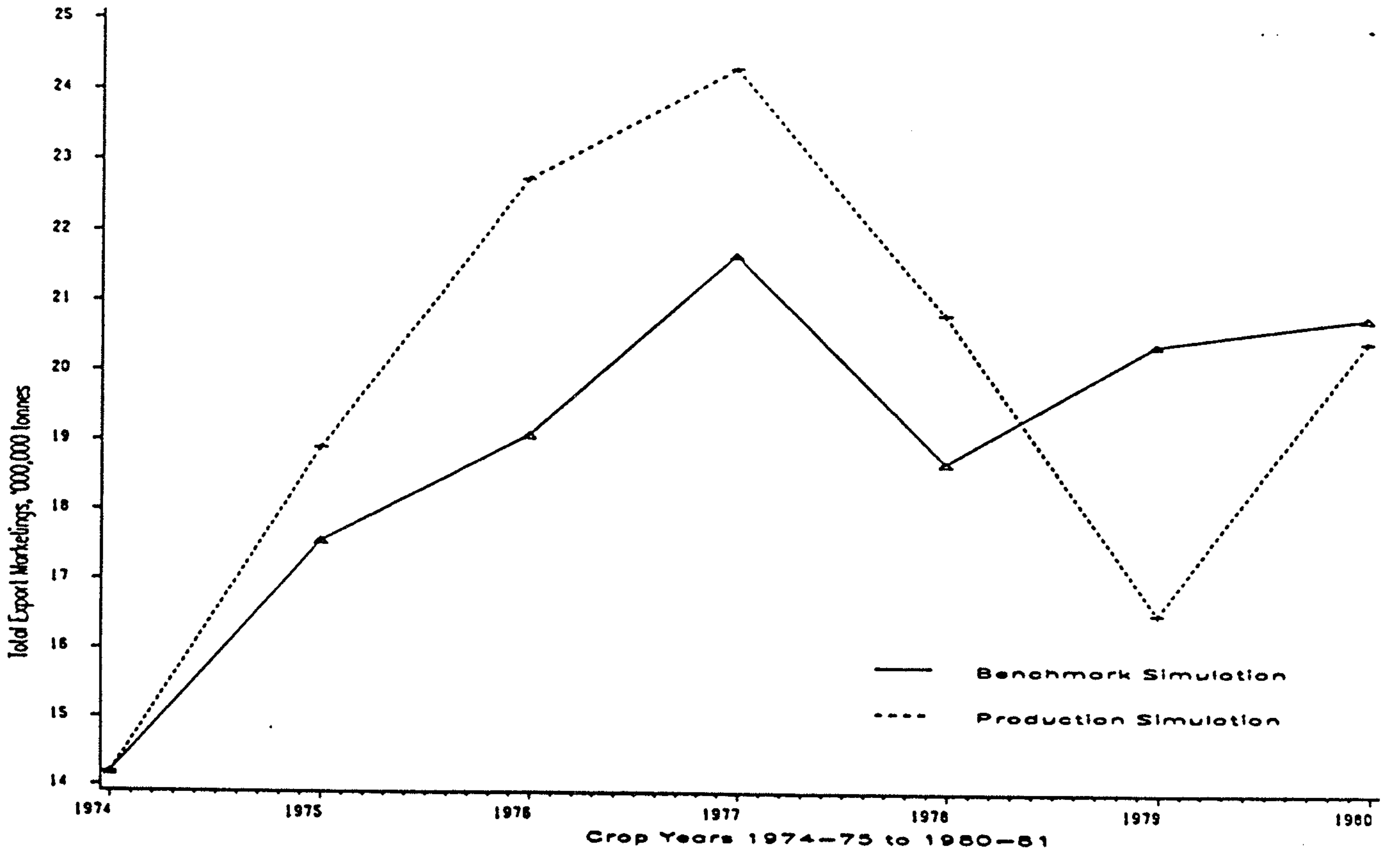
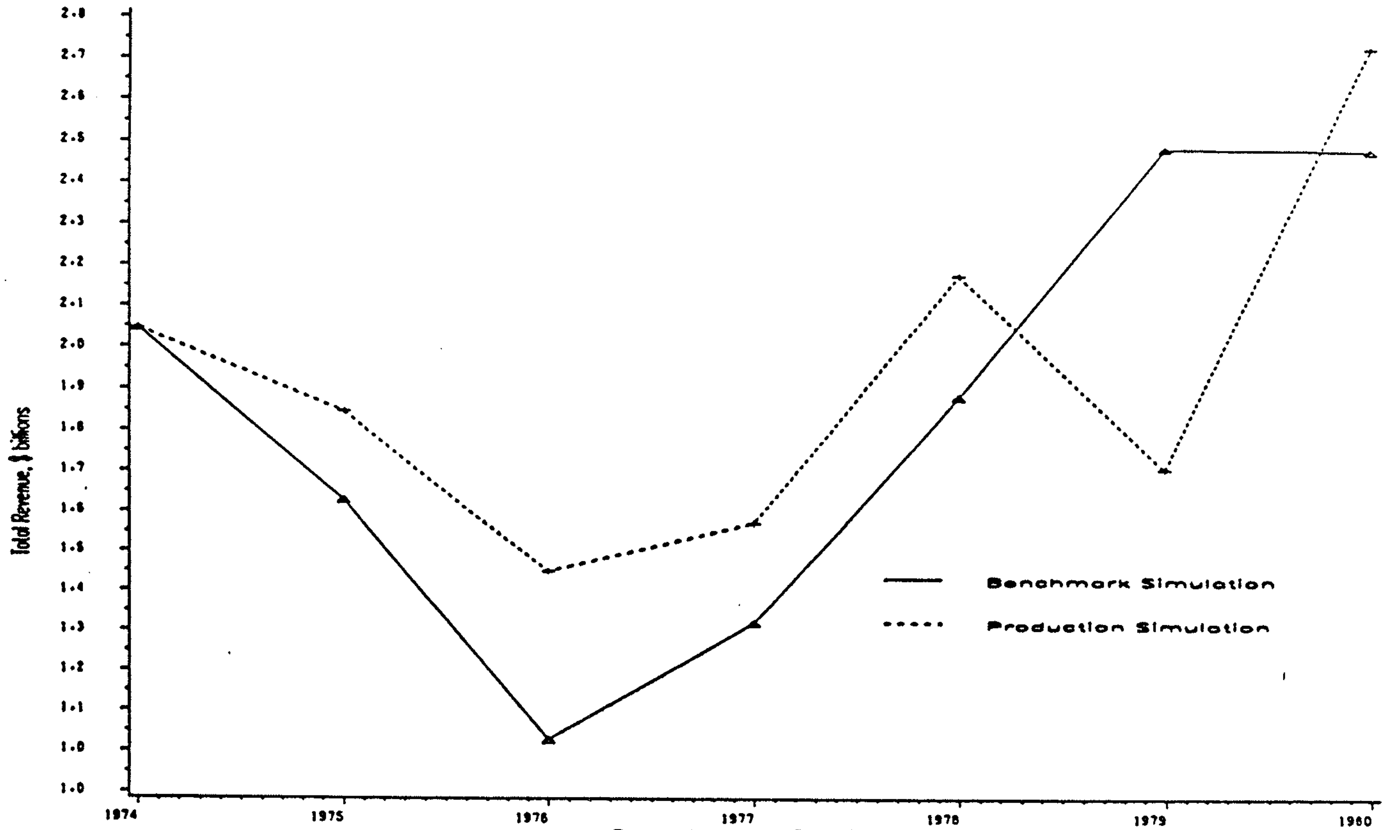


Figure 4.14
Gross Margin for The Five Principal Crops in Western Canada
1974-75 to 1980-81, $ billions



Crop Years 1974-75 to 1980-81

The annual difference between production and benchmark gross margin is compounded to 1980 to give an overall estimate of the additional revenue gain (lost) due to the removal of transportation constraints. As shown in Table 4.4, gross margin is forecasted to increase by $1.1 billion above benchmark levels. This net increase is due to a compounded increase in revenues of $1.3 billion less a compounded increase in variable production costs of $270 million.

Table 4.4

Compounded Change and Sum of Compounded Change
Sales Revenues, Production Costs and Gross Margins
Production Minus Benchmark Simulation(a)

	Compounded Difference			Sum of Compounded Difference		
Year	Sales Revenue	Production Cost	Gross Margin	Sales Revenue	Production Costs	Gross Margin
			$ million			
1975	350	0	350	350	0	350
1976	640	10	620	980	20	970
1977	400	50	340	1,380	70	1,310
1978	420	60	370	1,800	130	1,680
1979	-770	100	-880	1,030	230	800
1980	290	40	250	1,320	270	1,050

(a) May not sum due to rounding.

Gross margin declined in only 1979. Because of the decline in grain available to export, sales revenues are predicted to fall below benchmark levels. The compounding the difference results in a sales revenue loss of $770 million plus additional production costs of $100 million. As a result, compounded gross margin declined by $880 million in 1979.

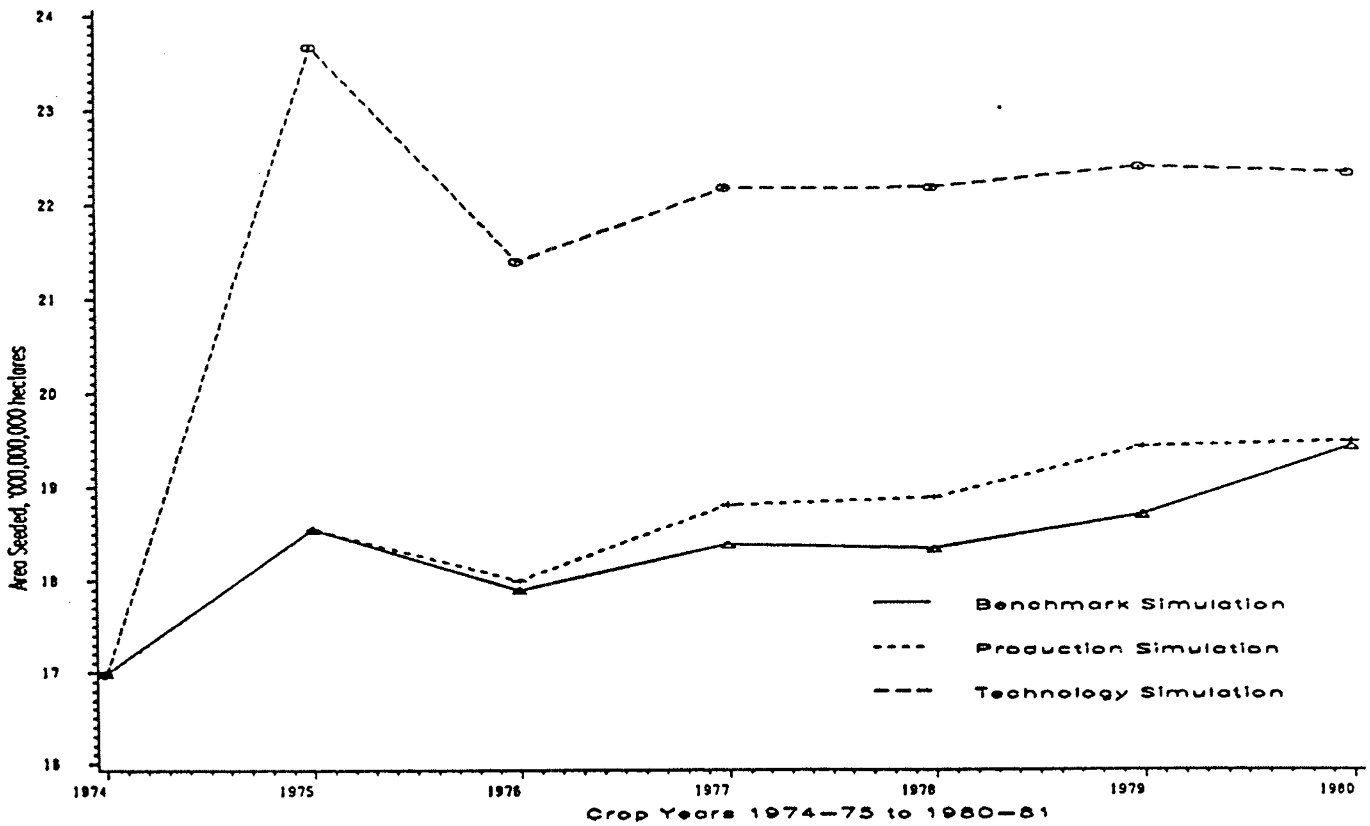
In summary, the comparison of production and benchmark simulations reveals many of the expected changes in aggregate area seeded, and supply and disposition. Total seeded area is predicted to increase due to a decrease in fallow area seeded combined with an increase in stubble seeded area. Forecasted production and marketings as well as export marketings are generally above benchmark levels except in 1979. Correspondingly, gross margin is forecasted to increase in all years except 1979 as the production of relatively more profitable grain is favoured. Gross margin is predicted to decline in 1979 due to less grain being available for export. Producers are forecasted to be $1.1 billion (1980 dollars) better off by 1980 with the provision of adequate transportation and handling capacity.

4.1.2 Comparison of Technology and Benchmark Simulations

The technology simulation includes the adjustment to system capacity used in the production simulation and an adjustment to reflect changes in the rate of adoption. The adoption rate is accelerated by increasing the rate of stubble area seeded and by increasing the rate of nutrient incorporation. These two adjustments increase production as more land is continuously cropped and yields are higher. The crop mix changes as accelerated yields affect the relative profitability between crops.

As shown in Figure 4.15, total cultivated area increased above benchmark levels from 1975 to 1980 while following the same trend as the production simulation. Forecasted area increased by approximately 20 percent above benchmark levels from 1976 to 1979 with increases of 28 and 15 percent, in 1975 and 1980. Total area seeded ranged from 23.7 to 21.4 million hectares. By comparison, 16.8 million hectares were seeded in 1985-86.

Figure 4.15
Area Seeded to the Five Principal Crops in Western Canada
1974-75 to 1980-81, '000,000,000 hectares



The increase in total seeded area primarily reflects increased continuous cropping and increased allocation of land previous seeded to the non-principal crops. Total area seeded on stubble seedbed is predicted to increase above benchmark levels (see Figure 4.16), while seeded fallow area is predicted to decline below benchmark levels in all years. However, the stubble area increase exceeds the fallow area decrease indicating that land previously seeded to other crops is being seeded to the principal crops.

Table 4.5

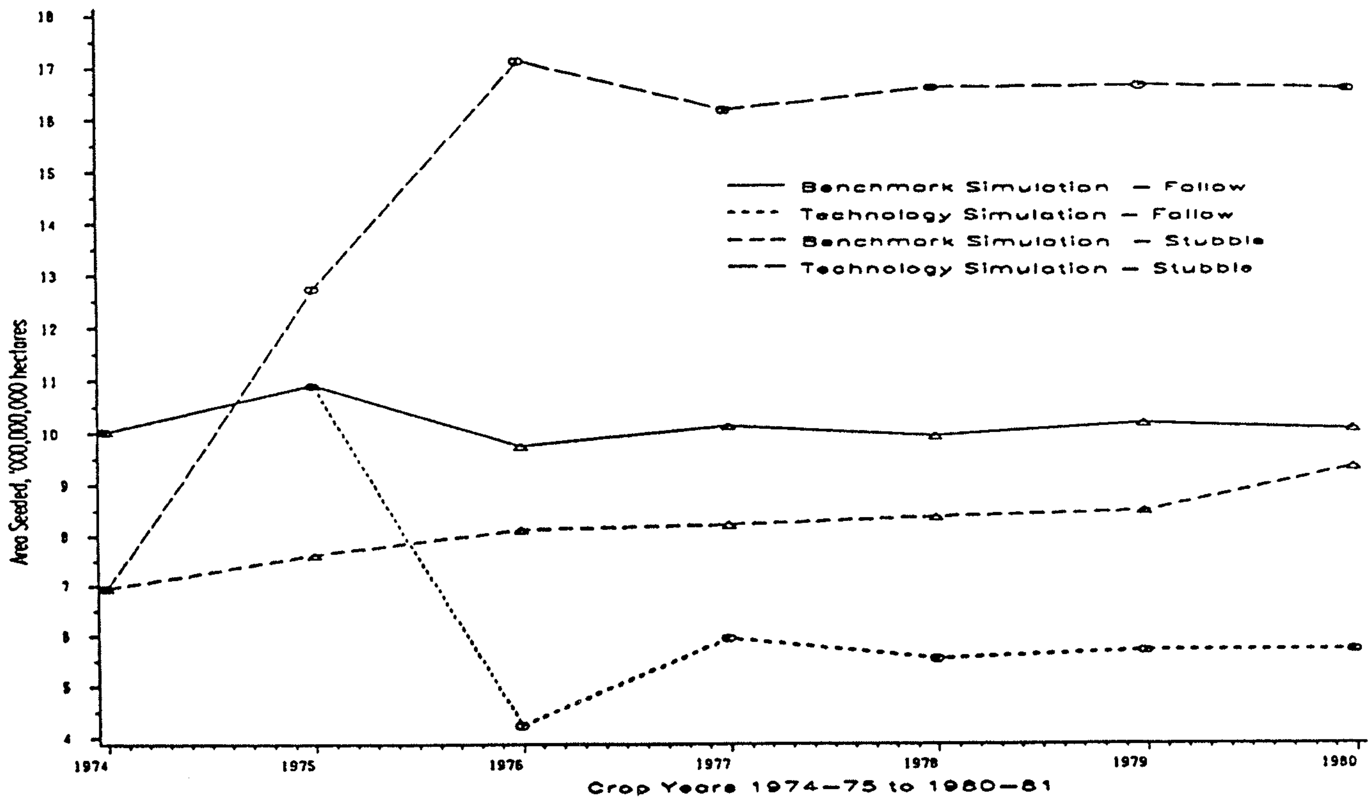
Change in Total Area Seeded
Technology Minus Benchmark Simulation

	Total	Manitoba	Saskatchewan	Alberta
		'000 hectares		
1975	5,130	420	3,680	1,020
1976	3,510	260	2,580	660
1977	3,790	350	2,590	850
1978	3,860	530	2,700	630
1979	3,710	600	2,470	640
1980	2,920	150	2,330	440

As indicated in Table 4.5, most of the increase in total area seeded occurred in Saskatchewan. For example, approximately 2.3 million hectares out of an additional 2.9 million hectares are seeded in Saskatchewan in 1980. Saskatchewan's contribution is largest primarily because of the higher historical level of summer fallowing.

An adjustment period occurs for both seedbeds in 1975 and 1976 after which seeded stubble and fallow area remain at fairly constant levels of approximately 16.6 and 5.7 million hectares. In 1975, stubble area

Figure 4.16
Area Seeded on Fallow and Stubble Seedbed
For the Five Principal Crops in Western Canada
1974-75 to 1980-81, '000,000,000 hectares



seeded increased as producers adopted minimum summer fallowing practises; however, fallow area is overstated as it is influenced by the total area from two years previous, stubble area from the previous year, and new land brought into production in the previous year. In the following year, fallow area is underestimated because it is derived based on 1975 stubble area. Forecasted stubble area is overstated in 1976 because it is a function of the 1975 total area seeded. As a result of the relative errors, total seeded area is overestimated in 1975 and underestimated in 1976.

Total forecasted production is significantly higher than benchmark production (see Figure 4.17). Forecasted production ranged from 42.0 million tonnes in 1977 to 34.3 million tonnes in 1980. By comparison, benchmark production ranged from 36.5 million tonnes in 1977 to 29.8 million tonnes in 1979.

Predicted total production roughly paralleled benchmark production in all years except 1976. Forecasted production declined in 1976 while benchmark production increased fairly significantly. The production decrease in the technology simulation reflects the underestimation of forecasted area seeded caused by an underestimation of seeded fallow area.

Total production is affected by changes in both area seeded and yields. Total area seeded is higher because of increased continuous cropping while yields are higher due to increased nutrient application. Higher yields and reduced carryovers also affect production by changing the relative profitability of crops between seedbeds which, in turn, alters the allocation of area between crops. As these factors simultaneously influence total production, production changes are difficult to attribute to a specific factor.

Figure 4.17
Total Production for the Five Principal Crops in Western Canada
1974-75 to 1980-81, '000,000 tonnes

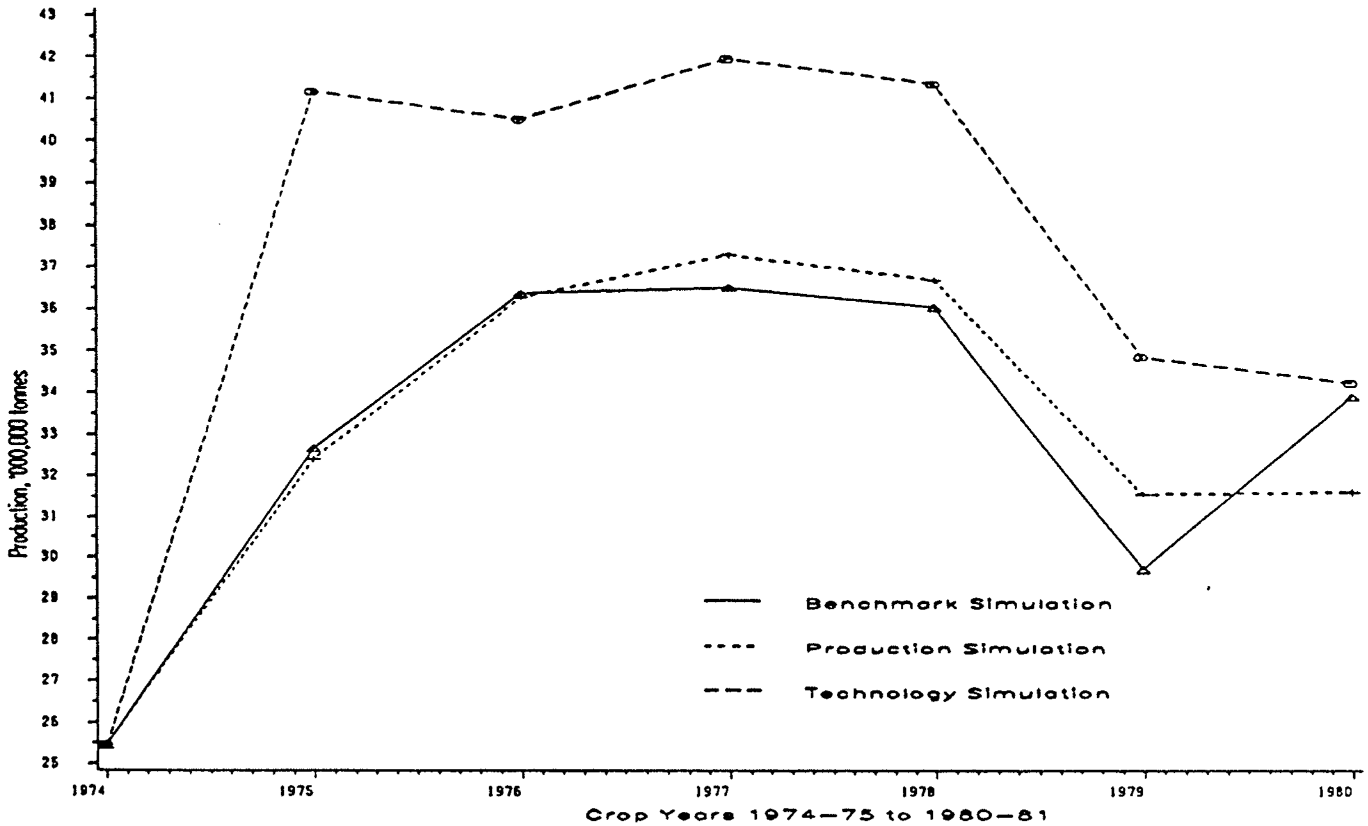


Table 4.6 indicates change in area seeded by crop between the technology and benchmark simulations. Predicted area seeded to wheat, barley and rapeseed generally increased above benchmark levels while oats and flaxseed declined below or remained near benchmark levels in all years. The increase in area seeded is greater than the decrease in area seeded as forecasted total area seeded expanded above benchmark levels.

The change in weighted yield by crop between the technology and benchmark simulation is also shown in Table 4.6. The largest change in yield is predicted for barley with relatively smaller changes in yields for wheat, oats, rapeseed, and flaxseed. Both rapeseed and wheat weighted yields decreased in each year.

Rapeseed weighted yields consistently decline relative to benchmark yields due to two major factors. First, the projected yields for rapeseed are set equal to the actual yields for 1975 to 1980 for rapeseed seeded on both seedbeds. Actual yields are used because producers incorporate nutrients at levels reasonably close to recommended levels.[35] Therefore, the yield response is relatively insignificant if nutrients are incorporated at recommended levels.

---

[35] For example, between 1977 and 1980 producers in Manitoba applied 15-18 kgs. of nitrogen and phosphorous per ha on stubble and 9-10 kgs. of nutrients per ha from 1977-80 based on estimates of average nutrient application rates by clients of the Manitoba Crop Insurance Corporation. The recommended application rates are 18-24 kgs per ha on stubble and 11-15 kgs. per ha on fallow.

Table 4.6

Change in Area Seeded and Absolute Yields by Crop
Technology Minus Benchmark Simulation

1975-1980

Year	Wheat	Oats	Barley	Rapeseed	Flaxseed	Total
			Change in Area Seeded - 000 hectares -			
1975	3,600	- 400	700	1,200	0	5,100
1976	3,900	- 700	- 300	700	0	3,600
1977	2,900	- 600	600	1,000	100	4,000
1978	3,600	- 500	100	600	-200	3,600
1979	4,000	0	0	- 200	-100	3,700
1980	3,800	-700	-1,900	1,700	0	2,900
			Weighted Yields - kg. per hectare -			
1975	- 20	110	220	- 90	-20	
1976	-190	30	280	-150	-10	
1977	-120	120	400	-180	30	
1978	-130	80	480	-120	20	
1979	- 90	180	440	- 70	12	
1980	-140	130	480	-101	-90	

(a) Actual yields are used in both simulations.

Second, the increase in stubble seeded area increases the relative effect of the lower stubble yields. A weighted yield on stubble seedbed is historically lower than the corresponding yield on fallow seedbed. For example, the weighted yield on stubble is 1.5 kgs per ha compared to 1.8 kgs per ha on fallow seedbed in 1980. The corresponding predicted weighted yield is 1.4 and 1.9 kgs per ha. The weighted yield declines as the relatively larger increases in area seeded to stubble offsets any increase in yield due to increased nutrient incorporation.

Forecasted export and, therefore, total marketings increased except in 1979, as by definition, any excess production is exported (refer to Figures 4.18 and 4.19). The increase in forecasted export marketings ranged from a high of 55 percent in 1975 to a low of 10 percent in 1980 above the corresponding benchmark values. Forecasted export marketings reached 28.7 million tonnes in 1977 with a low of 19.6 million tonnes in 1979. Exports declined by 4 percent in 1979 mainly because of lower available supply caused by reduced carryovers.

Forecasted total marketings followed a similar trend as forecasted export marketings. The predicted increase ranged from a high of 41 percent in 1975 to no change in 1979. Predicted marketings peaked in 1977 at 32.7 million tonnes and are lowest in 1979 at 25.1 million tonnes.

Though total marketings is primarily affected by export marketings, a relatively minor influence is exerted by domestic marketings. In situations such as simulated by the technology simulation, land may be allocated to favour export crops at the expense of crops produced primarily for domestic consumption (given relative profitabilities). This may lead to a deficit supply (import) situation if production is insufficient to meet domestic marketing requirements. This occurred for oats

Figure 4.18
Total Export Marketings for The Five Principal Crops in Western Canada
1974-75 to 1980-81, '000,000 tonnes

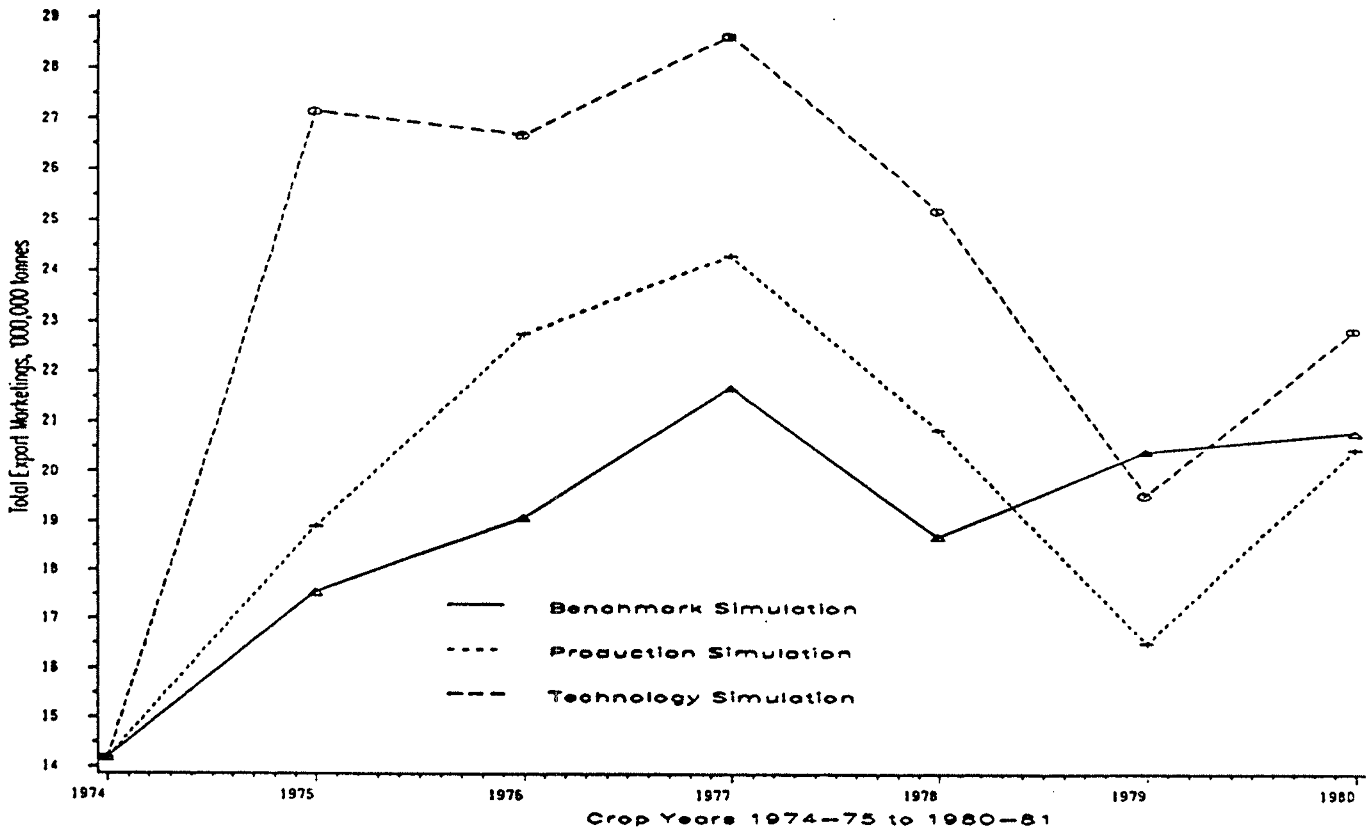
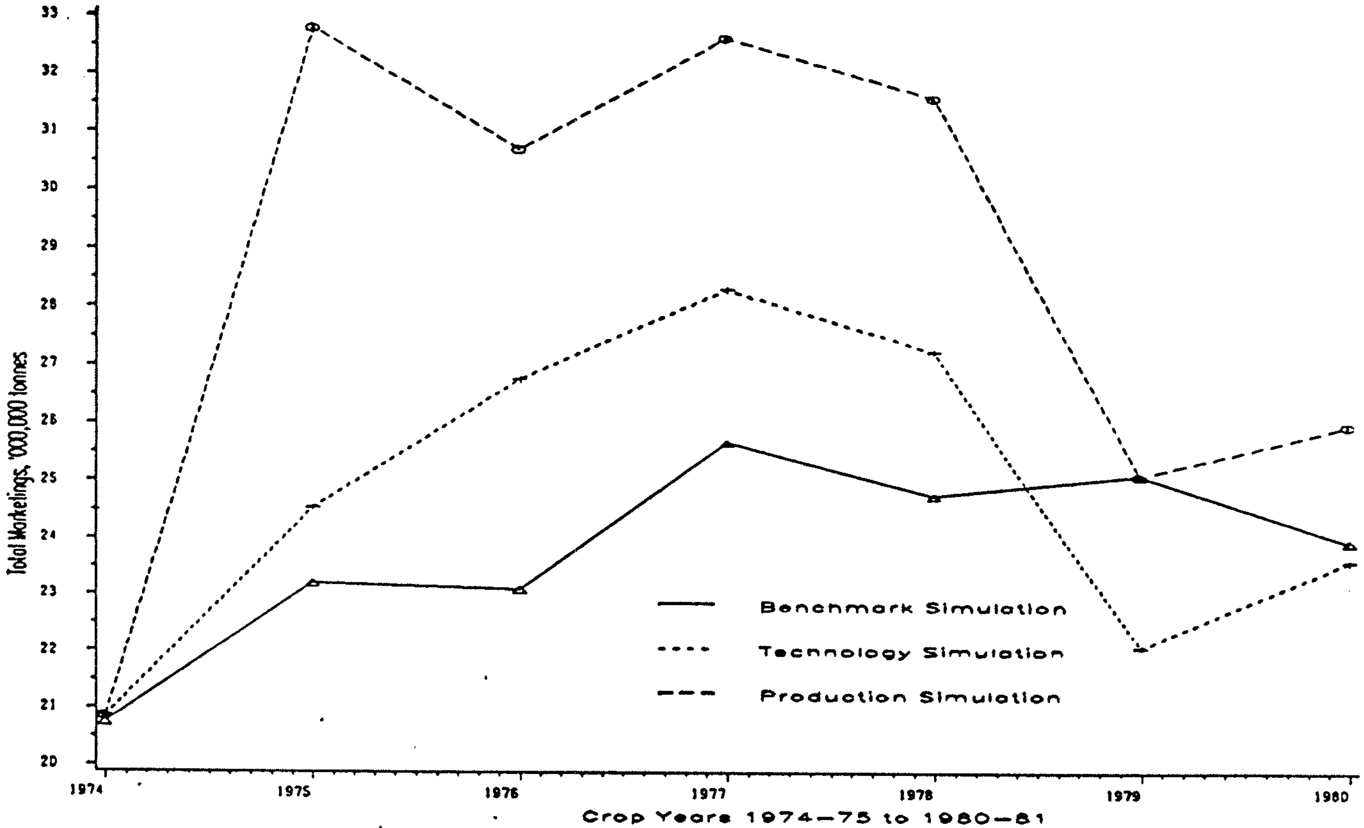


Figure 4.19
Total Marketings for The Five Principal Crops in Western Canada
1974-75 to 1980-81, '000,000 tonnes



from 1977 to 1980 as there is insufficient predicted available supply to meet domestic requirements. This caused minor fluctuations in total marketings.

Total gross margin increased significantly above benchmark levels in all years except 1979 (see Figure 4.20). Gross margins are predicted to be the highest in 1976 at $250 million and the lowest in 1980 at $580 million. Forecast gross margins are above benchmark revenues in all years except 1979. In 1979, the increases in area seeded and yields resulted in sufficient production combined with minimum carryovers to offset the decrease in gross margins primarily due to lower available supply.

The general trend of the predicted gross margin is an exaggerated version of the trend in the production simulation. Both gross margins are primarily affected by the redistribution of area seeded to favour export crops with the greatest redistribution occurring in the technology simulation.

The annual difference between production and benchmark gross margin is compounded to 1980 to give an overall net difference in gross margin due to changing the assumptions. The compounded difference is predicted to be $3.0 billion as shown in Table 4.7. Producers are better off under the technology simulation because additional monies are compounded at prevailing interest rates.

Figure 4.20
Gross Margin for The Five Principal Crops in Western Canada
1974-75 to 1980-81, $ billions

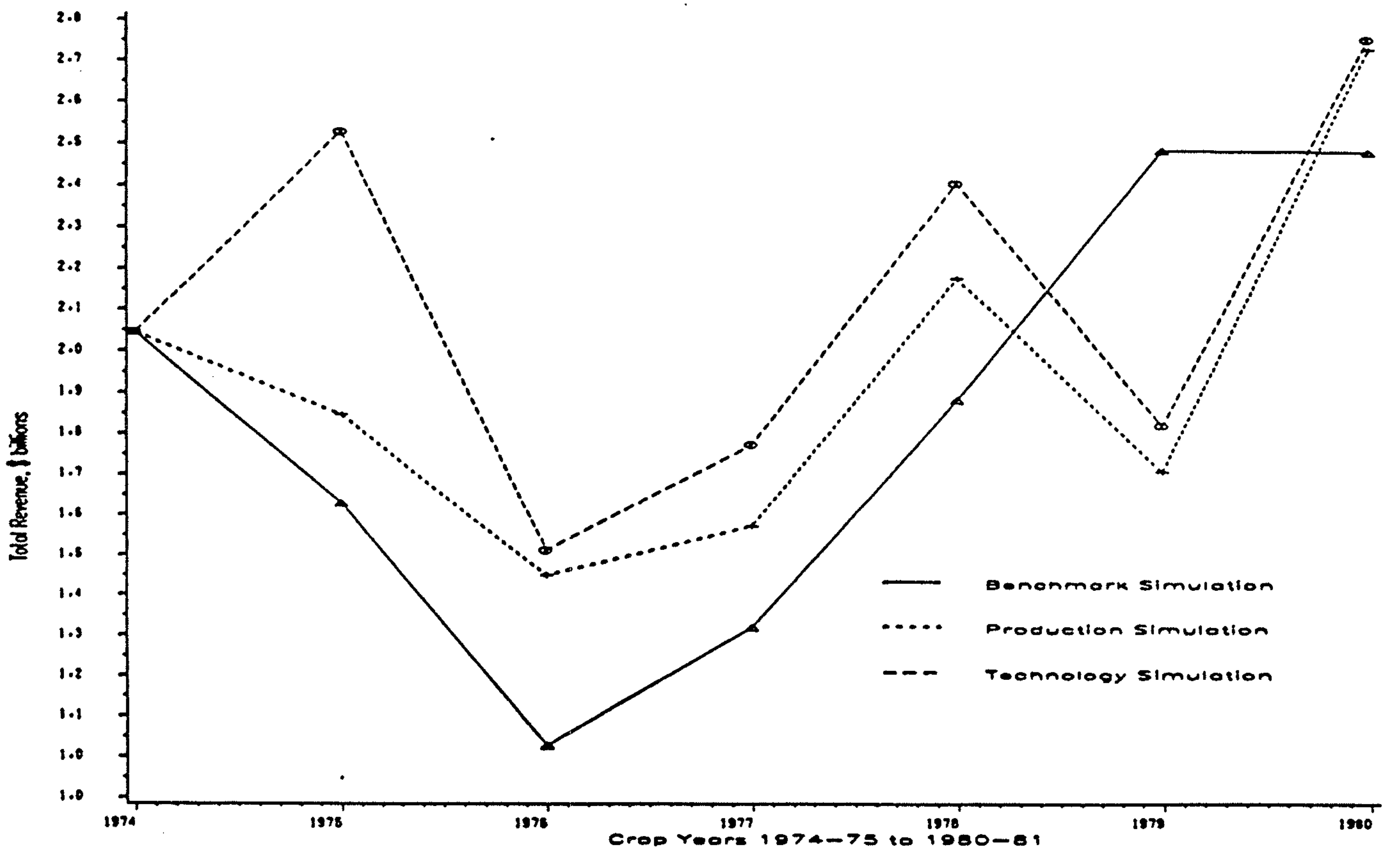


Table 4.7

Compounded Change and Sum of Compounded Change in
Sales Revenues, Production Costs and Gross Margins
Technology Minus Benchmark Simulation

	Compounded Difference			Sum of Compounded Difference		
Year	Sales Revenue	Production Costs	Gross Margin	Sales Revenue	Production Costs	Gross Margin
			- $ million -			
1975.	2,140	690	1,440	2,140	690	1,440
1976	1,310	590	720	3,440	1,290	2,160
1977	1,210	600	610	4,660	1,880	2,770
1978	1,221	570	650	5,880	2,450	3,420
1979	- 169	580	-750	5,710	3,040	2,670
1980	770	500	280	6,480	3,530	2,950

(a) May not add due to rounding.

As with the production simulation, gross margin increased in all years except 1979. The increase in production is insufficient to provide enough available supply to generate exports and, therefore, sales revenues equal to benchmark sales revenues. Gross margin declined as a result by $750 thousand when the compounded sales shortfall and production costs are considered.

In summary, the majority of the anticipated responses have been indicated in the comparison of technology and benchmark simulations with some additional comparison to the production simulation. Producers are predicted to significantly increase production given the willingness to adopt minimum summer fallowing practises. The mix of crops produced is forecasted to favour export crops such as wheat, rapeseed and barley while production of domestic crops such as oats is expected to decline. The shift to export crops is forecasted to significantly increase both export and total marketings which increased the gross margin received by producers in all years except 1979. Producers are predicted to receive an additional $3.0 billion (1980 dollars) by increasing the adoption rates given adequate capacity.

4.2 DISCUSSION OF RESULTS

4.2.1 Acceptability of Assumptions

The acceptability of the assumptions determine the significance of the results derived in the three simulations. If the assumptions are reasonable, the results are acceptable with a fair degree of confidence. The four key assumptions are evaluated against actual occurances in the 1984-85 crop year. This crop year is the most recent year for which complete information is available.

Carryovers are assumed to decline to the minimum level producers are willing to store in both the production and technology simulations. The minimum aggregate stock level is set at 2.9 million tonnes based on observed minimum carryovers by crop during the 1970s.[36] In 1984, two consecutive years of small crops reduced grain inventories to 3.3 million tonnes as the majority of production is consumed. As the difference is less than 500 thousand tonnes, the minimum level of carryover used in the simulations is deemed to be within an acceptable level.

---

[36] The minimum level for rapeseed was chosen from the crop years 1975-76 to 1980-81 as rapeseed is a relatively new crop.

Estimated exports are based on the following two assumptions:

1. Adequate capacity is available to move excess production in both the production and technology simulations.
2. Production is directed by export prices which fully reflect world demand and supply conditions.

Preliminary estimates by the Canadian Grain Commission indicate exports of 23.2 million tonnes for 1985-86 (from western Canada) while the production and technology simulations forecasted 20.8 and 21.1 million tonnes exported from the Prairie provinces in 1980.

The level of summer fallowing is affected by unusual weather conditions (i.e., low precipitation prior to and during the planting season), surplus grain inventories and the rate of acceptance and/or adoption of reduced fallow practices.[37] The recommended ratio of crop seeded on stubble to total cropland is 0.93 percent for Manitoba, 0.71 percent for Saskatchewan and 0.76 percent for Alberta. A straight-line trend is used to bring historical percentages to the minimum technically feasible levels by 1985 for the technology simulation. The increase reflects both the rate of acceptance and the absence of surplus grain inventories as carryovers were at minimum levels.

The rate of acceptance is within an reasonable range in all provinces except Saskatchewan in the technology simulation. Approximately 0.92, 0.71 and 0.76 percent of the total cropland is predicted to be seeded to stubble in Manitoba, Saskatchewan and Alberta in 1980. By comparison, 0.87, 0.45 and 0.71 percent of the total cropland was seeded to stubble

[37] Daryl F. Kraft and Valerie J. Fields, "Fertilizer Demand in the Prairie Provinces," (unpublished paper, University of Manitoba, 1981), pp. 4-7.

in Manitoba, Saskatchewan and Alberta in 1984. While the other provinces are close to technically feasible levels, Saskatchewan remains at approximately two-thirds of minimum level. As the acceptance of minimum fallowing is more gradual in Saskatchewan, the simulation overestimates the area seeded on stubble by approximately one-third.

The production and technology simulations are generated using the assumption that production in excess of historical levels is exported. Additional predicted exports ranged from 1.3 to 3.7 million tonnes in the production simulation and ranged from 2.0 to 8.5 million tonnes in the technology simulation. Given the world demand and supply situation, the additional exports from the production simulation are likely to be absorbed by the world market; however, the 33 per cent increase in exports in the technology simulation may not occur.

In conclusion, most of the assumptions are acceptable within limits. Minimum carryover levels used in the model are close to minimum levels in recent years given pipeline requirements. The practise of minimum summer fallowing has generally been accepted in Manitoba and Alberta although Saskatchewan is considerably below technically feasible levels. Finally, the ability to market excess production into export markets may be reduced by world surpluses for each of the major grains and by current changes in U.S. farm policy.

4.2.2 Implications of Results

The simulated results suggest several major implications from providing system capacity. Continuous cropping will require changes in farm management practises, particularly in Saskatchewan. Production is expected to shift in favour of exports with an increased specialization in a few major crops. Most importantly, producers are expected to gain from increased capacity even without accelerating their acceptance of technology assuming that they do not have to pay the full historical and additional capacity costs.

Continuous cropping requires different farm management practices than a combination of fallow and stubble. For example, increased usage of nutrients are necessary for maximum growth as there is a significant difference in nutrient availability between fallow and stubble fields. Better weed control and improved tillage practises are also required. In addition, either crop prices will have to improve or fertilizer prices decrease as recent decreases in crop prices of up to $20 a tonne are likely to reduce the financial incentive to increase fertilizer incorporation.[38]

Exports are forecasted to become more specialized depending on producer responses. As indicated in Table 4.8, exports are predicted to be more heavily concentrated in wheat (4 to 8 percent more) with more rapeseed exported (7 percent more) and substantially less barley (17 percent less).

---

[38] Kraft and Fields (1981) suggest that fertilizer application rates are conditional on the ratio of grain to fertilizer prices.

Table 4.8

Simulated Wheat, Barley and Rapeseed Exports As a Percentage of Total Exports
Prairie Provinces, 1980

Simulation	Wheat	Barley	Rapeseed
		- % -	
Benchmark	76	23	8
Production	79	6	15
Technology	84	6	14

The dependence on wheat exports introduces more susceptibility to economic and production conditions. The reliance on a single major export crop means that the industry would lack a cushion against negative price fluctuations and disease problems which is provided by crop diversity. This shift also has negative growth implications for domestic consumption of coarse grains as production is anticipated to be close to historical domestic consumption levels.

The growth in rapeseed exports may be constrainted by historically limited markets. Japan has imported the bulk of exports with traditionally poor export opportunities in other countries. The expansion of exports will depend on the willingness of Japan to further open its market and the possibility of competition from U.S. producers as canola is now acceptable for human consumption in the U.S.

Based on the relative changes in marketings and area seeded, producers are forecasted to be better off given adequate transportation and handling capacity. The compounded net difference in gross margin is predicted to be close to $1.1 billion (1980 dollars) between the production and benchmark simulations. By comparison, the difference between the technology and benchmark simulations is forecasted at approximately $3.0 billion (1980 dollars). In other words, approximately $1.1 to 3.0 billion were lost to producers because of inadequate capacity.

However, whether producers are better or worse off depends upon if the additional gross margin was sufficient to pay for the existing capacity as well as the additional capacity needed to move forecasted exports. The existing revenue shortfall is calculated by multiplying the cost per tonne paid by the federal government and other contributors (excluding users) times cereal grain and product movement. This is compounded to 1980 to allow a comparison between the cost of both existing and additional rail capacity and gross margin. As shown in Table 4.9, the revenue required to pay for the existing capacity is estimated to be approximately $2.0 billion.

Table 4.9

Calculation of Revenue Shortfall from Existing Capacity

	Other Cost/Tonne	Grain and Product Movement	Compounded Shortfall	Sum of Compounded Shtfall
	$/tonne	million tonnes	- $ million -	
1975	8.10	21.4	280(a)	280
1976	8.58	22.6	280	560
1977	9.53	27.2	350	910
1978	10.48	23.4	300	1,220
1979	11.53	27.4	350	1,570
1980	13.93	27.6	380	1,960

(a) The actual shortfall of $175 million equals $280 million by 1980 when interest is taken into account.

Additional capacity cost is estimated by multiplying exports in excess of estimated system capacity times the full cost, including the cost paid by users, the federal government and other contributors.[39] As shown in Table 4.10, additional capacity is predicted to cost producers an additional $80 million if they paid the full cost arising from exports in the production simulation. Additional grain movement estimated in the technology simulation is forecasted to cost producers an extra $590 million.

Table 4.10

Calculation of Additional Costs Due to Predicted Grain Movement

	Total Cost	Additional Grain and Product Movement	Compounded Shortfall	Sum of Compounded Shortfall
	$/tonne	million tonnes	- $ million -	
		Production Simulation		
1975	12.72	1.3	30	30
1976	13.48	3.6	70	100
1977	14.11	2.6	50	150
1978	15.52	2.2	40	190
1979	17.07	-3.9	-74	110
1980	18.39	-2.1	-40	80
		Technology Simulation		
1975	12.72	9.6	200	200
1976	13.48	7.5	150	340
1977	14.11	7.0	130	480
1978	15.52	6.5	120	600
1979	17.07	-0.9	-20	590
1980	18.39	0.3	10	590

[39] Dr. E.W. Tyrchniewicz, Professor, Department of Agricultural Economics, University of Manitoba, July 1986.

The additional $1.1 billion revenue is inadequate to the costs of the existing rail capacity as the total revenue shortfall including costs for additional capacity from 1975 to 1980 is estimated to be $2,080 million. Producers would have been worse off by $980 million; however, payments by government and other contributors would have been reduced from $2.2 million to $1.2 million.

By comparison, the additional $3.0 billion is more than sufficient to pay for both the existing rail revenue shortfall and additional costs incurred to move forecasted grain. Rail capacity would have cost approximately $2.7 billion of which $2.1 billion would cover the existing shortfall and $590 million would pay for additional capacity. This suggests that producers would have been financial better off by incurring the full transportation costs because the increase in revenue from an unconstrained market system would have offset historical and potential transport costs by approximately $300 million.

Secondary industries such as the chemical industry are also worse off because of constraints. Inputs estimated at $270 million (1980 dollars) are necessary for production assuming adequate capacity. An estimated $3.5 billion (1980 dollars) inputs are required for production assuming adequate capacity and accelerated technological adoption rates. Therefore, the direct loss in producer gross margins indirectly resulted in losses for secondary industries. The multiplier effect would further increase both of these losses to the rest of the economy.

Chapter V

SUMMARY

This chapter provides a brief summary of the entire study. The synopsis reviews the problem, the research methodology, the findings and policy implications. The limitations of the work, as well as, recommendations for further research are also presented.

5.1 PROBLEM DISCUSSION

The CWB suggested that $1.1 billion of sales are lost or deferred in 1972, 1978 and 1979 as the result of inadequate transportation capacity. Several studies disputed the issues concerning when capacity actually restricted sales and whether lost and/or foregone sales resulted in financial losses to producers. Previous studies also reviewed constraints within a crop year rather than evaluating the dynamics of the net financial situation. As a result, this study is undertaken to identify the dynamic impacts of domestic marketing system constraints on farm gate gross margins[40] for Prairie producers from 1970-71 to 1980-1981.

---

[40] Gross margin is defined as the revenue received minus the variable costs of production. Fixed costs are held at historical levels in the simulations.

5.2 THEORETICAL FRAMEWORK AND RESEARCH METHODOLOGY

Pure competition theory suggests that marketing system constraints affect producer gross margin through the quantity of grain sold and the volume of variable inputs used in the production process. Constraints reduce the volume of grain sold by restricting the physical movement of grain to export markets. Domestic markets are depressed as excess grain is sold or stored on-farms. Higher inventories cause producers to alter production plans by summer fallowing more land, altering the mix of crops seeded and using lower levels of fertilizer and herbicides.

The net financial cost or benefit to producers is difficult to predict, a priori. For example, the loss in revenue in the first year of constraints will be offset by the gain in revenue in the second year if the price received in the second year for the excess grain is equal to or greater than the price received in the first year plus associated storage costs. Variable costs may also be affected if less land is seeded in the second year. Costs are also affected in the third year if the fallowed land is brought into production as less inputs are required on fallow land to obtain the same yield. Therefore, the net gain or loss in gross margin depends on the interyear changes in revenues and costs.

Based on the above theory, a working hypothesis is developed which stated that domestic system constraints reduced the gross margin of Prairie producers during the latter seventies. This hypothesis is tested using a non-linear simultaneous-equation technique. A recursive acreage allocation model is used to estimate cultivated area by seedbed, by crop and by Prairie province with carryovers as the recursive variable. Simulated area seeded is used to generate provincial supply and disposition for each of the five principal grains. Disaggregation by province and crop accounted for differences in acreage allocation between seedbeds and differences in provincial production and marketing patterns. Simulated area seeded and marketings are used in determining costs, revenues and gross margins.

Three simulations are used to determine the effect of domestic marketing system constraints from 1975 to 1980. The historical simulation tested the predictive ability of the models as well as provided a benchmark for comparison for the remaining simulations. The production simulation forecasted producer response assuming adequate grain transportation and handling capacity. The technology simulation forecasted producer response assuming adequate capacity as well as a higher adoption rate. The higher adoption rate is simulated by accelerating the acceptance of stubble cropping and fertilizer incorporation to reach minimum summer fallow practises and recommended nutrient application levels by 1985.

5.3 MAJOR RESULTS

System constraints restricted exports in three years including 1975-76, 1977-78 and 1978-79. As constraints affect production decisions in years following the constrained year, gross margins are simulated from 1975-76 to 1980-81. The gross margins obtained from the historical simulation is subtracted from the gross margins obtained in the production and technology simulations. The respective differences in gross margin are compounded from 1975 to 1980 using the Canada Savings Bond as a reasonable rate of return. This facilitates a comparison between the differences in gross margins in 1980 dollars.

As indicated in Table 5.1, the provision of adequate grain transportation and handling capacity from 1975 to 1980 is forecasted to have a relatively minor impact on seeded area. Average annual seeded area is forecasted to increase by 0.5 million hectares above the average annual benchmark level of 18.4 million hectares. This increase is mainly due to increased continuous cropping. Cultivating the larger area seeded is forecasted to increase the average annual variable operating costs by $0.1 billion to $1.7 billion.

Table 5.1

Simulated Results of the Prairie Grain Economy with and without Marketing Constraints

(Average 1975-80)

Item	Historical	Production Adjustment(a)	Technology Adjustment(b)
Average Area Seeded (million hectares)	18.4	18.9	22.4
Average Production (million tonnes)	34.6	34.3	39.1
Average Exports (million tonnes)	20.2	20.7	25.0
Average Sales ($ billion)	$ 3.7	$ 3.7	$ 4.3
Average Operating Costs ($ billion)	$ 1.6	$ 1.7	$ 2.1
Average Gross Margin ($ billion)	$ 2.1	$ 2.0	$ 2.2
Compounded Gross Margin (Simulation - Historical, $ billion)		$ 1.1	$ 3.1

(a) Production adjustment simulation assumes Prairie farmers would increase production according to how they behaved between 1960 and 1985 whenever on-farm stocks of grain fell to minimal levels.

(b) Technology adoption simulation assumes Prairie farmers would accelerate the reduction in summer fallow and increased use of fertilizer above historical rates once they realized that the grain marketing system could accommodate the added production.

Although average annual total seeded area is forecasted to increase, average annual production is expected to slightly decline from 34.6 to 34.3 million tonnes yield differences between seedbeds and between crops. Increased stubble cropping reduced production because of lower yields obtained on stubble seedbeds compared to fallow seedbeds. The mix of crops reduced production because of increased wheat and rapeseed production at the expense of higher yielding barley. The shift in seedbed and mix of crops primarily reflects the relative profitability between crops given expected harvest prices and yields as low inventories are a minor decision factor. This shift in production plans suggests that producers diversified by growing more barley as well as resting more land during times of constraints.

Although average annual exports increased from 20.2 to 20.7 million tonnes average annual sales remained the same as historical average annual sales ($3.7 billion) because of changes in crops exported. The increase in relatively higher priced wheat and rapeseed exports is offset by the decline in barley exports and loss of export revenues in 1979. Sales revenue declined drastically in 1979-80 because of lower available supply as grain inventories are reduced to minimum levels.

The combination of increased average annual costs and unchanged average annual sales resulted in average annual gross margin declining by $0.1 to $2.0 billion. However, the compounded difference between simulated and historical gross margin increased by $1.1 billion because of the timing of gross margin changes. Predicted gross margin increased relative to historical gross margin because of export revenue increases in all years except 1979. As discussed earlier, export revenues declined in 1979 due to a reduction in available supply. The increase in compounded gross margin suggests that by 1980, $1.1 billion is unavailable for investment or consumption.

By comparison, adequate capacity and accelerated adoption rates significantly increased seeded area as shown by the technology adoption simulation in Table 5.1. Average annual seeded area increased from 18.4 to 22.4 million hectares or by approximately 22 percent as more land is continuously cropped and land previously seeded to non-principal crops is allocated to the five principal crops. As farmers are predicted to farm more intensively by increased continuous cropping and fertilizer usage, production costs are forecasted to increase from $1.6 to $2.1 billion.

The increased area seeded as well as accelerated yields resulted in average annual production increasing from 34.1 to 39.1 million tonnes. Production of wheat, barley and rapeseed increased as accelerated yields affected the relative profitability between crops. The increased production and sale of higher valued crops resulted in average annual exports increasing by 4.8 million tonnes to 25.0 million tonnes. Consequently, average annual sales increased from $3.7 to $4.3 billion.

Average annual gross margin increased by 100 million to $2.2 billion mainly as a result of increased sales revenue from exports. As in the production adjustment simulation, average annual export revenues increased in all years except in 1979 and the decline in 1979 is due to lower available supply. The changes in gross margin resulted in a net compounded increase of $3.1 billion (1980 dollars) in gross margin.

Despite the increase in gross margins, producers would be worse off if they had to pay the full cost of providing adequate capacity from

1975 to 1980. The existing capacity has a compounded revenue shortfall of $2.0 billion which was financed by the federal government and other contributors. Additional compounded capacity costs of $80 million would be incurred to move exports predicted in the production simulation. As producers are forecasted to increase their gross margin by $1.1 billion, a net loss of $980 million would result. Therefore, producers are better off under historical system constraints than if they had to pay the full costs of the adequate capacity.

By comparison, producers would benefit from an adequate transportation and handling system if they accelerated their adoption rates. In addition ($1980) to the $2.0 billion necessary to cover existing revenue shortfalls, producers would have to pay $600 million ($1980) to ship additional exports. However, producers are expected to generate a compounded gross margin of $3.1 billion which would offset the combined compounded transportation cost by $500 million. Therefore, producers would be better off by incurring the full costs necessary for adequate capacity.

5.4 POLICY IMPLICATIONS

The study shows that system constraints are costly to producers in terms of gross margin foregone. Policies affecting grain transportation capacity needed to be reviewed in the context of minimizing losses to the grain industry including the railways, grain handling companies, producers and taxpayers.

Inadequate investment in the grain transportation system occurred primarily because the statutory rate structure on grain and grain products did not foster capital investment and service by the railways. Monies were injected in the rail network by the federal and by provincial governments and by farmers through the CWB. However, these ad hoc methods fell short of the total requirements. Recent changes brought about through the Western Grain Transportation Act are slowly enabling some financial incentives which have the potential of meeting the future capital requirement for transportation capacity.

This analysis suggests the additional income from adequate capacity is sufficient to offset previous railway revenue shortfalls as well as cover added transportation costs provided producers have an incentive to accelerate adoption rates. Although producers could historically pay these costs, political pressures may prevent this type of payment system. In addition, current compensation schemes are part of an on-going settlement of statutory freight rates. A timely settlement of this and related issues would encourage producers to accelerate adoption rates if an adequate transportation system is assured.

This analysis suggests that modifications are necessary to policies affecting continuous cropping and fertilizer application rates. For example, the CWB allocates grain deliveries using seeded area as well as fallow area. In terms of this analysis, a system based on seeded area would provide incentive for producers to adopt minimum summer fallow practises. Producers would be better off by adopting these practices given an adequate transportation system and assuming both reasonable prices and available export markets.

Domestic surpluses during the latter seventies would have caused increased domestic usage by both the livestock and processing industries. As adequate transportation capacity becomes available, farmers production plans will alter to reflect relative profitablities without surplus stocks. Both industries may require assistance as they have responded to depressed prices by expanding physical plant. The resulting excess capacity will lead to downsizing and possibly plant closures. Therefore, policies aimed at reducing the impact of such action may be necessary.

5.5 LIMITATIONS

The simulation procedure led to an incorrect estimation of seeded acreage in 1975 and 1976 in the technology simulation. Seeded area is overestimated in 1975 and underestimated in 1976 because of the lagged effect of the equations estimating seeded stubble area and seeded fallow area. This led to a net overestimation of gross margins for the two year period.

The physical capacity[41] of the transportation and handling system is estimated at 95 percent of peak capacity once a peak is set. This may lead to an over- or underestimation of potential movement depending on the actual capacity.

Provincial feed requirements are calculated as reported feed, waste and dockage less estimated waste and dockage. Provincial estimated waste and dockage are calculated to be at the same proportional level as reported nationally. As a result, provincial feed accounted for any error in balancing supply and disposition in reported data while any error in forecasting is attributed to grain inventories.

---

[41] The physical capacity of the grain transportation and handling system refers to the total throughput of the entire system (all components).

Prairie marketings are underestimated in comparison to western Canada marketings. Provincial estimations are based on Canadian Grain Commission data while western Canada estimations are based on Statistics Canada data. Statistics Canada data are slightly larger as deliveries are included for unlicensed feed mills.

The fertilizer and continuous cropping rates are assumed to have reached recommended levels in all three provinces by 1985. While both Manitoba and Alberta are close to recommended levels, Saskatchewan's rates are approximately one-third of the recommended rates. This resulted in a disproportionate growth in production due to higher yields and increased seeded acreage. A slower hypothesized growth in the rate of acceptance would reconize Saskatchewan's lower base rates.

5.6 RECOMMENDATIONS FOR FURTHER RESEARCH

The current analysis could be expanded to evaluate the effect of adequate capacity on domestic requirements and market structure. Domestic market requirements are held at historical levels in this analysis but the reduction of grain inventories and changes in crop mix would affect domestic supply. Pork supply and oilseed processing could be specifically examined.

The role of the agricultural transportation and handling capacity could be examined within the larger issue of the entire transportation system. This would facilitate a more detailed review of the benefits and costs to the entire system of providing additional capacity to agriculture. The type of capacity and means of financing could also be explored. For example, the additional capacity could arise from more efficient usage of existing resources rather than adding new resources.

Export markets could be examined to determine if the forecasted growth in exports could be absorbed in world markets. A lower rate of growth would result in a change in the projected net benefit from providing adequate capacity. This analysis could be modified to include a projected market share.

The impact of the net compounded increase in gross margin could be analyzed to evaluate the multiplier effect of the revenue foregone on the Prairie economy. The direct impact on suppliers of variable inputs could be expanded to include estimates of such factors as taxes foregone. In addition, the effect of changes in gross margin could be analyzed relative to the rate of farm bankruptcy.

BIBLIOGRAPHY

Bjarnason, H.F. "World Grain Production and Consumption Trends." Address to the Second Canadian Grains Industry Course, Canada International Grains Institute, Winnipeg, 23 November 1979.

Booz-Allen And Hamiltion Inc./IBI Group. Grain Transportation and Handling in Western Canada. Ottawa: Grains Group, July 1979.

Campbell, D.E. Canadian National Rail, Winnipeg, Canada. Interview, 23 March 1983.

Canadian International Grains Institute. Grains and Oilseeds, Handling, Marketing and Processing. Winnipeg: Canadian International Grains Institute, 1973.

Canada Grains Council. Eastern Grain Movement Report. Winnipeg: Canada Grains Council, 1975.

__________. Grain Handling and Transportation in Eastern Canada. Winnipeg: Canada Grains Council, 1975.

__________. Pacific Coast Study. Winnipeg: Canada Grains Council, 1976.

__________. Supply and Demand Projections For Livestock and Feed Grains. Winnipeg: Canada Grains Council, 1976.

__________. Report on the Thunder Bay Subcommittee. Winnipeg: Canada Grains Council, 1977.

__________. Canada Grains Industry Statistical Handbook 82. Winnipeg: Canada Grains Council, 1982.

__________. Key Issues in Grain Transportation. Winnipeg: Canada Grains Council, 1982.

__________. Eastern Grain Handling and Transportation Report. Winnipeg: Canada Grains Council, 1979.

__________. Prospects for the Prairie Grain Industry 1990. Winnipeg: Canada Grains Council, 1982.

__________. A System Review of Factors Constraining the Increased Production of Grain in Western Canada, 1981. Winnipeg: Canada Grains Council, 1981.

Canada West Foundation. Outlook For The Canadian Cattle Industry 1979-89. Alberta: Planning and Research Secretariat, Alberta Agriculture, 1980.

Canadian Wheat Board. "The Objectives of a Market Assurance Plan." Address to the 1981 Farm District Meetings, 1981.

__________. Canadian Wheat Board Annual Report. Winnipeg: Canadian Wheat Board, annual.

Carter, C.A., A.B. Hickson, and D.F. Kraft. "Exports Constraints and Canadian Feed Grain Policy." University of Manitoba, 1982.

Fields, V.J. "The Influence of Grain Freight Rates on The Farm Land Market in the Prairie Provinces." M.Sc. thesis, University of Manitoba, 1978.

Grain by Rail. Report. Vol. 1, Ottawa: Supplies and Services Canada, 1976.

Hickson, A.B. "An Economic Model to Access the Costs of Labor Disputes in the Canadian Grain Movement System." M.Sc. thesis, University of Manitoba, 1978.

Hall Commission. Grain and Rail in Western Canada. Vol. 1, Ottawa: Queen's Printer, 1977.

Harvey, D.R. Christmas Turkey or Prairie Vulture? An Economic Analysis of Crow's Nest Pass Grain Rates. Montreal: Institute for Research on Public Policy, 1980.

Industry in Turmoil: Report on The Long Term Stabilization of the Beef Industry in Canada. By H.O. Sparrow, Chairman. Ottawa: The Standing Senate Committee on Agriculture, June 1982.

IBI Group/Theo Joseph Inc. Improvement of Grain Car Allocation Procedure. Winnipeg: Grains Transportation Authority, August 1981.

International Wheat Council. World Wheat Statistics. London, annual.

Snavely, King and Associates. 1977 Costs and Revenues Incurred by the Railways in the Transportation of Grain Under Statutory Rates. Report prepared for the Ministry of Transportation, Federal Government of Canada, Washington, D.C.: September 1973.

Nachtigall, C.D., G.F. Skinner and E.W. Tyrchniewicz. "Crownest Pass Grain Rates Time for a Change?" Canadian Transportation Research Forum: Proceeding---Sixth Annual Meeting Vol. XV1, No. 1, 1975.

P.S. Ross and Partners. Grain Handling and Transportation Costs in Canada. Ottawa: Grains Group, April 1971.

Quarterly Canadian Feed Grains Forecasting Model, Version 1. Working Paper. Ottawa: Agricultural Canada Policy, Planning and Economics Branch, 1979.

Statistics Canada. Canada Yearbook 1980-81. Ottawa.

__________ . Grain Trade of Canada. Ottawa, Catalogue Number 22-201.

The Effect of Transportation Costs on Farm Income and Expenses in Western Canada. Technical Working Paper No. 3 prepared for J.C. Gilson, Federal Representative on Western Rail Capacity, April 1982.

Tyrchniewicz, E.W. and Om P. Tangri. "Grain Transportation in Canada, Some Critical Issues and Implications for Research." CJAE. Vol. 16, No. 1, 1968.

Tyrchniewicz, E.W. "Transportation Problems in Canadian Agriculture with Specific Reference to Grains," AJAE. Proceedings of the annual meeting, July 1976.

Wansbutter, R. Grains Transportation Authority, Winnipeg, Canada. Interview, 17 March 1983.

Westburn Development Consultants Ltd. Report Respecting the Demand For Grain Handling and Storage Facilities East of Thunder Bay to 1985. Winnipeg: Westburn Development Consultants Ltd., 31 March 1978.

Western Grain Transportation: Report on Consultations and Recommendations. By J.C. Gilson, Chairman. Ottawa: Supplies and Services Canada, 1982.

Wilson, C.F. Grain Marketing in Canada. Winnipeg: Canadian International Grain Institute, 1979.

Worsfold, E. Grains Division, Canadian Transport Commission, Vancouver, B.C. Interview, 10 April 1983.

APPENDIX A - HISTORICAL DATA

Table A.1

CWB and WCE Prices For the Five Principal Grains

Historical Data

Year	CWB Prices						WCE Prices			
	Initial Wheat	Final Wheat	Initial Oats	Final Oats	Initial Barley	Final Barley	Canola	Flaxseed	Oats	Barley
	Dollars Per Tonne									
1969	55.12	2.68	35.66	6.29	37.20	1.01	100.13	128.10	55.20	48.33
1970	55.12	6.28	35.66	5.77	37.20	0.00	128.04	114.56	46.73	46.00
1971	53.65	5.00	35.66	5.38	37.20	0.00	121.96	98.93	55.44	57.40
1972	64.67	14.48	42.15	26.46	43.63	23.65	106.70	98.58	42.04	46.90
1973	137.79	30.42	68.08	43.38	98.75	20.30	137.79	166.46	66.46	61.90
1974	137.79	26.60	74.57	32.75	98.75	8.31	263.23	417.62	102.84	113.11
1975	137.79	8.49	74.57	30.86	87.27	16.81	209.92	386.79	121.84	128.10
1976	110.23	6.91	75.22	10.63	80.38	11.12	209.75	259.79	107.75	108.70
1977	110.23	10.07	74.57	0.01	80.38	17.32	259.83	274.95	83.02	90.80
1978	128.60	31.93	73.92	11.41	79.46	11.44	286.77	214.95	78.20	77.60
1979	156.16	40.27	73.92	11.41	89.56	17.91	306.26	298.72	85.53	76.90
1980	196.58	25.72	88.19	37.61	130.90	15.62	299.74	322.86	111.72	114.20

Table A.2

Acreage by Seedbed and Crop, Manitoba
Historical Data

Year	Wheat Fal	Wheat Stub	Oats Fal	Oats Stub	Barley Fal	Barley Stub	Canola Fal	Canola Stub	Flaxseed Fal	Flaxseed Stub
	....	....	....	....	'000 Hectares	....	....	....	....	....
1969	730.2	282.3	74.9	544.7	170.9	315.1	33.6	45.8	75.7	369.8
1970	457.7	109.4	98.8	411.5	295.7	311.9	99.6	62.4	141.8	303.8
1971	822.2	198.0	113.8	451.2	393.3	437.8	151.9	83.4	57.9	171.3
1972	650.4	402.6	51.0	410.7	217.9	632.6	93.2	97.2	40.5	162.0
1973	783.3	472.2	59.9	466.6	195.2	655.3	70.5	91.5	45.4	197.6
1974	605.1	528.9	66.0	420.0	175.8	553.2	91.1	111.4	54.3	229.2
1975	697.0	558.5	56.3	389.2	130.8	476.7	101.2	193.6	58.7	245.0
1976	737.9	801.1	72.5	433.8	113.8	534.2	48.6	52.7	39.7	172.9
1977	566.2	729.8	58.7	366.5	133.2	636.3	80.6	121.9	52.2	251.5
1978	541.1	835.9	47.4	256.4	96.0	612.8	138.1	287.1	48.2	255.6
1979	406.6	808.4	32.4	149.9	83.4	503.8	179.4	367.3	67.6	438.6
1980	473.0	863.5	34.4	147.8	103.6	706.3	120.3	203.7	38.1	258.9

Table A.3

Acreage by Seedbed and Crop, Saskatchewan
Historical Data

Year	Wheat Fal	Wheat Stub	Oats Fal	Oats Stub	Barley Fal	Barley Stub	Canola Fal	Canola Stub	Flaxseed Fal	Flaxseed Stub
	....				'000 Hectares	....				
1969	5 510.2	1 210.5	280.6	529.2	574.0	546.2	300.8	104.0	209.3	102.4
1970	3 063.2	175.7	505.7	283.8	1 003.6	332.4	816.2	74.5	562.8	64.8
1971	5 176.1	53.0	452.6	343.3	1 851.4	404.1	1 084.2	23.9	342.9	31.6
1972	4 613.8	1 013.8	285.8	398.4	1 026.7	835.6	550.2	57.1	203.6	59.5
1973	5 489.1	907.7	339.3	470.4	912.2	788.3	527.1	59.9	202.0	61.1
1974	4 967.6	902.8	324.3	444.9	941.7	758.7	534.0	53.0	175.7	47.0
1975	5 333.2	820.7	301.2	447.8	725.1	691.9	664.0	64.8	142.5	39.7
1976	6 112.6	1 053.4	256.3	391.5	571.7	622.7	287.0	16.6	59.9	21.1
1977	5 433.6	1 125.1	238.9	388.7	780.6	757.9	508.1	78.9	164.4	78.5
1978	5 423.5	1 499.6	172.5	313.4	508.5	746.6	951.8	181.8	109.7	72.5
1979	4 946.2	1 936.4	138.9	266.0	396.4	656.6	1 127.1	208.9	193.1	130.8
1980	5 289.5	1 755.1	147.0	217.4	530.8	785.0	741.7	68.0	113.0	69.2

Table A.4

Acreage by Seedbed and Crop, Alberta
Historical Data

Year	Wheat Fal	Wheat Stub	Oats Fal	Oats Stub	Barley Fal	Barley Stub	Canola Fal	Canola Stub	Flaxseed Fal	Flaxseed Stub
	'000 Hectares									
1969	1 624.3	521.5	217.8	551.4	633.6	1 350.2	201.6	128.7	133.2	49.0
1970	963.2	89.5	388.3	441.7	886.6	935.2	486.2	100.8	248.2	15.0
1971	1 223.5	170.4	339.3	451.8	1 240.1	1 063.2	674.1	130.8	102.8	6.9
1972	1 346.2	394.7	237.2	503.6	793.5	1 311.7	378.9	147.4	57.9	10.9
1973	1 630.8	353.0	280.2	529.6	689.9	1 354.7	386.2	140.1	69.6	11.3
1974	1 388.7	311.7	240.5	447.8	713.0	1 392.3	324.7	140.9	66.0	15.0
1975	1 304.5	253.4	298.4	473.7	867.6	1 208.5	451.8	130.4	109.3	11.7
1976	1 659.5	607.7	228.3	500.4	640.9	1 606.1	219.4	84.2	25.1	5.3
1977	1 398.5	545.3	194.7	432.8	593.5	1 613.0	389.9	237.7	35.2	13.4
1978	1 410.9	653.9	178.1	408.9	469.6	1 574.9	727.5	466.8	27.5	13.0
1979	1 271.3	834.0	145.7	360.3	335.2	1 506.9	717.4	699.6	60.7	40.5
1980	1 419.8	968.8	150.2	376.1	413.4	1 772.9	568.4	322.3	39.3	29.6

Table A.5

Yield by Seedbed and Crop, Manitoba
Historical Data

Year	Wheat Fal	Wheat Stub	Oats Fal	Oats Stub	Barley Fal	Barley Stub	Canola Fal	Canola Stub	Flaxseed Fal	Flaxseed Stub
	Kg per Ha									
1969	1 895.5	1 263.7	2 202.1	1 649.6	2 393.9	1 603.1	1 183.3	869.2	742.9	554.0
1970	1 532.6	1 169.6	1 904.9	1 531.5	2 092.6	1 581.6	1 116.0	835.6	812.2	585.5
1971	2 050.1	1 660.3	2 426.8	1 988.7	2 759.7	2 200.2	1 261.8	970.2	837.4	598.1
1972	1 949.3	1 519.1	2 205.9	1 790.6	2 560.6	2 044.2	1 104.8	925.3	944.4	692.6
1973	1 882.1	1 492.2	2 084.0	1 817.3	2 469.2	2 022.7	1 200.1	987.0	900.3	774.4
1974	1 572.9	1 236.8	1 661.1	1 318.2	1 882.8	1 490.1	1 099.2	835.6	749.2	554.0
1975	1 814.9	1 539.3	1 973.5	1 695.4	2 146.4	1 742.9	1 054.3	869.2	868.8	667.4
1976	1 935.9	1 714.0	2 148.7	1 809.7	2 662.8	2 167.9	1 166.5	863.6	900.3	724.0
1977	2 359.3	1 935.9	2 442.1	2 049.7	3 109.3	2 566.0	1 603.9	1 323.5	1 315.8	1 045.1
1978	2 271.9	1 915.7	2 278.3	2 045.9	3 109.3	2 533.7	1 531.0	1 278.6	1 215.1	1 019.9
1979	1 788.0	1 626.7	1 760.1	1 680.1	2 323.9	2 124.9	1 076.7	1 020.7	944.4	875.1
1980	1 855.2	1 189.8	1 794.4	1 463.0	2 566.0	1 845.2	1 149.6	768.3	1 007.3	623.3

Table A.6

Yield by Seedbed and Crop, Saskatchewan
Historical Data

Year	Wheat Fal	Wheat Stub	Oats Fal	Oats Stub	Barley Fal	Barley Stub	Canola Fal	Canola Stub	Flaxseed Fal	Flaxseed Stub
	....	....	....	....	.... Kg per Ha	....	....	....	....	....
1969	1 915.7	1 344.4	2 346.8	1 699.2	2 544.5	1 796.7	1 116.0	751.5	1 019.9	724.1
1970	1 788.0	1 364.5	2 304.9	1 706.8	2 490.7	1 791.4	1 037.5	689.8	1 070.3	824.8
1971	1 801.4	1 317.5	2 423.0	1 805.8	2 560.6	1 855.9	1 054.3	712.2	900.3	648.5
1972	1 673.8	1 129.4	2 087.8	1 562.0	2 404.6	1 662.3	959.0	633.7	925.5	686.3
1973	1 660.3	1 209.9	2 190.6	1 664.9	2 420.8	1 732.2	959.0	650.5	906.6	711.4
1974	1 472.1	1 048.6	1 748.7	1 325.8	1 947.4	1 430.9	925.3	600.1	579.2	377.8
1975	1 781.3	1 263.7	2 103.0	1 546.8	2 318.5	1 662.3	1 065.5	667.4	875.1	642.2
1976	2 177.8	1 593.1	2 571.6	1 863.0	2 867.2	2 124.9	1 295.4	959.0	1 108.1	969.6
1977	2 056.9	1 478.8	2 339.2	1 737.3	2 748.9	2 081.9	1 491.7	1 037.5	1 259.2	843.7
1978	2 070.3	1 579.6	2 270.6	1 752.5	2 700.5	2 071.1	1 334.7	1 009.4	1 234.0	950.7
1979	1 586.3	1 209.9	1 878.2	1 398.2	2 211.0	1 651.5	1 009.4	706.6	912.9	642.2
1980	1 660.3	1 176.3	1 931.6	1 531.5	2 415.4	1 920.5	1 261.8	936.5	969.6	812.2

Table A.7

Yield by Seedbed and Crop, Alberta
Historical Data

Year	Wheat Fal	Wheat Stub	Oats Fal	Oats Stub	Barley Fal	Barley Stub	Canola Fal	Canola Stub	Flaxseed Fal	Flaxseed Stub
	....					Kg per Ha				....
1969	1 909.0	1 351.1	2 384.9	1 798.2	2 700.5	1 893.6	919.7	622.4	957.0	673.7
1970	1 902.3	1 431.7	2 438.3	1 943.0	2 630.5	1 909.7	1 048.7	689.8	1 038.8	850.0
1971	1 828.3	1 404.8	2 259.2	1 752.5	21442.3	1 737.6	964.6	594.4	818.5	742.9
1972	1 929.1	1 546.0	2 510.7	2 004.0	2 770.4	2 141.0	1 110.4	841.2	1 057.7	698.9
1973	1 868.6	1 404.8	2 434.5	1 946.8	2 571.4	1 855.9	1 026.3	656.1	950.7	673.7
1974	1 687.2	1 398.1	2 072.5	1 642.0	2 313.2	1 818.3	987.0	740.3	812.2	680.0
1975	2 130.8	1 619.9	2 522.1	1 904.9	2 684.3	2 065.7	1 065.5	835.6	1 057.7	805.9
1976	2 345.9	1 734.2	2 655.4	2 057.3	2 931.8	2 248.6	1 200.1	863.6	1 013.6	969.6
1977	1 727.5	1 505.7	2 362.1	2 144.9	2 646.7	21399.2	1 374.0	1 138.4	1 082.9	761.8
1978	2 097.2	1 801.4	2 293.5	1 866.8	2 738.1	21334.7	1 228.2	1 099.2	1 297.0	1 183.6
1979	1 915.7	1 902.3	2 358.3	2 171.6	2 592.9	21442.3	1 076.7	953.4	1 133.3	1 070.3
1980	2 265.2	2 184.6	2 567.8	2 339.2	3 077.0	21646.7	1 351.5	1 132.8	1 359.9	1 032.5

Table A.8

Average Yield by Seedbed and Crop, Prairie Provinces
Historical Data

Year	Wheat Fal	Wheat Stub	Oats Fal	Oats Stub	Barley Fal	Barley Stub	Canola Fal	Canola Stub	Flaxseed Fal	Flaxseed Stub
	....	....	....	....	.... Kg per Ha	....	....	....	....	....
1970	1 787.3	1 324.3	2 317.8	1 735.6	2 493.8	1 820.2	1 046.2	727.5	1 020.6	555.8
1971	1 835.1	1 514.5	2 362.7	1 853.2	2 541.2	1 869.1	1 038.4	737.4	873.7	550.4
1972	1 753.6	1 307.3	2 273.6	1 803.5	2 563.9	1 975.2	1027.7	828.4	950.4	622.0
1973	1 726.0	1 327.2	2 282.3	1 815.6	2 484.0	1 860.2	1001.9	758.3	912.6	698.5
1974	1 524.4	1 168.7	1 863.5	1 431.6	2 083.8	1 642.6	962.4	750.1	660.3	511.8
1975	1 847.5	1 413.9	2 283.1	1 720.8	2 489.8	1 883.7	1 063.8	823.7	835.3	645.3
1976	2 190.7	1 668.0	2 551.6	1 919.4	2 881.1	2 205.3	1 245.6	873.3	1 019.8	737.5
1977	2 018.7	1 624.6	2 339.2	1 982.7	2 740.7	2 354.7	1 453.0	1 170.9	1 242.4	946.5
1978	2 091.2	1 722.9	2 282.3	1 877.6	2 753.7	2 309.3	1 306.0	1 136.0	1 234.6	988.5
1979	1 662.7	1 466.1	2 087.4	1 812.1	2 379.8	2 187.9	1 038.5	931.7	958.2	822.8
1980	1 793.5	1 452.5	2 206.1	1 928.1	2 691.5	2 298.8	1 287.1	984.7	1 054.4	671.7

Table A.9

Supply and Disposition for the Five Principal Grains, Prairie Provinces

Historical Data

Year	Beginning Carryover	Production	Available Supply	Marketings	Seed	Feed Waste & Dockage	Ending Carryover	Total Disposition
	'000 Tonnes							
1969	14 241	31 830	46 071	15 776	1 625	8 817	19 853	46 071
1970	18 853	24 440	43 293	18 226	1 155	9 913	13 999	43 293
1971	13 295	33 784	47 079	22 600	1 571	10 434	12 474	47 079
1972	12 197	30 308	42 505	24 335	1 552	10 809	5 809	42 505
1973	5 605	31 770	37 375	21 560	3 173	7 858	4 784	37 375
1974	4 522	25 719	30 241	17 702	1 561	7 547	3 431	30 241
1975	3 171	31 210	34 381	21 355	1 551	7 420	4 055	34 381
1976	3 494	38 066	41 559	22 642	1 724	7 816	9 377	41 559
1977	9 020	36 482	45 501	27 204	1 643	7 310	9 344	45 501
1978	9 022	37 044	46 066	23 372	1 624	7 979	13 091	46 066
1979	13 109	30 570	43 679	27 355	1 549	8 414	6 361	43 679
1980	6 044	33 947	39 992	27 628	1 661	6 435	4 268	39 992

Table A.10

Exports (Ex) and Domestic Marketings (Dom) by Principal Grain, Prairie Provinces
Historical Data

Year	Wheat Ex	Wheat Dom	Oats Ex	Oats Dom	Barley Ex	Barley Dom	Rapeseed Ex	Rapeseed Dom	Flaxseed Ex	Flaxseed Dom
	....				'000 Tonnes	....				
1970	4 409	5 976	615	258	3 846	1 180	1 059	27	1 003	-150
1971	9 721	4 265	-298	458	5 222	1 101	1 665	- 86	340	208
1972	13 989	3 187	-279	480	4 110	962	1 018	401	305	160
1973	13 265	1 285	116	472	4 088	958	610	374	307	84
1974	7 438	4 028	268	328	1 783	2 662	1 159	-240	384	-109
1975	11 354	2 539	99	672	3 085	1 485	603	742	193	201
1976	12 914	1 981	399	401	4 269	1 408	875	145	178	69
1977	17 276	1 783	389	347	3 627	1 535	1 508	243	424	71
1978	10 652	3 783	- 45	352	3 087	2 209	2 298	- 91	335	89
1979	16 724	1 905	-410	301	2 741	2 573	2 595	252	564	109
1980	16 985	1 513	- 85	372	5 962	329	1 497	628	226	198

Table A.11

Revenues (Rev) and Costs by Principal Grain, Prairie Provinces
Historical Data

Year	Wheat Rev	Wheat Costs	Oats Rev	Oats Costs	Barley Rev	Barley Costs	Rapeseed Rev	Rapeseed Costs	Flaxseed Rev	Flaxseed Costs
	$ 000									
1975	1 953	554	71	160	427	323	301	208	101	44
1976	1 595	747	58	167	456	354	280	102	65	25
1977	2 095	717	45	160	444	420	484	218	102	50
1978	2 160	832	22	142	417	405	810	442	113	48
1979	3 258	931	– 8	126	502	397	755	570	187	98
1980	3 898	1 134	32	142	840	562	592	408	135	70

Table A.12

Revenues (Rev) and Costs, Prairie Provinces
Historical Data

Year	Total Export Revenue	Total Dom Revenue	Total Revenue	Total Variable Costs	Total Fertilizer Costs	Total Costs	Gross Margins
	$ 000						
1975	2 087	766	2 853	1 006	198	1 204	1 650
1976	2 025	410	2 434	1 149	203	1 352	1 083
1977	2 739	431	3 170	1 254	219	1 473	1 698
1978	2 758	763	3 521	1 397	293	1 690	1 831
1979	4 000	694	4 694	1 512	397	1 909	2 785
1980	4 854	642	5 496	1 723	435	2 158	3 337

Table A.13

Elevation Charges on Canadian Wheat Board

($/tonne)

Year	Wheat	Oats	Barley
1970	2.94	2.94	2.94
1971	2.94	2.94	2.94
1972	2.94	2.94	2.94
1973	2.94	2.94	2.94
1974	5.51	5.51	5.51
1975	6.25	6.25	6.25
1976	7.35	11.67	7.35
1977	7.35	11.67	7.35
1978	7.35	11.67	7.35
1979	7.35	11.67	7.35
1980	7.35	11.67	7.35

Table A.14

Average Price of Rapeseed and Flaxseed Received in Prairie Provinces

($/tonne)

	Rapeseed		Flaxseed	
Year	Manitoba	Sask. & Alta.	Manitoba	Sask. & Alta.
1970	105.82	104.50	101.18	99.60
1971	103.61	102.29	84.64	83.07
1972	94.80	93.48	78.74	77.16
1973	136.68	135.36	161.40	159.83
1974	257.50	256.17	375.96	374.39
1975	311.73	310.41	376.36	374.78
1976	225.31	223.99	257.86	256.29
1977	256.61	255.29	266.92	265.34
1978	286.60	285.28	196.84	195.27
1979	275.58	274.25	295.26	293.69
1980	279.98	278.44	320.06	318.53

Table A.15

Average Rail Freight Rates

($/tonne)

Crop	Manitoba via Thunder Bay from Carberry	Saskatchewan via Vancouver or Thunder Bay from Scott	Alberta via Vancouver from Hanna
Wheat	3.53	5.07	5.07
Oats	3.50	5.06	5.06
Barley	3.54	5.05	5.05
Rapeseed	3.88	5.42	5.42
Flaxseed	3.86	5.39	5.39

Table A.16

Canadian Wheat Board (CWB) and Open Market (OM) Shipments of Wheat, Oats and Barley

	Wheat		Oats		Barley	
Year	CWB	OM	CWB	OM	CWB	OM
1970	875	0	429	0	871	0
1971	686	0	493	0	802	0
1972	877	0	562	0	880	0
1973	643	0	482	0	954	0
1974	338	286	218	173	173	154
1975	194	222	87	376	375	129
1976	0	335	0	307	0	961
1977	0	592	0	377	0	1,117
1978	0	790	0	282	0	1,463
1979	0	427	0	315	0	1,502
1980	0	328	0	347	0	1,182

Table A.17

Coverage of the Total Costs Incurred in the 1974, 1977 and 1980 Transportation of Statutory Grain by Rail

Source of Cost Coverage	Amount of Cost Coverage: Total Dollars (millions)	Amount of Cost Coverage: Dollars per ton	Percentage Distribution of coverage
<u>1974</u>			
User revenues	89.717	4.36	36.3
Federal Government Payments	54.364	2.64	22.0
Other contributors	103.028	5.00	41.7
TOTAL	247.109	12.00	100.0
<u>1977</u>			
User Revenues	114.764	4.58	32.4
Federal Government Payments	78.638	3.13	22.2
Other contributors	160.536	6.40	45.4
TOTAL	353.938	14.11	100.0
<u>1980</u>			
User Revenues	132.873	4.46	24.3
Federal Government Payments	170.166	5.72	31.1
Other contributors	244.441	8.21	44.6
TOTAL	547.480	18.39	100.0

Note: A 6 percent inflation rate was assumed between 1974 and 1977.
A 10 percent inflation rate was assumed between 1977 and 1980.

Table A.18

Actual and Predicted Nutrient Incorporation Rates

Year	Manitoba			Saskatchewan			Alberta		
	Nitrogen Fal	Nitrogen Stub	Phosphorus	Nitrogen Fal	Nitrogen Stub	Phosphorus	Nitrogen Fal	Nitrogen Stub	Phosphorus
	.... Kg per Ha								
	Actual Nutrient Incorporation								
1975	5.69	1.65	3.49	2.03	0.55	1.84	6.24	2.39	3.12
1976	6.79	1.84	3.30	2.02	0.55	1.47	6.98	2.39	2.75
1977	6.98	1.65	3.12	2.57	0.55	1.47	8.63	2.20	3.12
1978	7.16	2.02	3.49	3.49	0.92	2.02	9.00	2.57	3.30
1979	10.10	3.49	4.59	4.59	2.02	1.10	9.36	2.94	3.67
1980	10.28	3.12	4.59	4.59	1.29	1.84	8.81	3.12	3.49
	Predicted Nutrient Incorporation								
1975	6.93	2.04	4.28	3.15	0.96	2.50	6.86	2.56	3.71
1976	7.85	2.18	4.04	3.06	0.92	2.16	7.49	2.17	3.23
1977	7.85	1.95	3.73	3.51	0.87	2.04	9.03	2.30	3.53
1978	7.85	2.27	4.04	4.34	1.19	2.55	9.29	2.65	3.67
1979	10.60	3.70	5.01	5.35	2.25	1.58	9.54	2.98	3.97
1980	10.60	3.32	4.96	5.25	1.47	2.27	8.88	3.15	3.74

APPENDIX B - SCENARIO ONE RESULTS

Table B.1

Acreage by Seedbed and Crop, Prairie Provinces
Scenario One - Benchmark Simulation

Year	Wheat Fal	Wheat Stub	Oats Fal	Oats Stub	Barley Fal	Barley Stub	Rapeseed Fal	Rapeseed Stub	Flaxseed Fal	Flaxseed Stub
	....	....	....	....	'000 Hectares	....	....	....	....	....
1970	4 632	359	888	992	2 115	1 440	1 640	207	941	407
1971	8 275	417	829	1 078	3 320	2 094	1 497	177	393	189
1972	6 598	1 243	461	1 248	2 133	2 954	827	202	193	184
1973	8 519	1 424	696	1 533	1 995	2 587	973	349	397	272
1974	6 445	1 638	468	1 307	1 900	3 301	947	411	265	282
1975	7 385	2 213	685	1 434	1 635	3 119	974	490	236	339
1976	7 375	3 482	505	1 352	1 007	2 776	744	272	118	236
1977	7 705	2 786	330	1 116	1 200	3 320	726	547	182	403
1978	6 828	2 774	375	865	1 105	3 525	1 459	832	178	281
1979	6 910	3 131	278	766	719	2 883	2 065	1 035	226	513
1980	7 022	4 028	412	808	838	3 305	1 621	593	184	426

Table B.2

Supply and Disposition For The Five Principal Grains, Prairie Provinces
Scenario One - Benchmark Simulation

Year	Beginning Carryover	Production	Available Supply	Marketings	Seed	Feed Waste & Dockage	Ending Carryover	Total Disposition
	'000 Tonnes							
1970	18 853	23 512	42 365	18 400	1 110	9 844	13 011	42 365
1971	13 011	34 212	47 223	21 781	1 624	10 618	13 200	47 223
1972	13 200	29 287	42 486	21 354	1 473	11 258	8 401	42 486
1973	8 401	32 550	40 950	21 251	1 708	9 387	8 604	40 950
1974	8 604	25 464	34 068	20 748	1 525	7 712	4 083	34 068
1975	4 083	32 672	36 755	23 200	1 674	7 388	4 493	36 755
1976	4 493	36 402	40 895	23 100	1 669	7 816	8 310	40 895
1977	8 310	36 554	44 864	25 700	1 671	7 277	10 216	44 864
1978	10 216	36 085	46 301	24 771	1 570	8 176	11 784	46 301
1979	11 784	29 754	41 538	25 132	1 515	8 841	6 050	41 538
1980	6 050	33 969	40 019	23 969	1 675	6 340	8 035	40 019

Table B.3

Exports (Ex) and Domestic Marketings (Dom) by Principal Grain, Prairie Provinces
Scenario One - Benchmark Simulation

Year	Wheat Ex	Wheat Dom	Oats Ex	Oats Dom	Barley Ex	Barley Dom	Rapeseed Ex	Rapeseed Dom	Flaxseed Ex	Flaxseed Dom
	'000 Tonnes									
1970	6 540	5 976	437	258	2 291	1 180	1 000	27	840	-150
1971	9 489	4 265	-521	235	5 160	1 101	1 663	- 86	264	208
1972	11 164	3 187	-774	- 15	5 363	962	731	401	173	160
1973	13 082	1 285	38	472	3 908	958	675	374	374	84
1974	9 108	4 028	-110	219	3 281	2 662	1 448	-240	460	-109
1975	12 414	2 539	376	672	4 102	1 485	504	742	165	201
1976	14 907	1 981	424	401	2 851	1 408	766	145	147	69
1977	15 354	1 783	110	347	4 769	1 535	1 132	243	356	71
1978	12 429	3 783	-329	68	4 019	2 209	2 293	- 91	300	89
1979	15 618	1 905	868	157	2 407	2 573	2 837	252	455	109
1980	14 301	1 513	2	454	4 691	329	1 681	628	174	198

Table B.4

Revenues (Rev) and Costs by Principal Grain, Prairie Provinces
Scenario One - Benchmark Simulation

Year	Wheat Rev	Wheat Costs	Oats Rev	Oats Costs	Barley Rev	Barley Costs	Rapeseed Rev	Rapeseed Costs	Flaxseed Rev	Flaxseed Costs
	....	....	....	....	$ 000	....	....	....	....	....
1975	2 046	605	97	173	523	376	279	188	94	42
1976	1 808	763	60	166	342	330	232	146	57	28
1977	1 884	771	28	139	542	426	380	194	88	50
1978	2 426	769	-18	128	490	470	613	368	104	41
1979	3 064	905	-71	120	470	412	819	536	157	78
1980	3 333	1 174	50	161	670	546	643	448	118	74

Table B.5

Revenues (Rev) and Costs, Prairie Provinces
Scenario One - Benchmark Simulation

Year	Total Export Revenue	Total Dom Revenue	Total Revenue	Total Variable Costs	Total Fertilizer Costs	Total Costs	Gross Margins
	$ 000						
1975	2 272	766	2 938	1 082	225	1 307	1 730
1976	2 090	410	2 505	1 155	215	1 370	1 129
1977	2 491	431	2 922	1 268	232	1 500	1 422
1978	2 871	743	3 614	1 341	288	1 629	1 986
1979	3 777	662	4 439	1 468	381	1 849	2 591
1980	4 163	651	4 814	1 775	451	2 226	2 588

Table B.6

Difference Between Simulated Revenues (Rev) and Costs, Prairie Provinces
Production Minus Benchmark Simulation

Year	Total Export Revenue	Total Dom Revenue	Total Revenue	Total Variable Costs	Total Fertilizer Costs	Total Costs	Gross Margins
	$ 000						
			Difference Between Simulations				
1975	216	0	216	1	0	1	216
1976	433	0	433	8	2	10	423
1977	295	- 1	294	29	11	40	254
1978	340	2	342	30	16	46	295
1979	-750	61	-689	54	36	90	-780
1980	324	-37	287	18	19	37	251
			Compounded Difference Between Simulations				
1975	347	0	347	2	0	2	347
1976	695	0	695	13	3	16	679
1977	433	- 1	432	43	16	59	373
1978	460	3	463	41	22	63	399
1979	-928	75	-853	67	45	112	-965
1980	324	-37	287	18	19	37	251
			Sum of Compounded Difference Between Simulations				
1975	347	0	347	1	0	1	347
1976	1 042	0	1 042	14	3	17	1 025
1977	1 475	- 1	1 474	57	19	76	1 399
1978	1 935	1	1 936	98	41	139	1 798
1979	1 007	77	1 084	164	86	250	832
1980	1 331	40	1 371	182	104	286	1 083

Note: May not add due to rounding.

APPENDIX C - SCENARIO TWO RESULTS

Table C.1

Acreage by Seedbed and Crop, Prairie Provinces
Scenario Two - Production and Technology Simulations

Year	Wheat Fal	Wheat Stub	Oats Fal	Oats Stub	Barley Fal	Barley Stub	Rapeseed Fal	Rapeseed Stub	Flaxseed Fal	Flaxseed Stub
	....	....	....	....	'000 Hectares	....	....	....	....	....
					Production Simulation					
1975	7 249	2 333	681	1 413	1 528	2 988	1 217	491	241	361
1976	7 370	3 766	530	1 551	901	2 372	824	301	125	248
1977	7 860	3 133	342	1 071	1 043	3 559	634	603	157	341
1978	6 762	3 492	401	918	1 065	3 351	1 139	1 120	124	255
1979	6 928	4 338	311	1 230	834	2 573	1 368	935	137	541
1980	5 983	5 911	402	553	460	1 746	2 263	1 254	136	564
					Technology Simulation					
1975	7 308	5 863	621	1 130	1 367	4 408	1 417	1 265	203	366
1976	3 098	11 641	222	930	403	3 102	463	1 231	58	240
1977	4 480	8 904	211	677	656	4 415	498	1 820	112	340
1978	3 943	9 221	241	548	689	4 090	591	2 292	87	219
1979	3 888	10 147	195	877	540	3 072	988	1 881	103	492
1980	3 418	11 394	252	330	293	1 927	1 674	2 197	90	532

Table C.2

Average Yield by Seedbed and Crop, Prairie Provinces
Scenario Two - Technology Simulation

Year	Wheat Fal	Wheat Stub	Oats Fal	Oats Stub	Barley Fal	Barley Stub	Rapeseed Fal	Rapeseed Stub	Flaxseed Fal	Flaxseed Stub
	Kg per Ha									
1975	1 970	1 480	2 370	1 830	2 570	1 990	1 060	760	950	680
1976	2 360	1 760	2 710	2 000	3 050	2 300	1 250	920	1 110	770
1977	2 130	1 640	2 490	2 130	2 890	2 440	1 420	1 130	1 330	1 020
1978	2 170	1 720	2 360	1 960	2 830	2 410	1 300	1 080	1 290	1 020
1979	1 730	1 420	2 180	2 050	2 460	2 300	1 040	870	970	870
1980	1 900	1 430	2 240	2 080	2 820	2 440	1 270	960	1 060	650

Table C.3

Supply and Disposition for the Six Principal Grains, Prairie Provinces
Scenario Two Simulations - Production and Technology Simulations

Year	Beginning Carryover	Production	Available Supply	Marketings	Seed	Feed Waste & Dockage	Ending Carryover	Total Disposition
	'000 Tonnes							
				Product Simulation				
1975	4 083	32 420	36 503	24 541	1 650	7 428	2 883	36 502
1976	2 883	36 300	39 183	26 778	1 674	7 848	2 883	39 183
1977	2 883	37 338	40 221	28 332	1 721	7 285	2 883	40 221
1978	2 883	36 740	39 623	27 260	1 620	7 860	2 883	39 623
1979	2 883	31 595	34 478	22 095	1 665	7 835	2 883	34 478
1980	2 883	31 660	34 543	23 627	1 562	6 471	2 883	34 543
				Technology Simulation				
1975	4 083	41 192	45 274	32 811	2 069	7 511	2 883	45 274
1976	2 883	40 564	43 447	30 722	1 962	7 880	2 883	43 447
1977	2 883	42 009	44 892	32 669	1 956	10 267	2 883	44 892
1978	2 883	41 425	44 308	31 638	1 893	10 777	2 883	44 308
1979	2 883	34 901	37 784	25 126	1 914	10 744	2 883	37 784
1980	2 883	34 294	37 178	26 008	1 817	9 353	2 883	37 178

Table C.4

Exports (Ex) and Domestic Marketings (Dom) by Principal Grain, Prairie Provinces
Scenario Two - Production and Technology Simulations

Year	Wheat Ex	Wheat Dom	Oats Ex	Oats Dom	Barley Ex	Barley Dom	Rapeseed Ex	Rapeseed Dom	Flaxseed Ex	Flaxseed Dom
					'000 Tonnes					
					Production Simulation					
1975	13 480	2 540	386	672	4 030	1 485	810	742	196	201
1976	18 228	1 981	996	401	2 336	1 408	1 021	145	191	69
1977	17 071	1 783	- 13	334	5 670	1 535	1 240	243	384	71
1978	14 107	3 783	-305	91	943225	2 209	2 592	- 91	252	89
1979	13 585	1 905	165	711	621	2 573	1 814	252	359	109
1980	16 330	1 513	-333	124	1 235	329	3 093	628	176	198
					Technology Simulation					
1975	19 413	2 539	-20	652	6 104	1 485	1 487	742	186	201
1976	23 154	1 981	-796	-395	2 838	1 408	1 385	145	136	69
1977	20 045	1 783	-925	-578	6 959	1 535	2 250	243	361	71
1978	18 115	3 783	-1 241	-845	5 161	2 209	3 021	- 91	195	89
1979	16 487	1 905	-621	-90	1 279	2 573	2 117	252	314	109
1980	19 166	1 513	-990	-533	1 373	329	3 211	628	123	198

Table C.5

Revenues (Rev) and Costs by Principal Grain, Prairie Provinces
Scenario Two - Production and Technology Simulations

Year	Wheat Rev	Wheat Costs	Oats Rev	Oats Costs	Barley Rev	Barley Costs	Rapeseed Rev	Rapeseed Costs	Flaxseed Rev	Flaxseed Costs
	$ 000									
	Production Simulation									
1975	2 191	608	98	170	516	358	347	220	102	44
1976	2 164	789	101	186	301	284	297	162	69	29
1977	2 073	814	20	135	620	436	410	188	93	42
1978	2 677	836	- 15	135	506	450	696	358	91	34
1979	2 709	1 044	61	182	302	389	548	398	130	74
1980	3 760	1 328	- 23	124	209	291	1 036	708	119	88
	Technology Simulation									
1975	3 003	903	58	146	710	440	499	209	99	42
1976	2 691	1 184	-87	107	341	314	390	144	54	25
1977	2 400	1 109	- 91	88	731	492	689	214	89	40
1978	3 277	1 191	-148	83	580	501	816	287	76	29
1979	3 216	1 428	- 49	130	364	423	629	320	117	66
1980	4 358	1 780	-168	78	227	298	1 069	489	102	81

Table C.6

Revenues (Rev) and Costs, Prairie Provinces
Scenario Two - Production and Technology Simulation

Year	Total Export Revenue	Total Dom Revenue	Total Revenue	Total Variable Costs	Total Fertilizer Costs	Total Costs	Gross Margins
	$ 000						
			Production Simulation				
1975	2 488	766	3 254	1 083	225	1 308	1 946
1976	2 523	410	2 932	1 163	217	1 380	1 552
1977	2 786	430	3 216	1 297	243	1 540	1 676
1978	3 211	745	3 956	1 371	304	1 675	2 281
1979	3 027	723	3 750	1 522	417	1 939	1 811
1980	4 487	614	5 101	1 793	470	2 263	2 839
			Technology Simulation				
1975	3 605	764	4 369	1 404	335	1 739	2 630
1976	3 038	352	3 390	1 451	323	1 774	1 616
1977	3 443	375	3 818	1 596	345	1 941	1 876
1978	3 922	679	4 601	1 669	421	2 090	2 511
1979	3 609	679	4 288	1 823	544	2 367	1 923
1980	5 048	542	5 590	2 118	607	2 725	2 864

Table C.7

Difference Between Simulated Revenues (Rev) and Costs, Prairie Provinces
Technology Minus Benchmark Simulation

Year	Total Export Revenue	Total Dom Revenue	Total Revenue	Total Variable Costs	Total Fertilizer Costs	Total Costs	Gross Margins
	$ 000						
			Difference Between Simulations				
1975	3 510	0	3 510	322	460	782	2 729
1976	2 997	0	2 997	311	416	727	2 270
1977	3 358	- 12	3 346	338	471	809	2 537
1978	3 109	1	3 110	352	544	896	2 213
1979	1-014	20	1 034	412	664	1 078	-44
1980	2 644	-110	2 534	350	771	1 121	1 413
			Compounded Difference Between Simulations				
1975	5 633	0	5 633	517	738	1 255	4 380
1976	4 810	0	4 810	499	668	1 167	3 642
1977	4 934	- 17	4 917	497	692	1 189	3 728
1978	4 203	1	4 204	476	735	1 211	2 992
1979	1 255	25	1-280	510	822	1 332	-54
1980	2 644	-110	2 534	350	771	1 101	1 413
			Sum of Compounded Difference Between Simulations				
1975	4 380	0	4 380	517	738	1 255	4 380
1976	10 442	0	10 442	1 016	1 406	2 422	8 022
1977	15 377	-18	15 359	1 513	2 098	3 611	11 750
1978	19 580	-16	19 564	2 848	4 426	5 274	14 742
1979	20 835	8	20 843	2 498	3 655	6 153	14 688
1980	23 479	-102	23 377	2 848	4 426	5 274	16 101

Note: May not add due to rounding.