Prairie Agricultural Production Decisions Under Changing Grain Transportation Policies and Safety Net Support Levels

by

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PRAIRIE AGRICULTURAL PRODUCTION DECISIONS UNDER CHANGING GRAIN TRANSPORTATION POLICIES AND SAFETY NET SUPPORT LEVELS

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Abstract

This study uses a partial equilibrium model to forecast crop and livestock production under various agricultural policy environments for both the short and long run. In particular, the study analyzes the affects of the elimination of the Western Grain Transportation Act (WGTA) subsidy, changes in the Canadian Wheat Board (CWB) freight deductions, and discontinuation of the Gross Revenue Insurance Program (GRIP) on prairie crop production, Western Canadian grain exports, and cattle populations.

Grain and cattle production estimates are prepared for a base year (1993) and forecasts are estimated for the year 2000. Underlying the projected production levels are trends in crop yields and the allocation of land between annual and perennial crops. Supply functions are determined for the Crop Districts within the three Prairie provinces based on each region's capacity to produce wheat and forage crops, the costs of producing annual crops, and the prices for annual and perennial crops. Production estimates are predicted for the regions based on alternative world prices and government program scenarios. Land that is removed from annual crop production under the different scenarios is placed in perennial crop production. The expansion in the cattle herd is calculated based on the productivity of the additional perennial acres in terms of an alfalfa/grass forage crop and the feed requirements of cattle. Sensitivity analysis is performed on the model in terms of the mix of crops exported and the price elasticity of demand for a mix of exports.

The short run results indicate a 4.8 million tonne decrease in grain production as compared to the short run production capacity of the Western Canadian Prairies when the WGTA subsidy is eliminated, the CWB pooling point is shifted to St. Lawrence, and the government safety net subsidy is eliminated. This assumes an equillibrium export price of $169.49 per tonne. The model forecasts a 46 percent decrease in prairie grain production compared to the long run production capacity of the prairies.

The assumptions on short and long run export prices and short and long run costs of production are critical to the results of this analysis. The impact of the policy changes analyzed will be larger if grain prices remain low over the long term. Higher grain prices over the long term will reduce the amount of crop land taken out of cereal grain production. Overall, the long run results indicate that prairie grain production is much more sensitive to price changes than previously estimated.

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Chapter 1

Introduction

1. Introduction

Grain and livestock production in Western Canada have been influenced largely by domestic agricultural policy. The Western Grain Transportation Act, enacted in 1983, resulted in a freight rate structure that subsidized prairie grain exports which indirectly increased the costs of domestic livestock production, production of other non-subsidized crops, as well as value added processing. This legislation ensured that the rate charged for moving grain was lowered through a direct payment of the "Crow Benefit" to the railways from the federal government. The difference between the amount paid by grain producers and the actual cost of moving grain to export position was known as the "Crow Benefit." The payment to the railways from the federal government was known as the Western Grain Transportation Act subsidy (WGTA subsidy).

The WGTA subsidy was originally established at $658.6 million but was reduced to $561 million for the 1994/95 crop year. The average freight rate per tonne for the 1994/95 crop year was $30.35. Of this total cost per tonne, producers paid an average of $14.72 per tonne. The WGTA subsidy covered the remaining $15.63, or 51.5 percent of the total cost of transporting grain from prairie point to export location (Grain Transportation Agency, 1994).

On June 4, 1993, draft legislation was tabled in the House of Commons to publicize the federal government's intentions to reform the western grain transportation system. The announcement to end the WGTA subsidy was made in the federal government's budget speech on February 27, 1995. Effective August 1, 1995, the subsidy to reduce the cost of transporting Western Canadian grain to export position was completely eliminated. Compensation to farmers for the elimination of the subsidy was made in the form of a one-time payout of $1.6 billion to prairie landowners and a $300 million adjustment program. The elimination of the subsidy means shippers have to pay the full cost of moving grain by rail to export position.

In addition to the elimination of the WGTA subsidy, the Canadian Wheat Board (CWB) adjusted the freight rate deductions for CWB grains effective August 1, 1995. Prior this date, prairie producers paid rail rates based on the lesser of freight rates to Vancouver or Thunder Bay. In the past, export prices for Canadian Wheat Board grains were similar at these two locations. In recent years, the value of grain exported via Thunder Bay has decreased relative to the value of grain exported from the west coast. This has resulted in a cross-subsidization effect through the CWB pool accounts. Effective August 1, 1995, the eastern pooling point was adjusted from Thunder Bay to the lower St. Lawrence. This change will result in higher returns through the pool accounts. However, transportation costs to producers who deliver grain in the Thunder Bay catchment area will increase by the full costs of shipping grain through the Seaway.

Safety net subsidies linked to grain and oilseed production also affect production levels by creating incentives to seed land to qualifying crops. The Gross Revenue Insurance Plan (GRIP), established in 1991, guaranteed producers a minimum gross annual per acre return for their crops. GRIP was designed to "top up" revenues from crop insurance and market sales. GRIP contracts were not offered in province of Saskatchewan after the 1994 program year, while the provinces of Manitoba and Alberta curtailed this program a year later.

1.1 Problem Statement

The WGTA subsidy, CWB freight rate deductions basis Thunder Bay and Vancouver, and the GRIP safety net program are all linked to the production of grain. The policies have augmented prairie grain income and influenced the allocation of resources in Western Canada. The elimination of the WGTA subsidy, restructuring of the CWB pooling system, and the demise of the GRIP program, will see the Western Canadian grain economy becoming increasingly dependent on international and domestic market conditions. These policy changes will affect both producers and stakeholders in the grain and livestock industry. In order for stakeholders to make investment decisions and plan for the future it is necessary to know how the policy changes will affect future grain production, livestock production and export volumes of Western Canadian grain. The questions this study will address are:

1. What are the implications of the above policy changes to the allocation of land between grain and forage production?
2. What are the implications of the policy changes to Western Canadian grain production and export volumes, and to livestock populations?
3. Which grain producing areas of the prairies are most sensitive to the policy changes?

1.2 Goals and Objectives

The goals of this study are:

1. to determine the impact of the elimination of the WGTA subsidy and the GRIP safety net program, and adjustments to the CWB's freight rate deduction system on prairie grain production, export volumes, and livestock populations both in the short run and the long run, and
2. to determine the long run world price of wheat that will maintain Prairie grain production levels.

To achieve the above goals, the following objectives are identified:

1. develop short and long run supply functions for Western Canadian grain production,
2. develop excess demand functions for Canadian grain,
3. incorporate the supply and demand functions in a partial equilibrium model to simulate production patterns under varying policy scenarios in the short and long run,

4. examine the sensitivity of the model results to changes in various economic parameters used in conducting the analysis.

Attainment of these objectives will be beneficial to policy analysts and will provide valuable information to stakeholders in the grain and livestock industries for planning purposes by considering the possible reactions of Western Canadian grain producers to the policy changes mentioned above.

1.3 Hypotheses

The hypotheses for this study are as follows.

1. Agricultural policies have augmented grain production and land utilized for grain production. Both will decrease as subsidies tied to crop production decrease.
2. The changes resulting from the elimination of the subsidies will vary in magnitude across regions depending on the relative productivity of the land endowment of the region.

1.4 Outline of the Study

The remainder of the thesis is arranged as follows. Chapter 2 provides background information on the WGTA subsidy, CWB freight rate deductions, and the GRIP safety net program. Studies on the elimination of the WGTA subsidy are also reviewed. Chapter 3 describes the methodology and theory supporting the analysis. This chapter focuses on the theory of the firm and excess demand for Canadian grain. Chapter 4 discusses the formulation of the model and the data used in developing the model. The assumptions and data used in the analysis are described and the empirical model is developed. Chapter 5 presents the results from the simulation model. A discussion of the results under alternative scenarios is presented for each of the prairie provinces and regions within the provinces. The sensitivity of the results to relevant factors is also examined. Chapter 6 provides a summary of the study and conclusions from the study. Limitations of the study are also presented.

Chapter 2

Background

2. Background to the Study

Approximately 59 million acres of arable land in the Western Canadian prairie provinces is used to produce grains and oilseeds for domestic and export purposes annually (Statistics Canada, 1992). Grain production on this land averages approximately 44 million tonnes annually. Of this 44 million tonnes, approximately 15 million tonnes is consumed domestically, while the remaining 29 million tonnes is exported (Canadian Wheat Board, 1993). The majority of grain that is exported is shipped by rail from prairie elevators to either Pacific coast ports or to Thunder Bay on Lake Superior. Grain exported through Thunder Bay must be shipped by laker or rail to the lower St. Lawrence where it is transferred to ocean going vessels.

The WGTA subsidy and the CWB freight deductions (basis Thunder Bay/Vancouver) have resulted in distortions to farm-gate prices for grain. Value added processing and livestock production have been discriminated against in favour of subsidizing grain exports. In addition, government safety net subsidies linked to the production of grain promote incentives to maintain land in annual crops.

The following sections review the history of the WGTA subsidy, the CWB freight rate deductions, and the GRIP safety net program. As well, economic studies that analyze the affects of changes to the WGTA subsidy are reviewed.

2.1 History of Western Canadian Grain Freight Rates

The origin of Western Canadian grain freight rate subsidies dates back to 1897 when the Crow's Nest Pass Agreement was signed. This agreement provided a federal subsidy to Canadian Pacific Railways (C.P.R.) to build a 330 mile rail line from Lethbridge, Alberta through the Crow's Nest Pass to Nelson, British Columbia. (Alberta Pool, 1978). In exchange, C.P.R. agreed to reduce its western freight rates for a number of products, including the movement of prairie grain and flour from all points west of the Lakehead (Freisen, 1987). The rail line was built so Canada could gain access to mining and smelting opportunities in the British Columbia interior. The amount of the subsidy from the federal government to C.P.R. totaled $3.4 million and the reduced freight rates became known as the "Crow Rates."

The Crow Rates were set aside for a period of three years during the First World War as part of the War Measures Act. In July 1922, the rates were reinstated for grain and unprocessed flour as a result of the depressed conditions of the agricultural industry. The Crow Rates on all prairie grain and flour shipped to the Lakehead from all Western Canadian points (via Canadian Pacific Railway or Canadian National Railway) was entrenched in federal legislation in July, 1925 under the Railway Act. In 1927, the law was extended to apply to grain exported via the West Coast, and in 1931 to grain exported through Churchill, Manitoba (Alberta Pool, 1978).

By the end of 1983, it was estimated shippers were paying only 17 percent of the costs of transporting grain to export position (Freisen, 1987). The difference between the Crow Rate (statutory set rate) and the actual cost of shipping grain became known as the "Crow Benefit."

In November of 1983, the Federal Government enacted the Western Grain Transportation Act (WGTA). This Act established a new framework for the operations of the western grain transportation system. The Act removed the legislated rates of 1925 and set up an administered rate structure, with cost sharing for rail transportation between grain producers and the government (Freisen, 1987). The intent of the Act was to ensure rail carriers were adequately compensated for moving grain to export position, and encourage investment in the rail system. The legislation ensured the cost of moving grain was fully compensated through a direct payment of the Crow Benefit to the railways from the government. Export shipments from the prairies to Vancouver, Prince Rupert, Churchill, and Thunder Bay, and grain for domestic use shipped through Thunder Bay qualified for the WGTA subsidy.

The Crow Benefit was originally established at $658.6 million. This was the difference between railway earnings from the old statutory freight rates and the 1983 costs of moving grain by rail. The total value of the WGTA subsidy had been reduced to $561 million by crop year 1994/95 mainly due to federal budgetary constraints. On average, the total cost of moving grain from prairie point to export location was $30.35 per tonne in crop year 1994/95. Of this, producers paid an average of $14.72 per tonne. The government paid the remaining $15.63 per tonne or 51.5 percent of the total cost of moving grain from prairie point to export location (Grain Transportation Agency, 1994).

On June 4, 1993, draft legislation was tabled in the House of Commons to publicize the government's intentions to reform the Western Canadian grain transportation system. Two possibilities under consideration were: (1) payment of the Crow Benefit directly to farmers, and (2) the complete elimination of the Crow Benefit. In February 1995, the Federal Government announced the termination of the Western Grain Transportation Act effective July 31, 1995. The termination of the Act resulted in the complete elimination of the WGTA subsidy resulting in a substantial increase in rail rates paid by producers to export prairie grain. Compensation for the loss of the WGTA subsidy was made to grain producers in the form of a one time payout of $1.6 billion. The payout was based on farmland under annual crop production in 1994 and/or land under summerfallow in 1994 that was under annual crop production during 1993. The compensation was completely de-coupled from future production plans.

Many believe the Crow Rates and the succeeding WGTA subsidy have led to distortions in prairie grain markets and been detrimental to Western Canadian economic diversification and development (MacGregor et al, 1994). The elimination of the WGTA subsidy results in higher transportation costs to shippers to move Western Canadian grain to export position. The increased costs are expected to result in a reallocation of resources from grain production to forage production, as well as increased value added processing on the prairies.

2.2 Canadian Wheat Board Freight Deductions

In addition to the elimination of the WGTA subsidy, freight deductions for Canadian Wheat Board (CWB) grains were also adjusted effective August 1, 1995. The CWB is a Federal Crown Corporation that has sole jurisdiction over the sale of Western Canadian wheat and barley into the export market. The CWB is also the main supplier of wheat and barley for the Canadian industrial market.

The CWB operates four pool accounts (one each for wheat, durum, feed barley, and designated barley). As the CWB sells wheat and barley throughout the year, money received from the sale is pooled into the appropriate pool account. Producers receive an initial payment when they deliver grain and may receive a final payment if there are surplus funds in the pool account after all costs are met. The pool accounts are a form of risk management for Western Canadian producers. These accounts eliminate price fluctuations associated with the timing of sales and marketing opportunities. In addition, infrastructure constraints and costs, and the costs of operating the CWB are shared by all producers through the pool accounts (Canadian International Grains Institute, 1995).

Prior to August 1, 1995, all prairie producers shipping CWB grains shared in the cost of moving grain from Thunder Bay to the lower St. Lawrence Seaway through the pool accounts. The lesser of the freight costs from the producer's location to Vancouver or Thunder Bay was deducted from the initial payment to arrive at a payment to producers. Seaway freight costs from Thunder Bay to the lower St. Lawrence ports were shared by all producers shipping wheat or barley regardless of where the grain was actually shipped. The deduction for the Seaway freight costs averaged between $5.00 to $7.00 per tonne for all producers shipping wheat or barley through the CWB pool accounts. The CWB freight deduction, basis Thunder Bay/Vancouver, was a form of cross-subsidization whereby western prairie shipments subsidized eastern prairie shipments.

As of August 1, 1995, the eastern pooling point for board grains was shifted from Thunder Bay to the lower St. Lawrence River. Historically, the export price received at Thunder Bay was equivalent to the export price received at Vancouver. Recently, the CWB has been able to receive a premium on grains exported through the West Coast as opposed to those exported through Thunder Bay (Agriculture Canada, 1995b). In addition, the actual costs of moving grain through the St. Lawrence Seaway have increased. This has resulted in a decreased in the value of grain at Thunder Bay relative to the value of grain at Vancouver. According to the CWB, the price obtained from grain at port in Vancouver is currently equivalent to the price of grain at St. Lawrence (Gray, 1995).

The change in pooling point from Thunder Bay to the lower St. Lawrence raises freight costs to producers in the eastern part of the Prairies as they now must pay for costs that were previously pooled. Costs to Western Canadian producers will decrease as they no longer have to pay a portion of the St. Lawrence Seaway costs. The change in the pooling point from Thunder Bay to the lower St. Lawrence results in higher returns through the CWB pool accounts from export sales because Seaway costs are no longer deducted.

2.3 Gross Revenue Insurance Plan

In 1991, the Gross Revenue Insurance Plan (GRIP) was initiated as a farm safety net program to provide total income protection to grain producers in Canada. The GRIP program was a voluntary program that combined both a crop insurance and a revenue insurance component to provide grain producers with a minimum gross annual return for their crops. The program was jointly funded by the Federal and Provincial governments and producers (Manitoba Government, 1991). The crop insurance component of GRIP protected producers against yield loss due to natural hazards such as drought, frost, hail, insects, and disease. The revenue insurance component was a deficiency payment to farmers if crop revenues fell below a certain level due to low crop prices or yields. GRIP provided coverage according to a target per acre revenue that was calculated based on a support price for the crop (15 year indexed moving average price) and the long-term average yield determined by crop insurance. Producers were entitled to payouts when the market revenue plus any payout from crop insurance was lower than the target revenue. GRIP payouts to Canadian farmers, for the first three years of the program (1991-1993), totaled $2.78 billion (Agriculture Canada, 1995a). The province of Saskatchewan opted out of the GRIP program in 1995. The program was discontinued in the provinces of

Alberta and Manitoba in 1996. Crop insurance is still available in all prairie provinces through the provincial crop insurance corporations.

2.4 The Economics of Western Canadian Grain Transportation

Since the 1960's there have been numerous studies, consultations, and reviews related to the economics of Western Canadian grain transportation. Some of the studies and consultations conducted during the 1970's and 80's include:

- the Hall Commission, established by the Federal Government in 1975, to examine the status of branch lines and make recommendations on branch-line abandonment,
- the Snavely Commission, established in by the Federal Government in 1975, to examine the cost of moving grain by rail under the statutory rates. This Commission concluded that only 38 percent of the variable costs attributable to grain traffic were covered by users, 24 percent were covered by Federal branch-line subsidies, leaving 38 percent to be absorbed by the railways.
- Harvey (1980 and 1982) conducted an in-depth economic analysis of the Crow's Nest Pass Grain Rates and concluded that "...low transport rates for the movement of raw grain off the prairies is distorting resource allocation within Western Canada and discriminating against secondary processing of grain and livestock production to the extent that almost $400 million is being lost in foregone output" (Harvey, 1982, pp. 23).

- The Gilson Consultations (1982) were conducted to develop a comprehensive and financially sound framework for the western grain transportation system. The establishment of the Western Grain Transportation Act was partially based on the recommendations of these consultations.
- A comprehensive review of the WGTA was carried out and submitted to the Government in 1985. This committee recommended the Crow Benefit be paid through a "Grain Transportation Refund" paid directly to producers on the basis of their net sales of eligible grain in each crop year.

Some of the recent studies that have analyzed how changes to the western grain transportation system may affect grain production include the following.

Kerr et al. (1991) conducted a review of the studies on western grain transportation policies with the objective of determining whether sufficient information was available to assist in policy development on the "method of payment" of the Crow Benefit. Both qualitative studies and quantitative studies were reviewed. The qualitative studies concluded that the elimination of the WGTA subsidy would result in a decrease in farm-gate prices for eligible crops, income from grain would decline on the prairies, and production of higher valued crops would increase. In addition, there would be rapid rationalization of the handling and transportation system, total grain transportation costs would decrease, further processing of eligible crops would occur, and livestock production would increase significantly (Kerr et. al, 1991).

The quantitative studies provided a range of results on the impacts of a change in the method of payment of the WGTA subsidy. The authors concluded that the studies in aggregate did not provide consistent results and could not be used for policy decision making (Kerr, 1991).

Narayanan et al. (1993) evaluated the economic impact of transferring the WGTA benefits to grain producers in the brown, dark brown, and black soil zones in Saskatchewan. The study analyzed the impact on farm prices, farm cash receipts, producer income, and government payments. The authors also analyzed the impact of the change assuming a more efficient rail system, and adaptation in terms of cropping shifts from low-value high volume crops to high-value lower volume crops. The study used a simulation model ("REPCAN") to consider three scenarios; a) the baseline where the WGTA benefit is paid to the railways, b) scenario 2 where the WGTA benefit is paid to producers based on arable acres, and c) scenario 3 where the WGTA benefit is paid to producer based on marketings. The authors concluded that up to 5 million tonnes of grain could be diverted from exports into expansion of the domestic livestock industry and value-added processing industry due to lower on-farm prices in the long run. The authors did not look at a scenario where the WGTA benefit was completely eliminated and assumed Thunder Bay continued to be the CWB pooling point for grain movements eastward.

MacGregor et al. (1994) used an optimization model (Canadian Regional Agricultural Model) to quantitatively assess the implications of changing the method of payment of the Crow Benefit. The study focused on how Prairie grain production is affected by and responds to price changes when marketing costs increase. A number of policy scenarios relating to assumptions regarding the rail rate scale and CWB pooling location were examined. All scenarios are compared to a status quo where the Eastern pooling point remains at Thunder Bay and rail rates continue to be subsidized with the subsidy being paid to the railways. The GRIP program is assumed to be eliminated. In scenario 3, MacGregor et al. assume a revised rail rate scale where producers receive compensation for the elimination of the "Crow Benefit" through a decoupled payment. This scenario assumes the CWB pooling point is switched from Thunder Bay to the St. Lawrence. Scenario 3E considers the case where the beef herd expands to use approximately 50 percent of the unused cropland for forage production.

The results of the MacGregor et al. study suggest a change from the status quo to scenario 3 results in an 8 percent reduction in land seeded to grain in Western Canada. Western Canadian grain production is reduced by 9 percent (3.8 million tonnes) from the status quo scenario. Under scenario 3E, Western Canadian hog production increases by approximately 3 percent, and cattle populations increase by 19 percent. The authors conclude that paying the Crow benefit to the railways and basing CWB freight deductions on Thunder Bay distorts resource use thereby reducing economic returns in Western Canada.

2.5 The Affect of Government Policies on Production Decisions

According to Meilke and Weersink (1990), agricultural production decisions are based on output and input prices, expected yields, rotational considerations, and production technology. In addition, producers base their decisions on government support programs which generate artificial market conditions. Government safety net programs and subsidies tied to grain production have the potential to change the level of production and affect the mix of crops grown if the expected return for the crop are changed as a result of the program (Meilke and Weersink, 1990).

Wilson and Hope (1992) investigated the degree to which the economic environment for livestock production and value added processing in Western Canada is affected by government policies and regulations. They concluded that the WGTA subsidy affected livestock producers by raising the on-farm price of grain used for feed. The on-farm price of grain is related to the export price less the costs of moving grain to export position. Increased on-farm grain prices encourage production of grain on land that may otherwise be used for grazing purposes or forage crop production. The elimination of the WGTA subsidy increases the costs to producers of transporting grain to export position resulting in a decrease in on-farm grain prices and reduced feed costs to livestock producers.

According to Elliot (1995), the elimination of the Crow Benefit will cause a change in cropping patterns and markets. In particular, there will be a decrease in the area seeded to annual crops as the incentive to seed marginal land is reduced. There will be a shift in production to higher valued crops which generally have lower volumes, and value added processing on the prairies should become more attractive. As well, there will be an increase in feed requirements if livestock production activities increase substantially in the prairie provinces. These activities will result in a decrease in Canadian grain exports.

2.6 Other Considerations

Other issues that may influence future grain production decisions include the rail car allocation process which is currently under review, efficiency gains in the Canadian transportation and handling system, the future role of the CWB as well as other marketing issues under review by the Western Grain Marketing Panel. Grain production levels in Western Canada may also be affected if US routes become economical resulting in on-farm price changes associated with lower transportation rates (Transport Institute, 1994). However, according to Elliot (1995) if large volumes of grain are diverted south through the US, the Canadian grain handling and transportation system would have to adjust to become more competitive in terms of costs and reliability. Although these factors may have an affect on Western Canadian grain production they will not be examined in this paper.

2.7 Conclusions

Many studies have examined Western Canadian grain transportation issues, particularly various methods of paying the WGTA subsidy. The majority of studies have focused on the pay the producer method of payment option. The MacGregor et al. (1994)

study is one of the few studies that has qualitatively evaluated the impact of completely eliminating the WGTA subsidy combined with moving the CWB pooling point from Thunder Bay to the St. Lawrence Seaway. This study will enhance the qualitative information available on how the policy changes made in 1995 may impact future grain production levels in the agricultural regions of Western Canada.

Chapter 3

Methodology and Theory Supporting Analysis

3. Methodology and Theory Supporting Analysis

This chapter outlines the economic theory underlying the analysis used in this study. The first section outlines the theoretical framework of the analysis. The second section examines the economic theory of the firm and how it relates to the production decision making process. The third section examines the theory relating to the world excess demand function for Canadian grain. In addition, a discussion of simulation modeling and sensitivity analysis is included.

3.1 Theoretical Framework

This study uses a partial equilibrium model to analyze the impacts of the elimination of the WGTA subsidy, change in CWB freight deductions, and the elimination of the revenue component of the safety net program on the production decisions of Western Canadian grain producers. Partial equilibrium analysis does not include all variables that may be affected by changes to the economic system being studied (Varian, 1984). Some variables are assumed to be exogenous to the system and fixed at pre-determined levels. Partial equilibrium analysis is frequently used for economic analysis because the models are easier to develop and the results are easier to analyze.

In order to conduct this study, prairie grain supply and world excess demand functions are developed under various scenarios and the associated economic equilibrium points are determined. The supply and demand functions give the optimal choices of outputs and inputs as a function of prices (Varian, 1984). The economic equilibrium occurs when the world price is such that the excess supply of Canadian grain is equal to the world excess demand for Canadian grain. It is assumed that price adjusts to equilibriate the market at the point where no agent desires to change his or her actions (Varian, 1984). Both the excess demand functions and the excess supply functions calculated in this study are static in nature in that they show how much grain will be supplied or demanded per unit of time as price varies, other factors held constant (Varian, 1984). The model is non-spatial as it does not identify trade flows between specific regions.

3.2 The Theory of the Firm

The behavior of grain farmers with respect to production decisions can be explained within the microeconomic framework of the theory of the firm. It is assumed that a firm operates in an optimizing manner with an objective to maximize profits over both the short run and the long run, subject to technological and market constraints (Varian, 1984).

The short run is defined as the period of time in which some of the firms inputs are fixed. In other words, the firm cannot change the quantity or type of certain inputs during the period of time under consideration. Production plans are possible only if they are compatible with these fixed factors. Inputs such as labor, which the firm can vary in quantity in the short run are referred to as the firm's variable inputs. The long run is defined as the period of time in which all inputs are variable. The firm can make complete adjustment to any change in its environment in the long run. The short and long run are relative concepts as the time required for production response varies from commodity to commodity (Varian, 1984).

In attempting to maximize profits the firm faces technological and market constraints. Technological constraints refer to considerations that affect the technical feasibility of the production plan and must be considered when making output and input decisions, particularly in the short run. For example, grain producers are faced with land and equipment constraints in the short run. Not all levels of production can be achieved by the firm and the optimal solution is limited to those levels that are technologically feasible (Varian, 1984). The technological constraints determine the shape of the production function.

The firm also faces market constraints. Market constraints refer to the decisions and actions of other agents in the market. A firm cannot make production decisions nor set a price to sell output without taking into account the reactions of other firms in the same industry (Varian, 1984). For the purpose of this study, it is assumed grain producers operate under the market structure of perfect competition in both the input market and the output market. Perfect competition occurs when there are a large number of independent sellers of some uniform homogeneous product with free entry to and exit from the market without constraint. If perfect information exists among consumers, the price each firm charges for its product will be the same (Varian, 1984). Under the assumption of perfect competition, individual producers have no control over prices received for their crop or the costs of factor inputs. Each producer must take the market price for inputs and outputs as given when determining production levels.

The objective of the individual firm, is to maximize profits. Profits are defined as total revenue less total costs (including both variable costs and fixed costs). Revenue is composed of how much a firm sells of its outputs times the price of each output. Costs are composed of how much a firm uses of each input times the price of each input. Because it is assumed input prices and market prices for grain cannot be influenced by an individual producer, the firm's profit maximizing problem is to determine the optimum level of production it should undertake and the optimum level of inputs it should use.

Under the market structure of perfect competition with the objective of profit maximizing, microeconomic theory suggests that two conditions must be satisfied for optimal behavior of the firm. First, the producer must choose an output level such that the additional costs of producing one more unit just equals the additional revenue generated by the output. If the marginal revenue from an activity is greater than the marginal cost it makes sense to increase the level of the activity. If the marginal revenue is less than the marginal cost it would pay to decrease the level of the activity. Under perfect competition, marginal revenue is the market price from selling one more unit of output (Varian, 1984).

The second condition for profit maximization is that the marginal cost must be increasing at the optimal level of output (Varian, 1984).

A firm's supply function can be derived based on underlying input-output relationships using econometric methods. Econometric analysis is a method used to estimate the relationship between a dependent variable, such as the supply of cereal grains or oilseeds, and explanatory variables, such as the factors affecting supply. Econometric models can be used to predict future values of the dependent variable on the basis of known or forecasted values of the explanatory variables (Gujarati, 1978). Factors affecting the supply of cereal grains and oilseeds include the expected price of the commodity, the expected price of alternative commodities, input costs, biological factors such as weather, as well as technological and market constraints. The use of econometrics to estimate a Prairie supply function requires the estimation of supply functions for all major grains and oilseeds grown in Western Canada. The individual supply functions then have to be aggregated to determine a total supply function for Prairie cereal grain and oilseed production. Only a small portion of the supply curve is observable using historic data. Therefore, the estimated supply function using regression analysis techniques may not accurately represent all levels of Prairie supply.

An alternative method to the use of econometric techniques is to derive a firm's supply function based on the underlying cost functions of the firm. Cost curves are determined based on the physical production possibilities of a firm, and the costs of inputs (which are assumed to remain constant) (Tomek and Robinson, 1987). This is the approach employed in this study to determine Western Canadian cereal grain and oilseed supply.

When a firm takes prices as given in its output market and its input market the firm's short run cost function can be defined as:

$$c(y) = vc(y) + fc \tag{3.1}$$

where:

- $c(y)$ = total cost of producing a level of output y,
- $vc(y)$ = variable costs as a function of the output level y,
- fc = costs incurred in the short run for fixed inputs (constant),
- y = output level.

The above cost function represents the minimum cost of producing a level of output y when factor prices are given and represents the economic possibilities of the firm. In the short run, the cost function has two components. These are the variable costs of production which depend on the level of production and the fixed costs of production. In the long run, all costs are assumed to be variable (Varian, 1984). Under the assumption that input prices are given, production costs depend only on the level of output of a firm. The problem of the firm is to determine its level of output such that costs are just covered.

The profit maximizing conditions previously identified determine the supply function of a firm operating under perfect competition. In order for a competitive firm to supply an amount y, the market price must equal the marginal revenue or marginal costs, and the marginal costs must be increasing (Varian, 1984). This level of output is only optimum if output is greater than zero. In some cases, the firm is better off not producing anything. This occurs if the output price does not cover the average variable costs of production. If a firm chooses to produce at $y=0$, the firm still has to cover fixed costs of production. The supply curve for a firm under perfect competition is:

$$p = c'(y) \quad \textbf{if} \quad py - vc(y) - fc \geq -fc \qquad \textbf{(3.2)}$$
$$y = 0 \quad \textbf{if} \quad py - vc(y) - fc < -fc$$

The first equation indicates that the market price (p) must be greater than or equal to average variable costs for production to occur and the optimal production level will be at the point where marginal cost equals price. The second equation states that if market price is less than average variable costs the firm will not produce anything ($y=0$). If the market price does not cover variable costs it does not pay to remain in production. In the long run all costs are variable. Therefore the firm must cover all costs of production in the long run in order to remain in production (Varian, 1984).

The market supply curve is defined as the total quantity offered for sale by all producers within a given region at different prices, all other factors held constant. It is the summation of the individual supply curves.

In addition to the short and long run costs of production, opportunity costs of producing a commodity must be taken into account when determining the level of production of a firm. The opportunity cost is the income foregone by not producing another commodity. The opportunity cost of producing grain may include the revenue foregone from working off the farm or earnings that could be made by using the same resources of production in a different way (Tomek and Robinson, 1987).

3.3 Demand Theory

A demand function defines the relationship between price and quantity demanded, holding all other factors constant. Demand theory is based on the assumption that consumers strive to maximize utility subject to income constraints. In general, an inverse relationship exists between quantity demanded and price. A market demand curve is a summation of the individual demand curves for consumers in a particular market.

Factors that result in a shift in the demand curve include change in population size, change in consumer income and its distribution, prices and availability of other commodities and services, and consumer tastes and preferences (Tomek and Robinson, 1987). If the demand curve shifts to the right, consumers are willing to buy the same quantity at a higher price.

Western Canadian grain production decisions and exports are affected by world prices and government programs which affect the on-farm price realized by producers. For the most part Canada is a price taker in the world grains and oilseeds market. Factors affecting world grain and oilseed prices include market structure, overall trends in the economy, global stocks, government policies, and changes in supply and demand.

In order to estimate the world export price under varying government policy scenarios it is necessary to determine how a change in Canadian exports affects the world export price. The excess demand for Canadian exports is based on the world excess demand less the excess supply from other exporters. The price elasticity of export demand measures how a change in Canadian exports affects the world export price. Knowledge about the underlying price elasticity of export demand allows one to estimate the excess demand function for Canadian grain.

3.3.1 Price Elasticity of Export Demand

Price elasticity of export demand specifies a relationship between an export price and the quantity exported of a specific commodity. The estimate measures the percentage change in quantity of exports demanded for a one percent change in export price, all other factors held constant (Gardiner and Dixit, 1987). The measure summarizes the reactions of both importing and exporting countries to a price change by an exporting country. If the price elasticity of export demand is elastic (greater than 1), a given percentage change in price results in a greater percentage change in quantity demanded and a greater percentage change in quantity exported. If the price elasticity of export demand is inelastic (less than 1), a given percentage change in price results in a smaller percentage change in quantity demanded and a smaller percentage change in quantity exported.

A report by Gardiner and Dixit (1987) outlines the factors affecting the price elasticity of export demand and reviews numerous studies that calculate demand elasticities for wheat exports. Of the studies reviewed, 17 provided short run estimates (defined as 1 year or less), and 12 provided long run estimates (defined 3 to 5 years). The short run price elasticity of export demand estimates for US wheat ranged from -0.15 to -3.13 with an average of -0.72. Dropping the high and low values yielded an estimate of -

0.6. The summary by Gardiner and Dixet (1987) indicate that empirical estimates for the elasticity of export demand parameter can vary greatly depending on the methodology used and the time frame of the analysis. The long run estimates ranged from -0.23 to -6.72 with an average of -1.93. Dropping the high and low values yielded an estimate of -1.62.

There are many factors affecting the value of the price elasticity of export demand. In general, the elasticity of export demand is more elastic in the long run than in the short run (Gardiner and Dixit, 1987). This is because producers and consumers have greater opportunities to adjust their behavior in the long run. Government policy within exporting and importing countries also affect the price elasticity of export demand when the policies influence consumption, stockholding, and production patterns. Under conditions of liberalized trade, the price elasticity for export demand is estimated to be more elastic than under conditions where barriers to trade exist. In addition, the share of the market that a country supplies determines the responsiveness of that country's exports to a price change. The larger a country's share of the market, other things unchanged, the smaller the elasticity of export demand for the commodity (Gardiner and Dixit, 1987).

Changes in the above factors as well as changes affecting demand such as population growth, income growth, and changes in taste and preferences cause the export demand curve to shift or rotate. The elasticity of export demand depends on the new equilibrium level of the export price and quantity, as well as the shape and position of the excess demand schedule (Devadoss and Meyers, 1988). Both Gardiner and Dixit (1987) and Devadoss and Meyers (1988) state that despite the number of studies that have been devoted to estimating the price elasticity of export demand for agricultural exports, there has not been a consensus on the magnitude of the elasticity estimates.

3.4 Simulation Modeling and Sensitivity Analysis

The objective of this study is to determine the change in prairie grain production and export volumes in response to the elimination of various grain transportation subsidies and the GRIP safety net program. This is achieved through the simulation of a partial equilibrium model. Simulation models are often used in analyzing the implications of policy changes, and to observe how a system behaves over time (Groebner et al., 1992). Producers and stakeholders in the grain industry are often required to make important economic decisions that will affect their enterprises for many years. A computer simulation model allows decision makers (for example individual farmers, industry stakeholders, or policy makers) to test "what if" scenarios and see the possible short and long term consequences of the scenarios without making changes to the real system or having to wait the "actual" time for the consequences to happen.

There are many factors affecting the production decisions of Western Canadian farmers. The model developed in this study represents, as accurately as possible, the production decision making process of producers in Western Canada. However, in order to determine how policy changes affect short and long run grain production it is necessary to make assumptions about many parameters used in this study. Therefore, the affects of transportation freight subsidies on prairie land use, grain production, and livestock populations can not be calculated with certainty. Sensitivity analysis is used to determine how sensitive the results of the analysis are to different assumptions used in the study. It shows how a change in a parameter will affect the results of the study. This allows the comparison of various equilibrium states under different assumptions (Chiang, 1984).

Chapter 4

Methodology and Description of Data

4. Methodology and Description of Data

This chapter describes the methodology and data used to formulate the simulation model used in this study. The model forecasts grain production under varying scenarios for the Western Canadian prairie provinces as well as for the crop districts within the provinces. Maps A.1, A.2, and A.3 in Appendix A outline the 12 crop district boundaries in Manitoba, the 9 crop district boundaries in Saskatchewan, and the 7 agricultural regions in Alberta respectively.

Short and long run supply functions are estimated for each province and crop district in terms of hard red spring wheat production. The supply functions are determined based on each region's capability to produce wheat and perennial crops, the costs of producing annual crops, and the value of perennial crops. Volume estimates are then predicted for the provinces and crop districts based on alternative world prices and government program scenarios. An excess demand function for Canadian grain exports is developed to determine how a change in Canadian grain exports affects world export price. Cultivated land that is removed from annual crop production under the different scenarios is assumed to be placed into perennial crop production. The expansion in the cattle herd is linked to the output of the additional forage production, and the feed requirements of the cattle. The following methods and data sources are used in the compilation of this study.

4.1 Crop Productivity

The provincial crop insurance corporations have categorized all arable land in Western Canada in terms of its relative capability for crop production. The crop insurance corporations have divided the provinces into zones called risk areas. These divisions are made to separate areas on the basis of productivity capabilities and the relative climatic risks to crop production. For example, the province of Manitoba is divided into 16 risk areas for the production of annual and perennial crops. Map A.4 in Appendix A illustrates the risk area boundaries in the province of Manitoba. Within each risk area, all arable land has been further categorized in terms of a soil productivity rating based on relative yields associated with the soil characteristics. For example, in Manitoba each risk area is further subdivided into soil zones A through J, with soil zone A being the most productive and soil zone J being the least productive. Map A.5 in Appendix A illustrates the soil productivity zones in the municipality of MacDonald, which is located in risk area 12 in Manitoba.

The number of risk areas and soil productivity zones varies for each province. In Manitoba, the risk area boundaries and soil productivity classifications are the same for annual and forage crops. In Alberta, there are 22 risk areas for annual crops, with soil productivity zones A through F. The province is divided into 35 forage risk areas with no soil productivity classifications for forage crops. The province of Saskatchewan is divided into 23 risk areas for annual crops with soil productivity zones A through P. The province is divided into 17 risk areas for forage crops with no soil productivity classifications.

4.1.1 Yield

The provincial crop insurance corporations have assigned annual crop yield capabilities to each soil productivity zone within each risk area. The yield ratings are called coverage levels and are based on crop production records collected from farmers insured by the corporation. The yield rating for each soil productivity zone provide the basis for the corporation to determine and set coverage levels for all the crops they insure. In this study, the long term average yields assigned for hard red spring wheat and an alfalfa-grass forage mixture serve as the basis for determining the production capabilities of annual and perennial crops for each soil productivity zone in each municipality.

Table 4.1 illustrates the range of wheat yields in Manitoba for the different crop insurance soil productivity classifications. The range in yields for each soil class (A through J), and the overlap in yields between each class, is a result of differences in productivity associated with the different risk areas. For example, a "B" soil class in risk area 6 has a wheat long term average yield of 0.95 tonnes per acre while a "B" soil class in risk area 11 has a wheat long term average yield of 1.16 tonnes per acre. A "C" soil class in risk area 11 has a wheat long term average yield of 1.05 tonnes per acre.

Table 4.1: Range of Long Term Average Wheat Yields based on Manitoba Crop Insurance Corporation's Soil Productivity Classifications.

Soil Productivity Class	Low Wheat Yield (Tonnes/Acre)	High Wheat Yield (Tonnes/Acre)
A	1.17	1.17
B	0.95	1.16
C	0.83	1.07
D	0.82	1.05
E	0.75	1.00
F	0.75	0.99
G	0.64	0.95
H	0.56	0.87
I	0.50	0.80
J	0.44	0.64

Source: Manitoba Crop Insurance Corporation, 1993.

The crop insurance corporations in Saskatchewan and Alberta determine yield ratings for annual crops seeded on stubble land as well as annual crops seeded on fallow land. A crop seeded on stubble refers to a crop that is seeded on land that was under crop production in the previous year. A crop seeded on fallow refers to a crop that is seeded on land that was left idle or "fallowed" in the previous year. Summerfallow is a common practice in the dryer areas of the prairies, particularly in Saskatchewan. Crops seeded on land previously under fallow tend to have higher yields than those seeded on stubble due to the replenishment of soil moisture during the fallow year. Table 4.2 illustrates the yield differences for crops seeded on stubble and crops seeded on fallow in risk area 1 in Saskatchewan. The Manitoba Crop Insurance Corporation does not differentiate long term average yields on the basis of stubble or fallow seeded crops. In Manitoba, Saskatchewan, and Alberta approximately 10, 30, and 16 percent respectively of the total land base available for crop production is under summerfallow annually (Statistics Canada, 1992).

Table 4.2: Comparison of Wheat Long Term Average Yields under Stubble or Fallow Cropping Practices.

Long Term Average Wheat Yields In Saskatchewan Risk Area 1		
Soil Productivity Class	Fallow Wheat Yield (Tonnes/Acre)	Stubble Wheat Yield (Tonnes/Acre)
F	0.84	0.67
G	0.81	0.64
H	0.78	0.61
J	0.74	0.57
K	0.70	0.54
L	0.64	0.47
M	0.58	0.41
O	0.52	0.34
P	0.43	0.26

Source: Saskatchewan Crop Insurance Corporation, 1993.

The long term average hard red spring wheat yields, established by the provincial crop insurance corporations, are used to represent the yields of prairie grains and oilseeds and to determine potential grain production on the prairies. Land under annual crop production is identified as stubble acres or fallow acres in Saskatchewan and Alberta due to the large percentage of summerfallow in these provinces and the differential yields and costs associated with these practices.

4.1.2 Yield Trend

Over the past 85 years there has been a monotonic upward trend in the production of grains and oilseeds on the Canadian prairies of approximately two percent annually (IISD, 1994). This output trend is due to increased land under cultivation, increased genetic potential of crops, improved pest control, and increased fertilizer use. The continuation of this trend in yield is becoming more of a challenge. The crop insurance long term average yields are based on 15 year average yields for Manitoba and Saskatchewan (1978-1992), and 10 year average yields for Alberta (1983-1992). The following yield index equation is used to adjust the crop insurance long term average yields to 1993 levels, and to project grain production for the year 2000 assuming a 1.5 percent increase in yield per year.

$$YI = (1.015)^{(Y^P - Y^B)} \tag{4.1}$$

where:

YI = index used to adjust yields to a particular year,

Y^P = year of grain production projections,

Y^B = base year of the crop insurance long term average yields.

A study, by Kraft and Monchamp (1994), concluded that Manitoba Crop Insurance Corporation long term average yields for risk area 12 (Red River Valley) in Manitoba are too low for wheat, barley, canola, and flax. The yields supplied by Manitoba Crop Insurance for risk area 12 were adjusted upward by the amounts shown in Table 4.3 to reflect the current production potential in this area.

Table 4.3: Adjustment to Manitoba Crop Insurance Corporation Risk Area 12 Wheat Long Term Average Yields.

Increase in the Long Term Average Yields in Risk Area 12 by Soil Class.	
Soil Productivity Class	Increase in Wheat Long Term Average Yields (Kg/Acre)
12B	144
12C, 12D	131
12E, 12F, 12G	147
32C, 32D	120
32E,32F,32G	147
32H	278

Source: Kraft and Monchamp, 1994.

4.2 Cropped Acreage

In order to determine the area currently in annual crop production and the relative productivity of this land two data sources are used. The 1991 Agricultural Census data (Statistics Canada, 1992) reports the number of acres seeded to annual crops and the number of acres in summerfallow in each province on a municipality basis. These values are used as the basis for determining the total land base available for annual crop production in each municipality. Provincial crop insurance data is then used to determine the production capability of land within each municipality. Since 1991, crop insurance contracts have included between 55 to 95 percent of all land producing annual crops. Each year, the area insured under crop insurance is recorded for each municipality. Not only is the total area insured recorded, but the soil productivity classification of each field is also filed. For example, in 1993 the total insured area producing crops on land with capability rating "A" is known for each municipality. On this basis, given the long term average hard red spring wheat yield assigned to soils A through J, it is possible to determine the production capability of an area in terms of a wheat equivalent. Before this can be done however, the land not insured must be accounted for.

The difference between the 1991 crop insurance municipality totals and the land seeded to annual crops reported in the 1991 Agricultural Census (by municipality) reflects uninsured cropland. The uninsured acres are assigned to the various crop insurance soil productivity zones in the same proportion as the insured lands as long as the total area of any one soil class is not exceeded. Equation (4.2) illustrates the formula used to determine the area under annual crop production in each soil productivity zone for each municipality.

$$A_{xi} = \left[CI_{xi} + \left(\frac{CI_{xi}}{\sum_x CI_{xi}} \right) \times (TA_i - \sum_x CI_{xi}) \right] \qquad \textbf{(4.2)}$$

where:

A_{xi} = total area under annual crop production in soil productivity zone x municipality i,

CI_{xi} = area insured by crop insurance in soil productivity zone x municipality i,

TA_i = total area under annual crop production in municipality i (as reported in the 1991 Agriculture Census),

x = soil productivity zone,

i = municipality.

The adjusted area (A_{xi} in equation 4.2) accounts for the land seeded to annual crops only. Land reported in the 1991 Census as being under forage production is not included in the land base. It is assumed this proportion of land will remain in forage production and will not be used to produce grain crops in future years. For Saskatchewan and Alberta it is necessary to further specify these cropped acres in terms of acres seeded on stubble and acres seeded on fallow.

4.2.1 Summerfallow Land

Significant amounts of arable land on the Canadian prairies is under summerfallow each year in order to reduce the risk of crop failure in more arid regions. The practice of fallowing land is most predominant in the hot dry areas of the prairie provinces where seasonal moisture supply is a serious limiting factor to crop production. Other benefits of fallowing may include weed control and conversion of organic nitrogen to a plant useable inorganic form (Campbell, 1990).

Arable soils in the prairie provinces range in type from Brown and Dark Brown in the southern parts of Saskatchewan and Alberta, to Black and Gray soils in Manitoba, central and northern Saskatchewan, and Alberta (see Map A.6 in Appendix A). Moisture deficits are a major limiting factor to crop production in the Brown soil zone . In the Dark Brown soil zone moisture deficits are also a serious concern to crop production, however the problem is generally not as limiting as in the Brown soil zone. Summerfallow is a legitimate option in the Brown and Dark Brown soil zones, as the year of summerfallow replenishes soil moisture. In the Black and Gray soil zones, moisture deficits are not generally a limiting factor to crop production and the practice of summerfallowing land for the replenishment of moisture is not as critical (Campbell, 1990).

The area under summerfallow (summerfallow share) is calculated for the predominant soil colour classifications (Black, Dark Brown, Brown, and Gray Wooded) for the provinces of Saskatchewan and Alberta. Each municipality is assigned to a colour group based on the predominant soil type in the municipality (municipalities in Alberta as determined by Environmental Management Associates, and municipalities in Saskatchewan by overlaying a municipality map with a soil type map). The summerfallow share is initially determined on a municipality basis using the information provided by farmers in the 1991 Agriculture Census. The summerfallow share for each soil type (Brown, Dark Brown, Black and Gray Wooded) is then determined by province as shown in equation (4.3). The summerfallow share is weighted according to the number of acres in annual crop production in each municipality for the particular soil type.

$$\%SF_a = \left(\frac{\sum_{i=1}^{n} SF_{ai} \times TA_{ai}}{\sum_{i=1}^{n} TA_{ai}} \right) \times 100 \qquad \textbf{(4.3)}$$

where:

$\% SF_a$ = weighted average summerfallow share for soil type a,

SF_{ai} = summerfallow share for soil type a in municipality i,

TA_{ai} = total area seeded to annual crops in soil type a in municipality i,

a = predominant soil type (Brown, Black, Dark Brown, or Gray Wooded),

i = municipality.

Table 4.4 illustrates the weighted average share of land under summerfallow in Alberta and Saskatchewan by soil type calculated using equation (4.3).

Table 4.4: Summerfallow Share per Year by Soil Type.

Soil Type	Saskatchewan Share Summerfallow	Alberta Share Summerfallow
Brown	43 %	30 %
Dark Brown	34 %	23 %
Black	20 %	9 %
Gray Wooded	Not Applicable	9 %

It is also necessary to determine the total land base available for annual crop production in each municipality for each crop insurance soil productivity zone. The total land base includes the area seeded to annual crops as well as the land under summerfallow. The total land base is calculated as follows:

$$TLB_{ai} = \frac{TA_{ai}}{(1 - \% SF_a)} \tag{4.4}$$

where:

TLB_{ai} = total area available for crop production in municipality i soil type a,

TA_{ai} = area seeded to annual crops in municipality i soil type a,

$\% SF_a$ = percent summerfallow corresponding to soil type a,

a = soil type (Brown, Dark Brown, Black, Grey Wooded),

i = municipality.

The total land base within each crop insurance soil productivity zone is then assigned to either idle summerfallow acres, acres seeded on stubble, or acres seeded on fallow. The land is assigned to these categories based on the weighted average summerfallow share of the dominant soil type (Brown, Dark Brown, Black, or Gray Wooded) in the municipality as shown in equations (4.5) through (4.7).

$$ISFA_i = \%SF_a \times TLB_{ai} \quad (4.5)$$

$$FA_i = \%SF_a \times TLB_{ai} \quad (4.6)$$

$$SA_i = (1 - 2 \times \%SF_a) \times TLB_{ai} \quad (4.7)$$

where:

$ISFA_i$ = idle summerfallow acres in municipality *i*,

$\% SF_a$ = share summerfallow corresponding to the predominant soil type *a* of the municipality,

TLB_{ai} = total land base in municipality *i* soil type *a*,

FA_i = annual acres seeded on fallow land in municipality *i*,

SA_i = annual acres seeded on stubble land in municipality *i*,

i = municipality,

a = predominant soil type of the municipality (Brown, Dark Brown, Black, Grey Wooded).

An exogenous summerfallow change variable is built into the model to allow assumptions about future levels of summerfallow. The summerfallow change variable is specified as follows:

$$\% SF_{new} = \% SF_{orig} - (\% SF\Delta \times \% SF_{orig}) \qquad \textbf{(4.8)}$$

where:

$\% SF_{new}$ = percent adjusted summerfallow,

$\% SF_{orig}$ = percent summerfallow based on the 1991 Census,

$\% SF\Delta$ = percent change in the level of summerfallow (exogenously defined).

For example, it is possible to assume the summerfallow levels will decrease by 25 percent from current levels by the year 2000. The model will calculate the relative shift in uncropped land, summerfallow cropping, and stubble cropping. The total land base, however, is assumed to remain at current levels.

In Manitoba, the summerfallow share is determined on a crop district basis. Long term average yields based on stubble or fallow cropping practices are not available from Manitoba Crop Insurance. Therefore cropped acres are not assigned to specific fallow or stubble practices. However, it is still possible to exogenously adjust the level of summerfallow in a crop district which will affect the number of cropped and idle acres.

4.3 Grain Production

The volume of grain produced in each crop insurance soil productivity zone in each municipality is calculated by multiplying the area seeded to annual crops in each soil productivity zone within each municipality by the trend adjusted long term average wheat yield for the corresponding soil productivity zone. The crop yields for stubble and fallow seeded crops in Saskatchewan and Alberta are multiplied by the respective areas seeded to stubble or fallow for each soil productivity zone in each municipality. The volume of grain produced on fallow and stubble is then added together to determine the total volume produced per soil productivity zone per municipality.

By merging the crop insurance data with the Agricultural Census data it is possible to build a data set for each municipality in terms of the areas producing annual crops and the differential yield capabilities of the land in each area. The purpose of identifying the relative distribution of agricultural land in terms of productivity within each municipality is to determine which regions are more sensitive in switching from annual to perennial crops when the relative earnings change.

4.4 Crop Production Costs

The analytical model assumes that unless farmers can recover the costs of producing grains and oilseeds they will switch to forages. In the short run, the sum of the variable costs of grain production and the opportunity cost of using the land for grain production must be less than the revenue from grain sales. In the long run, the study assumes crop receipts must also exceed the additional fixed costs of grain production. These costs include depreciation and investment in machinery and buildings, and the opportunity costs of family labour and management. Costs within the farm gate exclude transportation and handling costs for local delivery and export of grain. Variable costs are linked directly to the annual production of cereal grains and oilseeds. Fixed costs include the machinery and buildings used in the grain operation that must be replaced over time. Opportunity costs include the rental value of the land seeded to grasses and alfalfa in the short run as well as unpaid family labour in the long run.

The provincial departments of agriculture, through farm management specialists, develop crop budgets. These budgets are compiled through farm consultations and analysis of farm records. In Manitoba there is one crop budget for the entire province. However, in Saskatchewan and Alberta the budgets vary by region or soil type (Brown, Dark Brown, Black, or Gray), and whether the crop is seeded on stubble or fallow. In the 1991 Agricultural Census farmers were asked to provide information on fertilizer, pesticide, fuel, and farm machinery repair expenditures, as well as the market value of farm machinery and equipment, and the farm interest expenses on operating debt. The variable costs and fixed costs used in this study are based on the provincial crop budgets, as well as on statistical analysis of the expenditures reported by farmers in the 1991 Agricultural Census. The variable and fixed costs calculated using the 1991 Census data are verified with other sources such as the Farm Credit Corporation's Farm Survey Report (1992), Statistics Canada information, and the provincial crop budgets. The costs are converted to 1993 dollars through the Western Canada Farm Input Price Index. The Farm Input Price Index

(FIPI) is a weighted average price of a basket of crop production inputs such as fertilizer, pesticides, fuel, seed grain, labour machinery maintenance, small tools, electricity, telephone, custom work, property tax and operating interest. For the long run analysis, costs are adjusted assuming a 2.5 percent increase in costs per year. This increase is based on Agriculture Canada's Western Canadian Farm Input Price Index Forecast to the year 2000 (Agriculture Canada, 1995c). The 1991 Census records are used to determine any regional cost differences by crop district or soil type.

The costs for Saskatchewan and Alberta differ depending on whether the crop is seeded on stubble land or fallow land. A crop seeded on fallow generally has a higher yield potential and a lower input requirement than a crop seeded on stubble. However, there are costs incurred in the year of fallow which must be included in costs of the production for the subsequent crop. There are 3 distinct soil zones in Saskatchewan (Black, Dark Brown, and Brown) and 4 in Alberta (Gray Wooded, Black, Dark Brown and Brown). The crop budgets developed by the Saskatchewan and Alberta Departments of Agriculture are different for each soil type due to differences in agricultural practices utilized in each soil type. Therefore, costs for Saskatchewan and Alberta are determined on a per acre basis for crops seeded on stubble or crops seeded on fallow, for each predominant soil type.

4.4.1 Variable Costs of Production

Variable costs for this study include expenditures on seed, fertilizer, pesticides, fuel, machinery repairs, and interest paid on operating debt. Expenditures for crop and revenue insurance were excluded because programs of this nature change the expected crop yield and revenue due to the fact that governments subsidize premiums. These programs may be critical in retaining some lands in cereal grains and oilseed production, however, they are not the subject of the current study. To the extent that these programs influence the volume of production, the subsidies paid in terms of premium contributions by the Federal and Provincial governments are added to the market revenues to determine production with and without such programs.

4.4.1.1 Seed

The seed costs for Manitoba and Saskatchewan are taken from the crop budgets developed by the provincial departments of agriculture. The seed costs in Manitoba are constant throughout the province, while the costs in Saskatchewan vary according to soil type. The seed costs for Alberta are assumed to be similar to the costs in Saskatchewan.

4.4.1.2 Interest on Operating Expenditures

The interest on operating expenditures represents the interest charges on cash operating costs. The value used for Manitoba is the value reported in the Manitoba crop production guide. The values for Saskatchewan and Alberta are calculated by performing regression analysis using the 1991 Agricultural Census data. The farm interest expenses paid on operating debt, as reported by farmers, is the dependent variable and the annual and forage acres are the independent variables. Table B.1 in Appendix B provides the results from the regression analysis.

4.4.1.3 Fertilizer, Pesticides, Fuel, and Machinery Repairs

Expenditures on fertilizer, pesticides, fuel and machinery repairs are determined using information provided by farmers in the 1991 Agricultural Census. The procedure for determining these costs is similar for the provinces of Saskatchewan and Alberta, however the procedure for determining these costs for the province of Manitoba is slightly different.

The fertilizer, pesticide, fuel, and machinery variable costs for the province of Manitoba are initially calculated for each crop district using the 1991 Census information. In order to determine the fertilizer and pesticide expenditures on a per acre basis, regression analysis is performed for each crop district using the dollars spent on the input as the dependent variable, and the area seeded to annual crops as the independent variable. In order to determine the costs of fuel and machinery repairs on a per acre basis the same procedure is used, however the area seeded to forage crops is also included as an independent variable to account for dollars spent in the forage and livestock industry. Crop districts that appear to have similar cost coefficients are statistically tested using a Chow T-test to determine if the data can be pooled. The regression analysis is then repeated using the pooled data. The regression results for the pooled crop districts are reported in Table B.2 in Appendix B.

In order to determine the fertilizer, pesticide, fuel, and machinery repair costs associated with the production of annual crops in Saskatchewan and Alberta a two stage process is used. First, regression analysis is used to evaluate the influence of forage crops, irrigated crops (Alberta only), and soil type on the expenditures for various inputs. In order to capture the affects of soil type on expenditures a dummy variable is used to represent the dominant soil colour classification in each municipality. The Black and Brown soils represent the bench mark soils in Alberta and Saskatchewan respectively, and thus a unique variable is specified for these soil types in the respective regressions. A model is specified for each of the above expenditures with a separate equation for each input. The dependent variable for each model is the amount spent on the input (fertilizer, pesticides, fuel or machinery repairs) as reported by farmers in the 1991 Agriculture Census. The independent variables are the area seeded to forage crops, area seeded to annual crops, area under irrigation (Alberta only), and soil type classification. In order to account for the soil type classification, an interaction variable of soil type (ST) by area seeded to annual crops (AA) is generated by multiplying the soil type dummy variables by the area seeded to annual crops variable. The interaction variable captures the affect of the different soil type classifications on the expenditures for the particular input.

Equation (4.9) represents the regression equation used to estimate the amount spent on the various inputs in Alberta. The equations used to determine the input costs in Saskatchewan are the same as equation (4.9) however there are no variables for irrigated acres or the Gray Wooded soil type.

$$I_j = \beta_0 + \beta_1 FA + \beta_2 IrrA + \beta_3 AA + \beta_4 AA_B \times ST_B + \beta_5 AA_{DB} \times ST_{DB} + \beta_6 AA_{GW} \times ST_{GW} + \varepsilon \quad \textbf{(4.9)}$$

where:

I_j = dollars spent on input j,

FA = forage acres,

$IrrA$ = irrigated acres,

AA = acres seeded to annual crops,

$AA_a \times ST_a$ = interaction variable of a dummy variable for soil type a * acres seeded to annual crops in soil type a,

B = brown soil type,

DB = dark brown soil type,

GW = gray wooded soil type,

$\beta_0 .. \beta_6$ = regression coefficients,

ε = random error.

Secondly, per acre input costs are estimated for crops seeded on fallow land using the regression estimates and values provided in the provincial crop budget guides. The regression coefficient is assumed to be the weighted average of the cost of the input on fallow and the cost of the input on stubble. The cost of the input on stubble is then calculated for each soil type using the percent of annual crops seeded on fallow (by soil type) and percent of annual crops seeded on stubble (by soil type) as illustrated in equation (4.10).

$$CS_{ja} = \frac{\beta_{ja} - \%SF_a \times CF_{ja}}{\%STUB_a} \tag{4.10}$$

where:

CS_{ja} = cost of input j on stubble for soil type a,

β_{ja} = β regression coefficient for input j soil type a,

$\% SF_a$ = share of summerfallow acres on soil type a,

CF_{ja} = cost of input j on fallow for soil type a,

$\% STUB_a$ = percent stubble acres on soil type a.

The results of the regression analysis for the fertilizer, herbicides, fuel, and machinery repair costs, for the provinces of Saskatchewan and Alberta, are provided in Tables B.3 and B.4 in Appendix B. The variable costs of production for Manitoba, Saskatchewan, and Alberta calculated for this study are summarized in Table 4.5.

Table 4.5: Variable Costs of Production by Province (Year = 1993).

Crop District or Cropping Practice and Soil Type	Fertilizer ($/acre)	Pesticides ($/acre)	Fuel ($/acre)	Repairs ($/acre)	Seed ($/acre)	Interest on Operating ($/acre)	Total Variable Costs ($/acre)
Manitoba							
1 and 2	14.12	9.56	8.49	10.50	6.72	5.85	55.24
3 and 4	16.64	12.06	11.33	11.63	6.72	5.85	64.23
5 and 6	20.08	14.20	11.48	11.82	6.72	5.85	70.15
7 and 8	21.66	14.51	11.16	14.36	6.72	5.85	74.27
9, 10, 11, and 12	24.40	15.57	12.32	15.40	6.72	5.85	80.26
Saskatchewan							
Fallow - Brown	4.05	7.33	11.55	12.22	6.59	2.94	44.64
Fallow - Dark Brown	5.07	8.12	11.55	12.71	7.13	2.94	47.51
Fallow - Black	5.07	10.01	11.72	13.05	7.13	2.94	49.91
Stubble - Brown	7.12	7.33	9.91	10.63	6.56	2.94	44.47
Stubble - Dark Brown	10.55	8.12	9.18	10.63	7.13	2.94	48.55
Stubble - Black	15.74	10.01	10.11	10.63	7.13	2.94	56.55
Alberta							
Fallow - Brown	4.05	5.95	9.74	14.76	6.59	6.03	47.66
Fallow - Dark Brown	5.07	8.06	9.62	13.61	7.13	6.03	49.52
Fallow - Black	5.07	10.55	10.90	15.60	7.13	6.03	55.28
Fallow - Gray Wooded	5.07	10.55	8.57	8.20	7.13	6.03	45.55
Stubble - Brown	6.74	5.95	8.23	13.17	6.56	6.03	47.25
Stubble - Dark Brown	13.42	8.06	7.98	11.53	7.13	6.03	54.15
Stubble - Black	18.05	10.55	9.28	13.17	7.13	6.03	64.21
Stubble - Gray Wooded	9.44	10.55	6.48	5.77	7.13	6.03	45.41

4.4.2 Fixed Costs of Production

Replacement costs for farm machinery and buildings, and the return the farm operator realizes for labour and management are dependent upon the size of farm when they are prorated to a land area. These costs, along with other general overhead costs such as taxes, utilities and business services are included to represent long run expenditures which must be recovered from grain production. The combined variable production costs and fixed costs of production will affect the long run supply elasticity as annual crop revenues must be sufficient to maintain capital and labour in the grain industry. Fixed costs are determined on a per acre basis for each province. For Saskatchewan and Alberta, the additional fixed costs associated with summerfallowing land for one year are determined and added to the fixed costs for crops seeded on fallow.

4.4.2.1 Machinery Investment

In the 1991 Census, farmers provided information on the market value of all farm machinery and equipment they owned, as well as the area seeded to annual and forage crops. In order to determine the machinery investment on a per acre basis, regression analysis is performed using this information. The dependent variable is specified as the market value for machinery, while the independent variables are specified as the acres in annual crop production and the acres in forage crop production. In other words, the value of all farm equipment is dependent upon the number of acres in annual crop production and the number of acres in forage crop production. The resulting regression coefficient for the area in annual crop production is the amount invested in machinery per acre seeded to an annual crop. The regression results are provided in Table B.5 in Appendix B. The regression coefficients for each province are compared to the average value of intermediate term assets for cash crop farms published by the Farm Credit Corporation (FCC, 1992). The FCC values on a cropped acre basis are comparable to the values determined using the 1991 Census information. Machinery depreciation ($/acre) is assumed to be ten percent depreciation with no salvage value. Machinery investment is assumed to be a 9 percent opportunity cost on the machinery investment per acre.

4.4.2.2 Land Taxes

Land taxes for Manitoba are taken from the Manitoba Agriculture farm planning guide. This value is "...an average for the province, based on land tax assessment and mill rates of a sample of municipalities growing crops, less the provincial tax rebate" (Manitoba Government, 1993). The land tax value for Saskatchewan is a weighted average of the land tax values published in the three Saskatchewan production guides (1993) (Black, Brown, and Dark Brown Soils). Alberta land tax values are a weighted average of the values published in the Alberta regional production guides (1993).

4.4.2.3 Storage Costs

The value for farm storage costs is taken from the Manitoba crop production guide (1993). This value assumes farm storage requirements to be 30 bushels per acre costing

$1.00 per bushel for 75 percent of the storage and $1.25 per bushel for 25 percent aerated storage. It is assumed there is a 5 percent depreciation cost and a 9 percent investment cost for storage facilities.

4.4.2.4 Labor and Management

Labour and management is valued at $18.00 per cultivated acre based on living costs of $23,000 per 1280 cultivated acres (1991 dollars). This value is taken from the Manitoba Crop Production Guide and is considered to be representative of the labour and management costs in Manitoba and Saskatchewan. The labour and management costs for the province of Alberta are based on the Alberta Cost of Production Guides.

4.4.2.5 Other Fixed Costs of Production

Other fixed costs encompass overhead expenses which include such things as hydro, telephone, accounting, building and supplies insurance. Other costs for the province of Manitoba are from the Manitoba Crop Production Guide. In Saskatchewan, these costs are a weighted average of the costs published in the three crop production guides. For the province of Alberta, other costs are based on a weighted average of the Alberta regional cost of production information.

Table 4.6 illustrates the fixed costs for Manitoba, Saskatchewan, and Alberta used in this analysis.

Table 4.6: Fixed Costs (Year = 1993).

	Manitoba Fixed Costs ($/acre)	Saskatchewan Fixed Costs ($/acre)		Alberta Fixed Costs ($/acre)	
		Stubble	Fallow	Stubble	Fallow
Land Taxes	5.38	3.04	6.09	3.33	6.67
Machinery Depreciation	22.99	21.74	21.74	26.09	26.09
Machinery Investment	20.69	19.57	19.57	23.48	23.48
Storage Costs	3.25	3.25	3.25	3.25	3.25
Labour and Management	19.36	19.36	19.36	19.25	19.25
Other Costs[1]	8.07	4.49	8.97	4.82	9.63
Total Fixed Costs (1993)	79.74	71.46	78.99	80.22	88.38

1. Includes utilities, accounting costs, and insurance expenses.

4.4.3 Opportunity Costs for Land Producing Cereal Grains and Oilseeds.

Forage crops, in terms of pasture or hay, represent an alternative to cereal and oilseed grain production. Lands currently seeded to annual crops could instead be seeded to perennials. The perennial alternative is represented in terms of the land's capability to produce grasses and alfalfa. The forage biomass determines the carrying capacity for grazing beef cattle.

Private and public lands are leased for grazing cattle on a monthly or seasonal basis. Leasing rates and the land's carrying capacity are used to determine a minimum rental alternative for every acre currently seeded to cereal grains, oilseeds, or pulse crops. The assumed rental value for grazing is added to the variable costs since farmers should evaluate whether the revenue from annual crops exceeds the variable costs plus the rent possible from pasture.

Long term average forage yields, estimated by the provincial crop insurance corporations can be readily converted into seasonal grazing capacities. Grazing fees charged on lands owned by the provincial and federal governments are used to represent land rent. The Prairie Farm Rehabilitation Administration (PFRA) grazing fees, in terms of cents per animal-unit per day, are converted to a dollar per acre rate by a conversion factor based on the carrying capacity of an acre of land.

The yield of an alfalfa/grass forage for a particular area is based on the crop insurance corporation's long term average yield for an alfalfa/grass mixture according to the soil productivity rating for that particular area. The amount of feed required by cattle is calculated using nutritional guidelines for beef cattle obtained from Manitoba Agriculture and is based on the requirements of an animal unit (AU) consisting of a cow-calf pair. The nutritional requirement of one AU is approximately 6.517 Kg TDN/day. An alfalfa/grass forage mixture is composed of approximately 90 percent dry matter (DM), and 51 percent total digestible nutrients (TDN). The grazing efficiency of livestock is assumed to be 60 percent. In other words, cattle remove 60 percent of the forage that could be mechanically removed by a hay mower or swather. Therefore, the TDN available to livestock from one acre of land is equal to:

$$TDN_{avail} = FLTAY \times 0.90 \times 0.51 \times 0.60 \tag{4.11}$$

where:

TDN_{avail} = TDN available to livestock per acre,

$FLTAY$ = forage long term average yield.

The per day TDN necessary for one AU (6.517) is divided by the TDN available to livestock from one acre of land to determine the area of land required for one AU per day during the grazing period. The reciprocal of this is the days required per AU per acre (days/AU/acre). The PFRA pasture rates are charged on a cents per day per AU basis (1993 rates = 31 cents/day/AU). Hence, the PFRA pasture rate is multiplied by the days required per AU per acre to determine the per acre grazing rate.

Table 4.7 illustrates the long term average forage yield for an alfalfa/grass mixture for the different crop insurance soil productivity classifications in risk area 1 in Manitoba, as well as the corresponding seasonal grazing rental value (opportunity cost) of the land, and the grazing carrying capacity in terms of the acres required per animal unit per grazing season (assuming 139 available grazing days).

Table 4.7: Opportunity Cost and Grazing Carrying Capacity of Soils in Risk Area 1 in Manitoba.

Soil Productivity Class in Manitoba Risk Area 1	Forage Yield (Kg/Acre)	Opportunity Cost ($/Acre Grazing Rate)	Seasonal Carrying Capacity (Acres/AU)
D	1143	14.97	3.8
E	1086	14.23	4.0
F	1014	13.28	4.3
G	957	12.54	4.5
H	886	11.61	4.9
I	829	10.86	5.2
J	771	10.10	5.6

4.4.4 Regional Production Costs

Two production cost functions (short and long run) are estimated for a representative farm in each of the crop districts in Manitoba (12), Saskatchewan (9) and Alberta (7). The short run production cost functions include the variable costs and the opportunity costs of seeding land to an annual crop. The long run production cost functions include the variable costs, opportunity costs of land and labour, and the fixed costs associated with grain production. These cost functions are unique for each area due to the differences in wheat and forage long term average yields, the endowment of cropland, and the differential farm expenditures and cost structures.

The variable production costs, opportunity costs, and fixed costs of production determined for each crop district are converted from a per acre basis to a per tonne basis according to the trend adjusted wheat yields. The costs of producing grain on a per tonne basis are unique for different soil productivity classes within each municipality based on the relative productivity of the land. In Saskatchewan and Alberta, the costs of producing grains on fallow and stubble are weighted in terms of the share of each practice to the total tonnes produced (i.e. 70 % of total tonnes from stubble, 30 % of total tonnes from fallow) to determine a weighted average variable cost and fixed cost for each soil productivity zone. The opportunity cost of land in the provinces of Alberta and Saskatchewan is converted from a per acre basis to a per tonne basis by weighting according to land use (percent stubble land, percent fallow land, and percent idle summerfallow land).

Figures 4.1 through 4.8 show the aggregate short and long run supply functions derived for Manitoba, Southern and Northern Saskatchewan, and Alberta. Theses supply functions correspond to total annual cropped acres of 9.8 million acres in Manitoba, 11.6 million acres in Southern Saskatchewan (Crop Districts 1,2,3 and 4), 19.0 million acres in Northern Saskatchewan (Crop Districts 5,6,7,8, and 9), and 18.4 million acres in Alberta.

The projected supply involves equating the cost functions (dollars per tonne) to the on-farm price of grain (dollars per tonne) and solving for the level of production (tonnes).

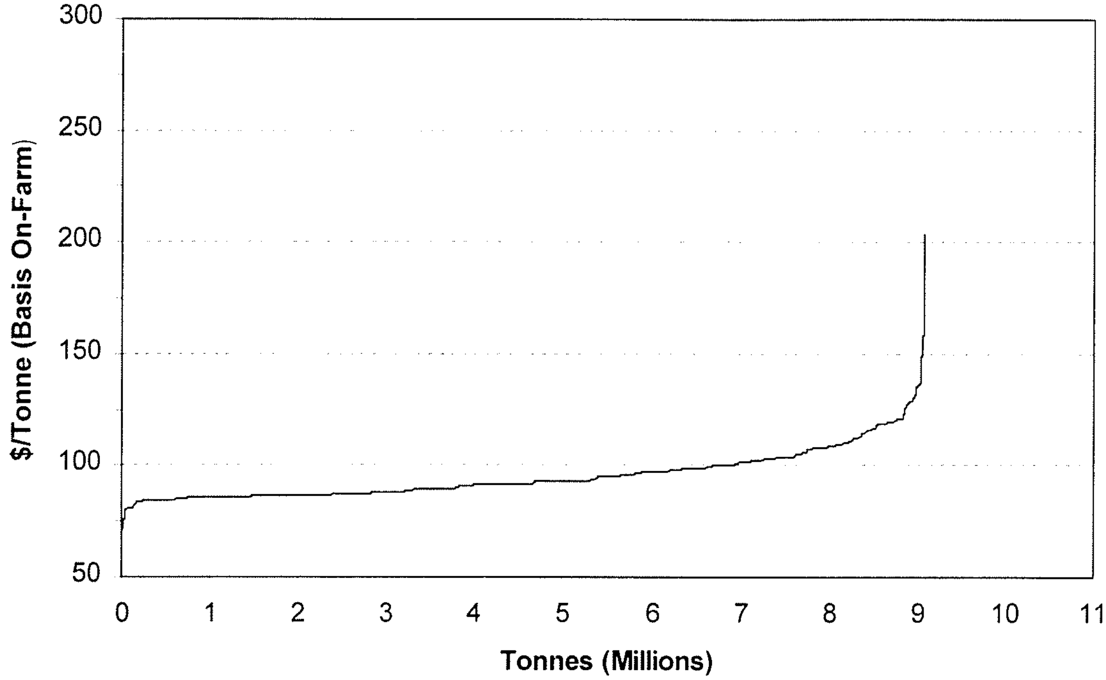

Figure 4.1: Province of Manitoba – Short Run Projected Supply of Grain.

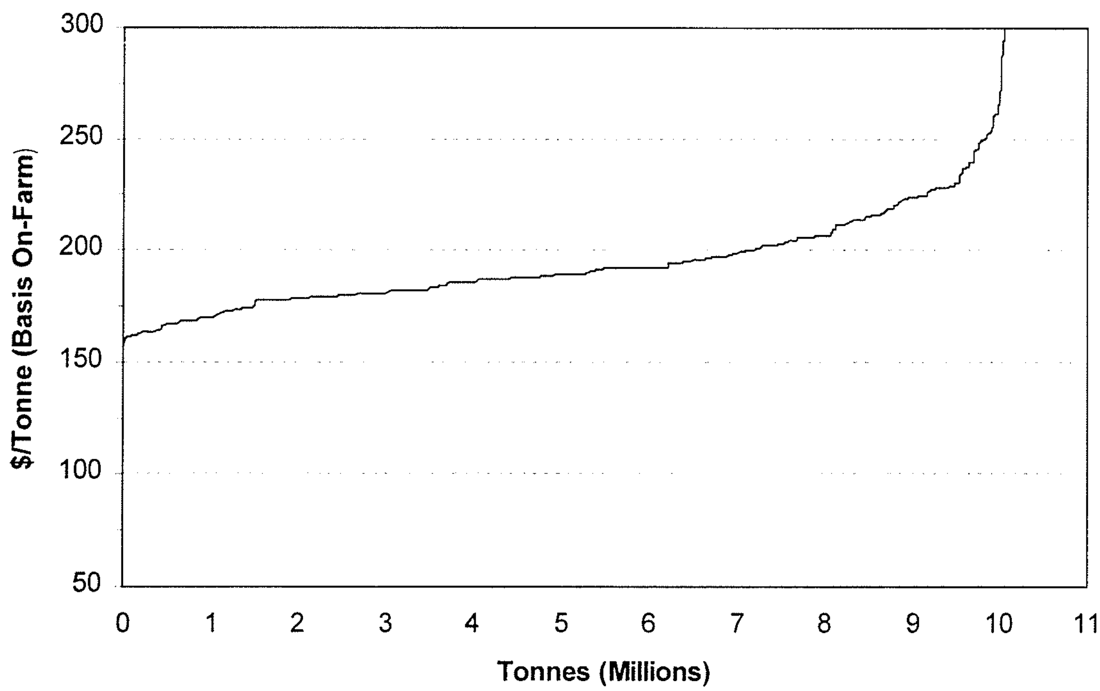

Figure 4.2: Province of Manitoba – Long Run Projected Supply of Grain.

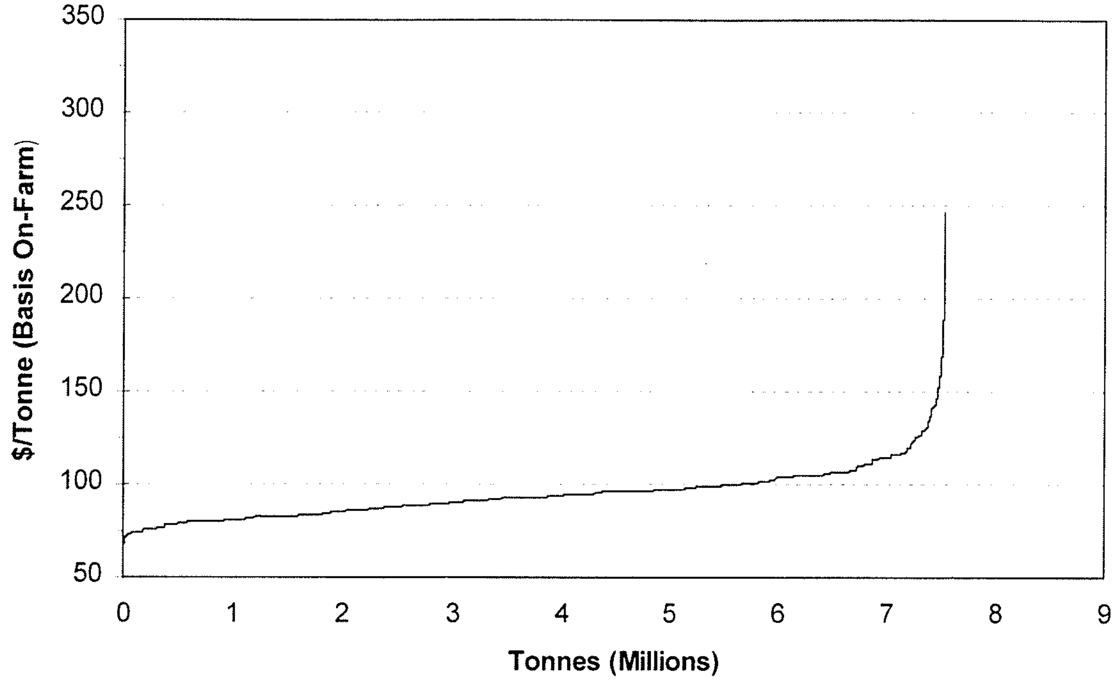

Figure 4.3: Southern Saskatchewan – Short Run Projected Supply of Grain.

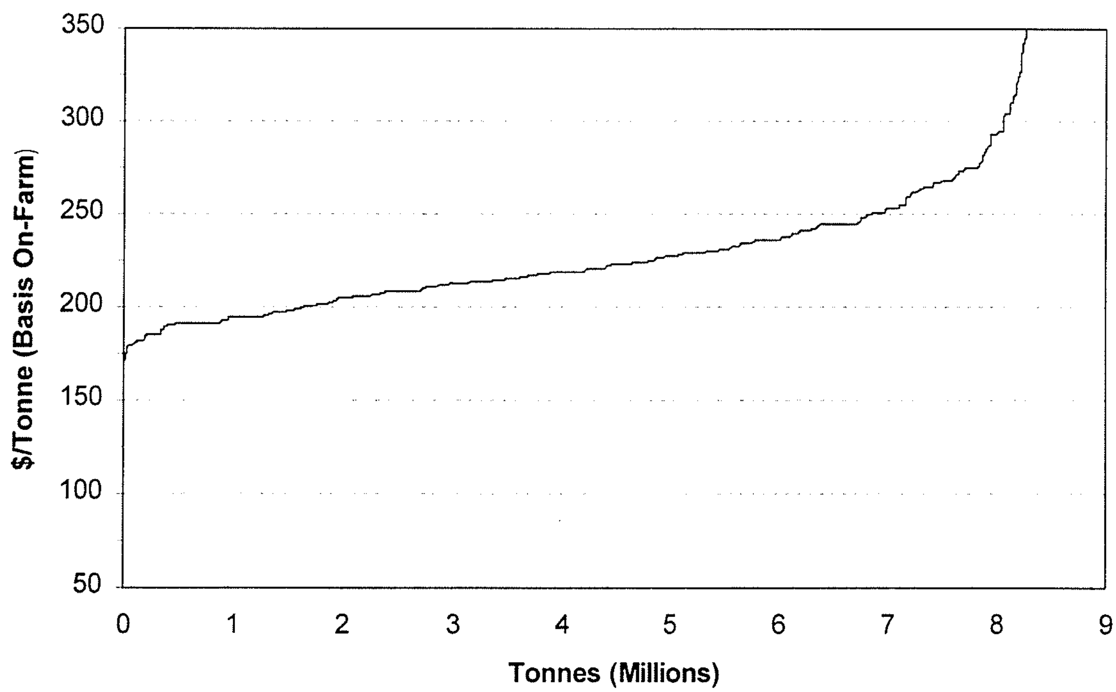

Figure 4.4: Southern Saskatchewan – Long Run Projected Supply of Grain.

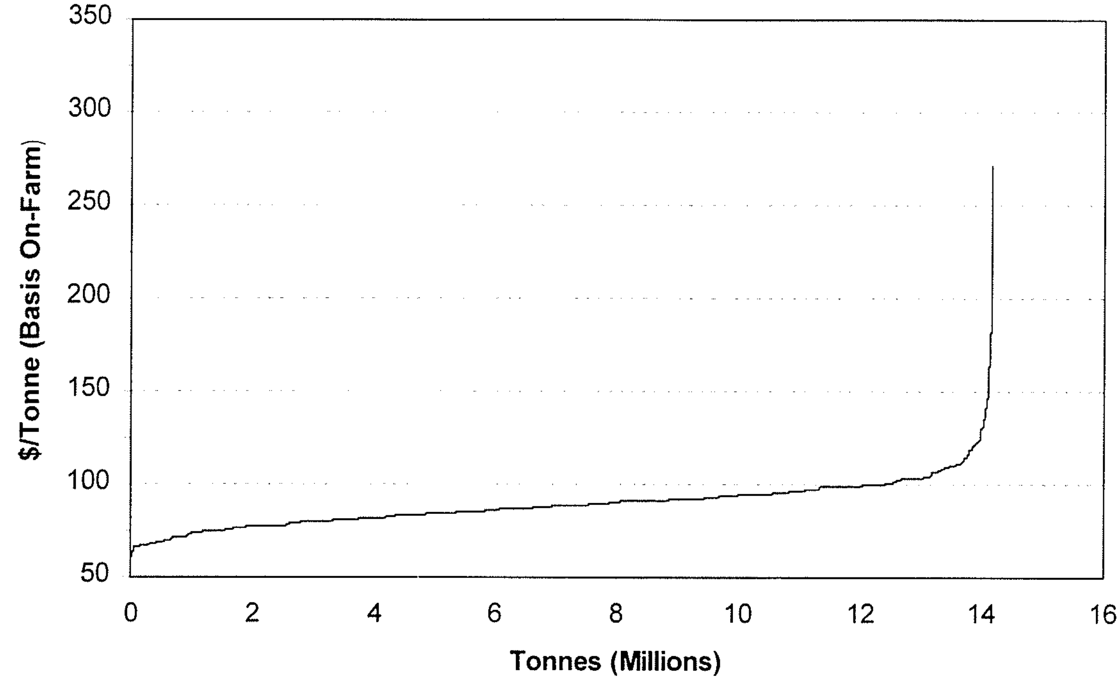

Figure 4.5: Northern Saskatchewan – Short Run Projected Supply of Grain.

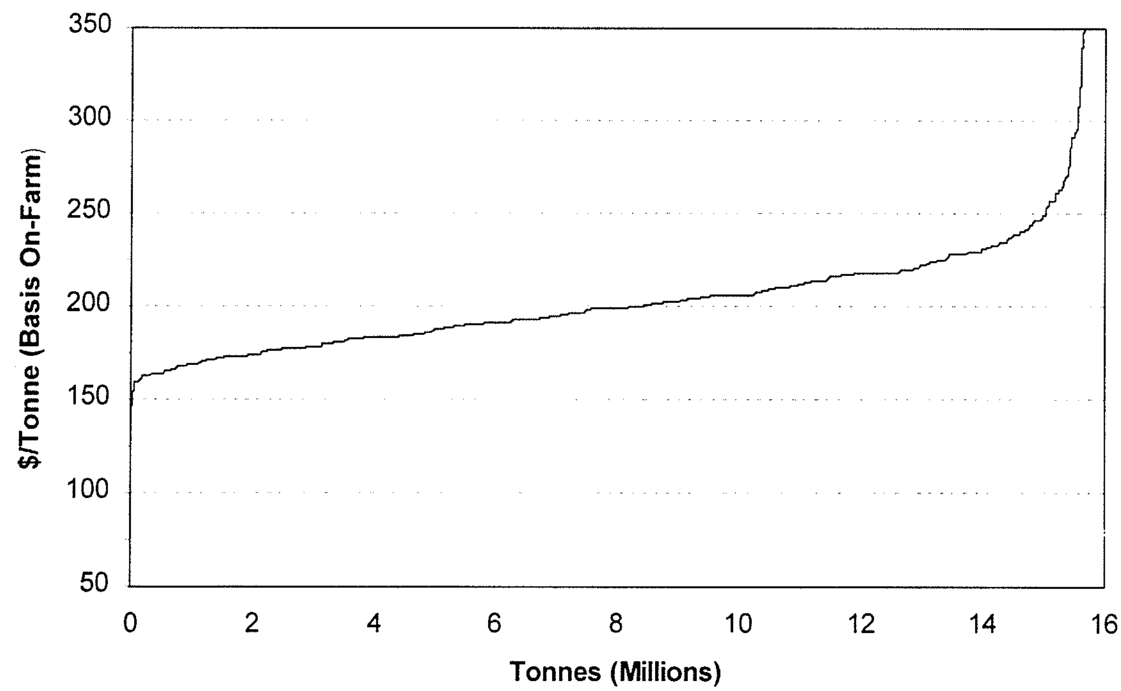

Figure 4.6: Northern Saskatchewan – Long Run Projected Supply of Grain.

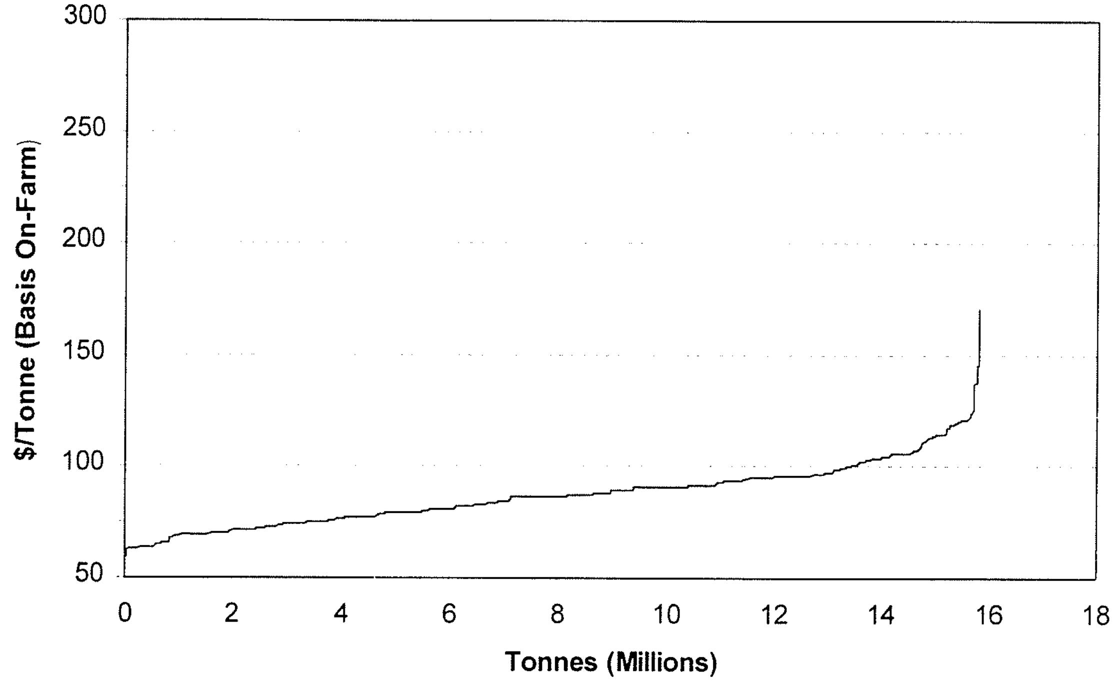

Figure 4.7: Province of Alberta – Short Run Projected Supply of Grain.

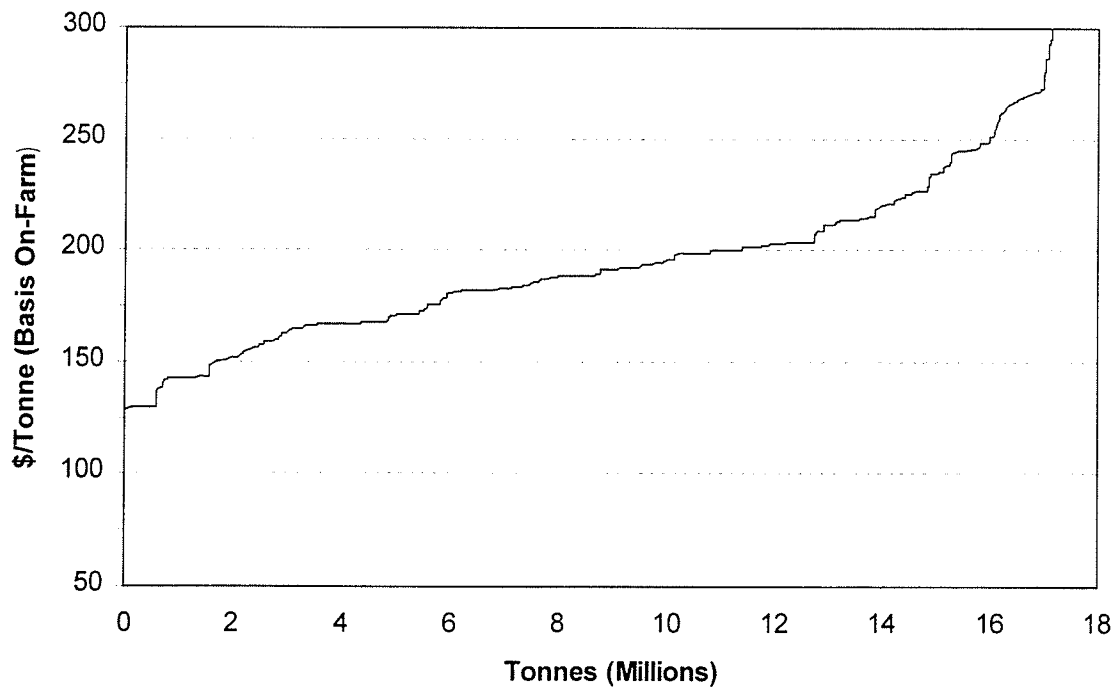

Figure 4.8: Province of Alberta – Long Run Projected Supply of Grain.

4.5 Marketing Costs

Determining the on-farm price of grain involves deducting trucking, rail, barge, handling, storage, and carrying costs from the price received at the export point (F.O.B. Pacific or St. Lawrence). Table 4.8 illustrates the marketing costs incurred in exporting wheat. The export price is specified for the year of grain production projections (short- or long-run) based on an estimated equilibrium world price.

Handling, storage, and carrying charges include marketing costs incurred for handling grain at primary and terminal elevators, and additional marketing costs incurred through the CWB pool accounts. Primary elevator charges include elevation, storage, and removal of dockage tariffs. Terminal elevator costs include storage tariffs, and fobbing charges which consist of elevation, outward weighing and inspection, terminal elevator receipt and cancellation, clearance association charges, and wharfage. Additional marketing costs consist of CWB administrative and general expenses, freight charges consisting of demurrage charges and additional rail freight costs to cover the shift in movement of grain necessary to meet sales requirements, interest and depreciation costs on CWB hopper cars, and drying charges. Handling, storage, and carrying charges are assumed to remain constant for all scenarios investigated. Rail costs vary depending on the location of the specific crop districts to export position, whether the WGTA subsidy is in place or not, and long run rail line abandonment. Trucking costs vary depending on the WGTA subsidy, and long-run rail line abandonment.

Table 4.8: Calculation of On-Farm Grain Price ($/Tonne).

					$/Tonne
A. Grain Receipts ($/Tonne)					
	Export (Basis Vancouver/St. Lawrence)				Variable
B. Marketing Costs ($/Tonne)					
1.	Handling, Storage and Carrying Charges				
	a) Primary Elevator [1]				
		(i) Elevation, Dockage	10.63		
		(ii) Storage	2.82		
				13.45	
	b) Terminal Position [2]				
		(i) Fobbing	6.71		
		(ii) Storage	1.24		
				7.95	
	c) Admin, Demurrage, Add. Freight [3]				
		(i) CWB	1.30		
		(ii) Freight	2.05		
		(iii) Interest and Drying	0.25		
				3.60	
					25.00
2.	Great Lakes Shipping and Handling Cost [3]				
	a) Lake Freight			14.00	
	b) Other Charges			1.35	
	c) Elevation St. Lawrence			2.80	
					18.15
		WGTA Subsidy	No WGTA Subsidy		
3.	Rail Costs	Shipper Costs	Total Rail Costs - Variable (SR/LR)		
4.	Trucking Costs (Farm - Elevator [4]	4.00	Variable (SR/LR)		

Source:
[1] Canadian Grain Commission. *Tariff Reports*. 1993.
[2] Canadian Grain Commission. *Canadian Grain Exports: 1993-1994.*
[3] Canadian Wheat Board. *Annual Report: 1993-94.*
[4] Manitoba Pool Elevators Corporate Trucking Rates.

4.5.1 Transportation Costs to Export Position

The cost of transporting grain from each crop district to export position is subtracted from the export price received basis Vancouver/St. Lawrence. These costs are attained through the Grain Transportation Agency's Canadian Freight Tariff Report (crop year 1994/95). For each crop district a rate zone central to the crop district is chosen as being representative of the rail costs for that crop district. The export position for grain produced in Manitoba is assumed to be the lower St. Lawrence. Vancouver is assumed to be the export position for grain produced in Saskatchewan and Alberta. The costs associated with shipping grain via Thunder Bay to the St. Lawrence include Great Lake freight charges, and elevation charges to the St. Lawrence. The additional Great Lake shipping and handling costs are shared by all prairie producers when the CWB eastern pooling point is Thunder Bay. These costs are paid entirely by producers exporting grain through Thunder Bay when the CWB pooling point is basis the St. Lawrence.

Two rail pricing scenarios are examined. The first scenario assumes the WGTA remains in place and rail transportation is subsidized by the government at 1994/95 subsidy levels. Under this scenario, producers continue to pay rail rates equal to the 1994/95 shipper costs. The shipper costs are assumed to remain the same in both the short and long run. Under the second scenario, the WGTA subsidy is removed. In this case, producers pay the entire cost for rail transportation to export position. The short run costs are equal to the total 1994/95 costs of shipping grain. In the long run, it is assumed rail costs decrease by \$3.00 per tonne due to branch line abandonment. Table B.6 in Appendix B provides the rate zones and rail costs used in this study.

4.5.2 Trucking Costs

In addition to rail costs, producers must pay trucking costs to move grain from the farm to primary elevators. These costs are obtained from Manitoba Pool Elevators' Corporate Trucking Program rates. Under the scenario where the WGTA subsidy remains in place a typical haul to a prairie elevator is assumed to be less than 20 miles, in both the short and long run. The corporate trucking rate for hauling grain this distance is \$4.00 per tonne. When the WGTA subsidy is removed the trucking distance is assumed to remain the same in the short run (20 miles or less). However, the trucking distance is assumed to increase in the long run due to rail line abandonment. The Manitoba Pool Elevator corporate trucking rate to move grain from 20 to 40 miles is \$5.50 per tonne.

Figure 4.9 and 4.10 illustrate the short and long run prairie supply functions after marketing costs have been taken into account. These supply functions are F.O.B. Pacific and the Lower St. Lawrence and illustrate the two rail pricing scenarios and CWB pooling scenarios. The supply curves with the WGTA subsidy and Thunder Bay pooling in place shift up by approximately \$40 per tonne as compared to Figures 4.1 through 4.8 as a result of additional marketing costs incurred in shipping grain from prairie point to export location. When the WGTA subsidy is eliminated and the CWB pooling point is shifted to the lower St. Lawrence, the supply curve shifts up a further \$10 to \$25 per tonne as a result of increased costs.

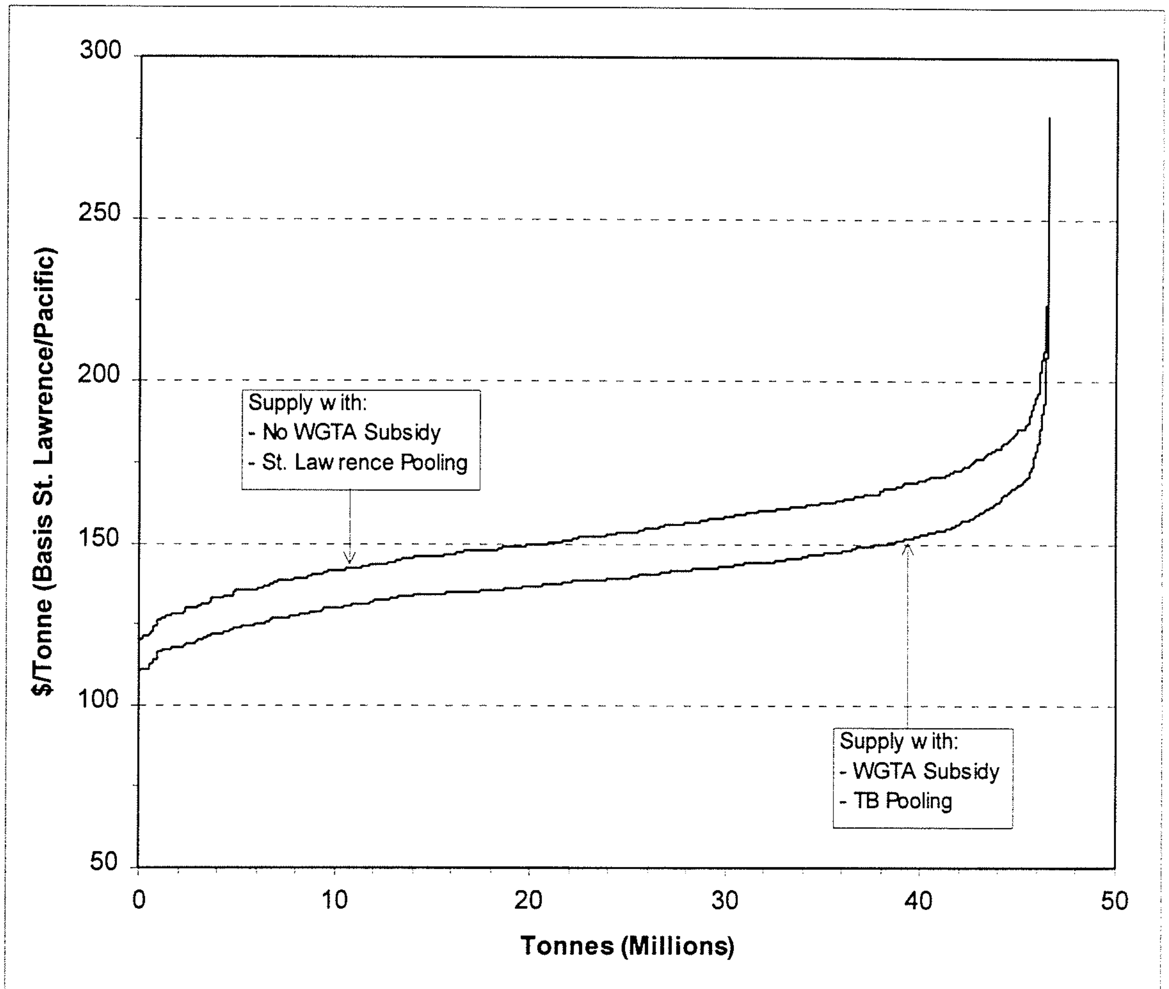

Figure 4.9: Short Run Prairie Supply F.O.B. Pacific/St. Lawrence Under the Two Rail Pricing Scenarios and CWB Pooling Scenarios.

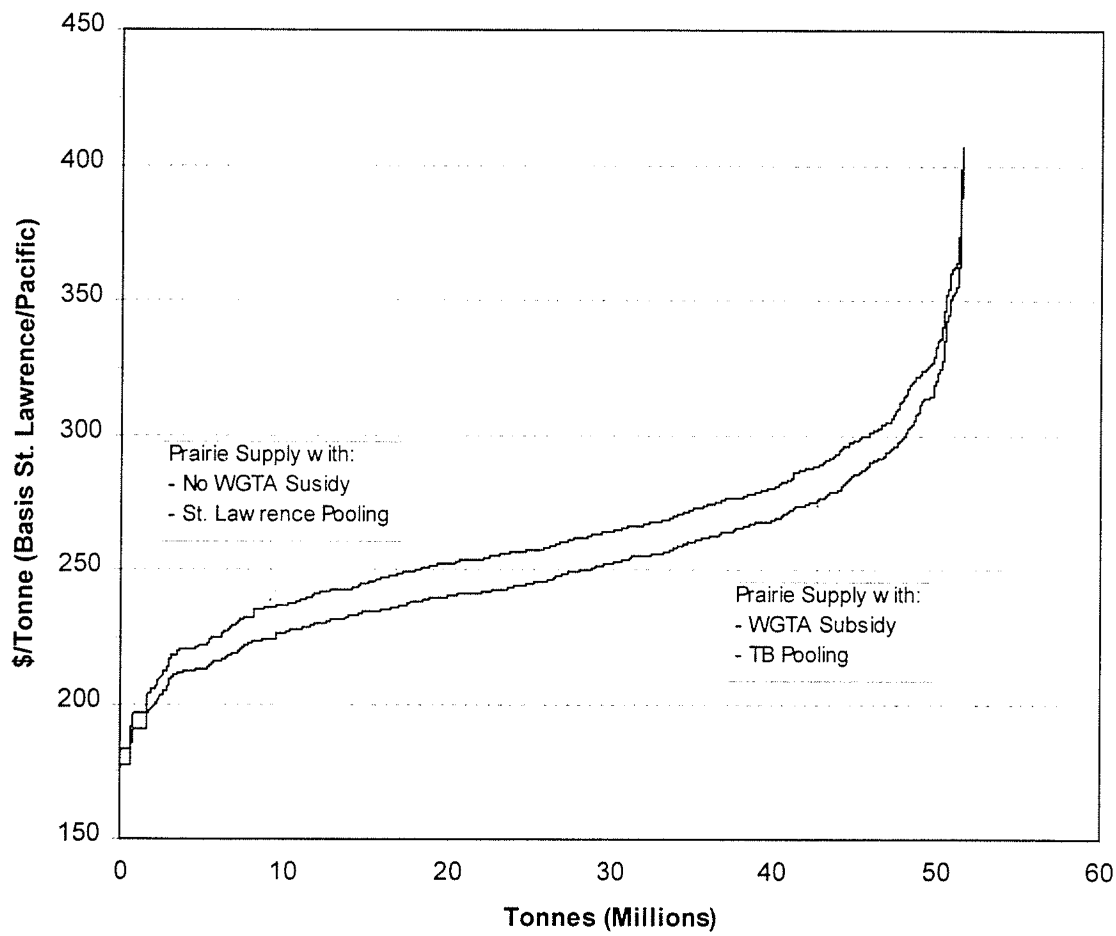

Figure 4.10: Long Run Prairie Supply F.O.B. Pacific/St. Lawrence Under the Two Rail Pricing Scenarios and CWB Pooling Scenarios.

The Western Canadian supply functions for cereal grains and oilseeds are estimated using approximately 4,000 co-ordinates consisting of short or long run cost of production estimates and the corresponding production forecasts both of which are a function of regional soil productivity levels. The aggregate Prairie or regional supply of wheat is determined as the costs of production increase. Table 4.9 illustrates a selection of data points from the aggregate Prairie supply curve. This table shows the on-farm short run costs of producing grains and oilseeds and the corresponding short run wheat production potential associated with these cost levels. These data points correspond to a very small portion of the Prairie supply curve (basis farm-gate).

Table 4.9: Data Points from the Short Run Prairie Supply Functions.

Province	On-Farm Short Run Costs ($/tonne)	Regional Supply (000 tonnes)	Cumulative Prairie Supply (000 tonnes)
Southern Saskatchewan	81.10	36.474	11.813
Southern Saskatchewan	81.17	3.330	11.817
Northern Saskatchewan	81.33	0.341	11.817
Northern Saskatchewan	81.42	1.903	11.819
Manitoba	82.56	11.311	11.830
Alberta	83.76	1.934	11.832

4.6 Excess (Export) Demand for Grains and Oilseeds

This section reviews the methodology used to determine the world equilibrium export price for varying levels of Prairie grain exports. In order to determine how a change in Prairie grain exports affects the world export price it is necessary to develop an excess demand function for Prairie grain exports. Two cases for determining the world equilibrium export price for levels of Prairie grain exports are analyzed by specifying two demand functions for the world grain market. The first demand function is based on the assumption that wheat is representative of Western Canadian grain and oilseed production. The excess demand function for Prairie grain is estimated in terms of wheat. The world price level and elasticity of excess demand are represented on a wheat equivalent basis. The second export demand function is based on the assumption of a crop mix composed of 70 percent wheat and 30 percent "other" crops. The excess demand equation for Prairie grain is calculated based on a world excess demand for both cereals and oilseeds less the excess supply from other exporters. This excess demand function is used to test the sensitivity of the results derived from the wheat equivalent model. This section outlines the basic assumptions underlying both export demand function scenarios.

It is assumed the world export price for wheat is \$150 and \$250 per tonne in the short run, and \$230 per tonne in the long run (basis Pacific/St. Lawrence) for the wheat equivalent analysis. These world export prices are based on historic and projected world grain market equilibriums. In other words, they correspond to exporting all Prairie grain above domestic requirements. Domestic consumption of Prairie grains is assumed to be 14 million tonnes with the WGTA subsidy, and 15 million tonnes when the WGTA subsidy is eliminated. The increase in domestic consumption is due to an increase in feed requirements due to a projected growth in the livestock population. It is assumed the world trade in wheat is 110 million tonnes. Therefore the world trade in wheat (accounting for Canadian share of exports) is equal to:

$$Q^w = [110 - (Q^c - (Q^p - Q^d))] \qquad \textbf{(4.12)}$$

where:

Q^w = world trade,

Q^c = Canadian share of world trade,

Q^p = Western Canadian grain production,

Q^d = domestic consumption requirements.

The excess demand function for Western Canadian wheat is specified as having a constant price elasticity of demand. The price elasticity of demand for Prairie exports of wheat is assumed to be -0.5 in the short run and -2.0 long run (Clyde, 1993 and Gardiner and Dixit, 1988). The excess demand function for the Western Canadian wheat equivalent is specified as:

$$Q = b_o P^{-e} \quad \textbf{(4.13)}$$

where:

Q = excess demand for Western Canadian wheat,

P = world price of wheat,

b_o = positive constant,

e = constant (elasticity of demand).

The equilibrium point for estimating the excess demand function for the Western Canadian wheat equivalent is $150 and $250 per tonne in the short run and $230 per tonne in the long run. The $150 short run equilibrium point is based on a scenario where export subsidies are used to the maximum allowable level under GATT, while the $250 short run equilibrium point assumes tight world supply and low use of export subsidies. The $230 long run equilibrium point is based on estimates provided by Sparks Commodities (1993). These export prices correspond to maximum Prairie exports after domestic needs have been met. The world price of wheat (basis Pacific and St. Lawrence ports) and the corresponding level of Western Canadian wheat available for export is determined for all levels of the excess demand for Western Canadian wheat.

The second demand function is estimated to determine how a fixed cereal/oilseed crop mix affects a blended equilibrium world export price for these crops. The weighted world equilibrium price is determined assuming 70 percent of total Prairie grain exports are composed of wheat and 30 percent of Prairie grain exports are composed of other crops (based on export projections provided by CP Rail Systems). The total world trade in wheat is assumed to be 110 million tonnes, while the total world trade in other grains is assumed to be 100 million tonnes. Domestic consumption of grains and oilseeds is assumed to be 14 million tonnes when the WGTA subsidy remains in place and 15 million tonnes when the WGTA subsidy is removed. The world trade in wheat and other crops is calculated using equation (4.12). The short run world export prices are assumed to be \$150 (\$250) per tonne for wheat and \$200 (\$279) per tonne for other crops under low (high) export prices. The long run world export price for wheat is assumed to be \$230 per tonne for wheat and \$277 per tonne for other crops (CP Rail Systems). These prices correspond to maximum Prairie exports after domestic consumption requirements have been met.

In the short run, the elasticity of demand for Prairie exports of grain is assumed to be -0.5 for wheat and -1.0 for other crops. In the long run, the elasticity of demand for exports of Western Canadian grain is assumed to be -2.0 for wheat and -4.0 for other crops. Two excess demand function are specified, one corresponding to wheat and the other to all other grains. The excess demand functions are specified using equation (4.13). The equilibrium point for estimating the two excess demand functions are the world export prices specified above and the corresponding level of maximum Western Canadian exports after domestic needs have been met.

The world price of wheat, and the corresponding level of Western Canadian wheat available for export is determined for all levels of the excess demand for Western Canadian wheat. As well, the world price for all other grains and oilseeds, and the corresponding level of Western Canadian grains and oilseeds available for export, is determined. The equilibrium weighted average world price is determined for all levels of Prairie grain exports. The world price is weighted according to the Prairie exports consisting of 70 percent wheat and 30 percent other grains and oilseeds.

The price elasticity of demand for the wheat equivalent analysis is constant. In other words, at all levels of excess demand for Prairie wheat the elasticity is -0.5 in the short run and -2.0 in the long run. However, the price elasticity of demand for the grains and oilseed crop mix varies depending on the relative reduction of wheat exports and other crops to the world export market. The individual demand functions for wheat and other grains and oilseeds are specified with a constant elasticity of demand, however the price elasticity of demand for the blended demand function varies. The price elasticity of demand for the crop mix excess demand function ranges from -0.5 to -1.0 in the short run and -2.0 and -4.0 in the long run.

Figure 4.11 and Figure 4.12 show the excess demand functions estimated for the different elasticities and beginning market clearing price levels in the short and long run respectively. These figures show that the short run demand functions for wheat and the crop mix result in the same world price when Prairie exports range between 20 million tonnes and 25 million tonnes when export subsidies are used by competing countries, and between 25 and 30 million tonnes world supplies are tight. Prices are comparable in the long run when exports range between 10 million tonnes and 20 million tonnes. The difference in export levels derived under the two export demand functions will be more sensitive to the supply elasticity for Prairie grain production as opposed to the demand elasticity for Prairie exports. An elastic supply function in the range of 20 to 35 million tonnes of Prairie exports will produce wide swings in exports when it shifts up due to higher production and shipping costs. On the other hand if the equilibrium level of exports is associated with an inelastic (price) supply the level of exports will be stable. The price elasticity assumptions underlying the export demand for prairie grains appear to be less critical than the price elasticities derived for exportable supply. By considering Western Canadian grain exports in terms of wheat equivalent units the magnitude of world export price changes on Prairie exports are less than those under the grains and oilseeds crop mix scenario.

The equilibrium world price corresponding to the equilibrium level of Prairie exports is determined where the world price is equal to the Western Canadian supply price. The export prices are used to determine the short and long run production levels in the different crop districts across the prairies. The farm-gate price (supply price) is determined by adding (subtracting) the rail and trucking costs, as well as the handling, storage, and carrying charges to the short and long run costs of production (export price) for wheat across the prairies. While the export equilibrium prices that determine the short and long run production levels are the same for all regions, the resulting farm-gate prices differ.

The world prices and prairie export levels are determined for two scenarios. The first scenario (model benchmark) assumes the WGTA remains in place at 1994/95 levels of government support and the CWB eastern pooling point is based on Thunder Bay. The second scenario assumes the WGTA subsidy is eliminated and the CWB eastern pooling point shifts to the lower St. Lawrence. Under the second scenario, producers bear the entire cost of transporting grain to export position. After determining the equilibrium export price in the world market, the affect of the GRIP safety net program is considered under the model benchmark scenario.

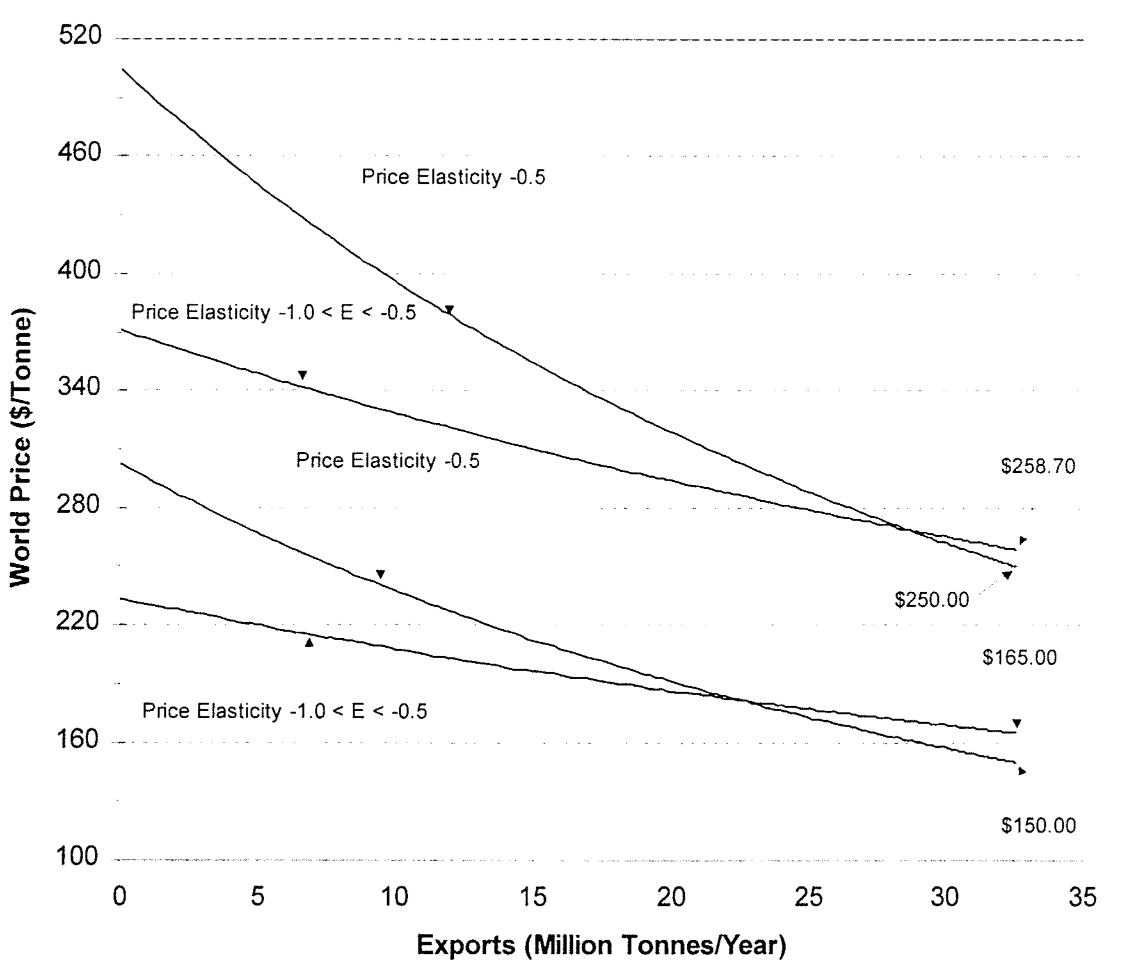

Figure 4.11: World Demand for Canadian Grain – Short Run.

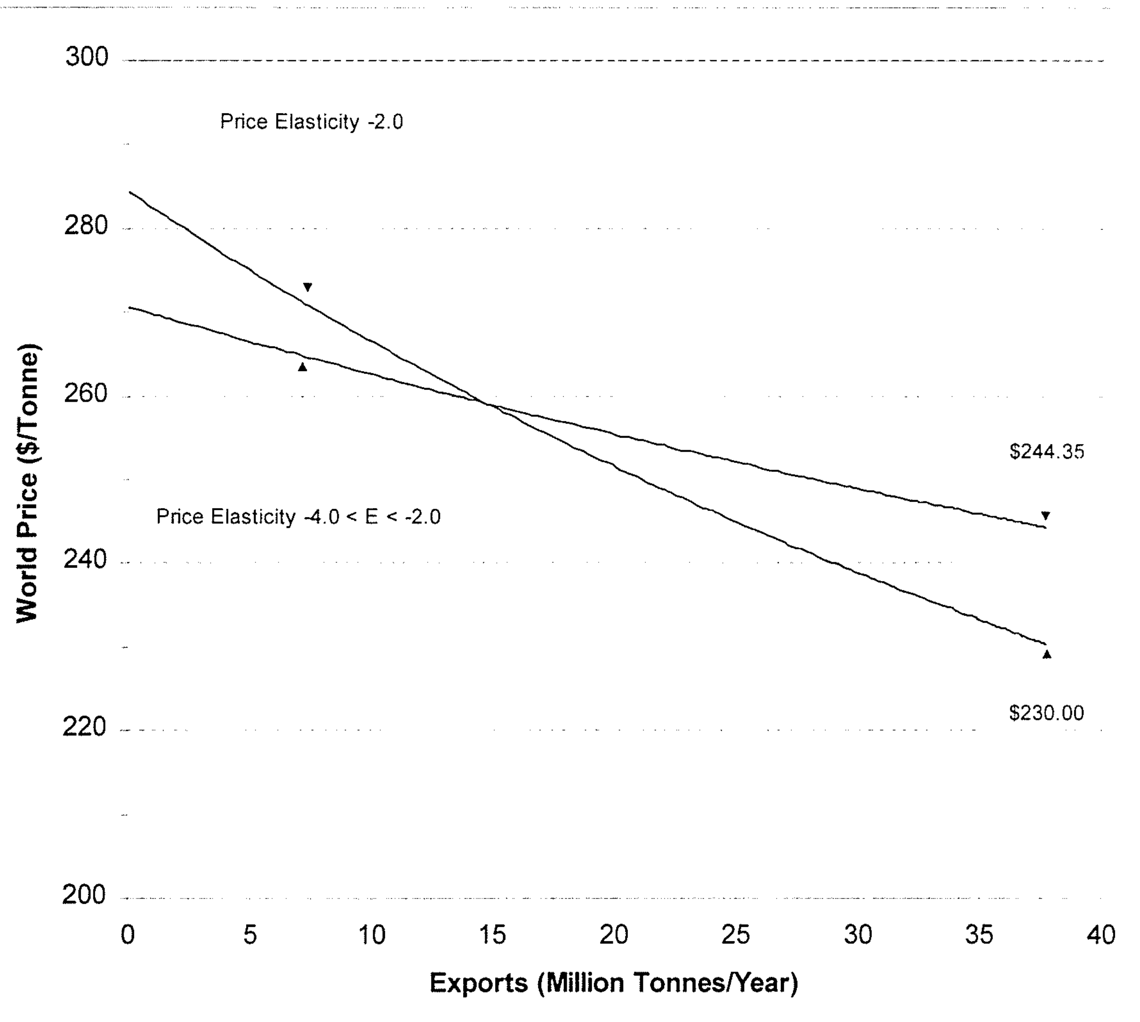

Figure 4.12: World Demand for Canadian Grain – Long Run.

4.7 Safety Net Subsidy

The safety net payment is the amount the government contributes to the premiums for GRIP (revenue and crop insurance). This amount varies depending on whether the short or long run is being considered. The safety net payment is only determined for the model benchmark scenario where the WGTA subsidy remains in place and CWB pooling is basis Thunder Bay. The safety net support levels are established based on historical export volumes, and historical and projected levels of safety net payments. The support levels are established at the equilibrium export prices of $150 per tonne in the short run and $230 per tonne in the long run. The safety net support levels are assumed to be $167.88 per tonne in the short run and $249.00 in the long run. These levels are based on safety net premium subsidies of $17.88 per tonne in the short run and $19.00 per tonne in the long run.

The short run support level is an average value of the 1991/92 government payment to producers of grains and oilseeds ($17.88 per tonne). The government safety net payment corresponding to a long run export price of $230 per tonne is approximately 15 percent of the long run farm-gate price ($19.00 per tonne). These safety net payments are based on historic levels of grain exports and a farm-gate price before the Western Canadian supply response is taken into account. When the Western Canadian supply response is taken into account, the safety net price support levels are maintained at $167.88 per tonne and $249.00 per tonne in the short and long run respectively. The safety net payments decrease because the difference between the market-clearing price and the price guaranteed to farmers (the safety net support level) is less due to the decrease in Prairie exports and the corresponding increase in world export price. In other words, as the export price increases due to reductions in Prairie export supply, the amount the government has to pay in order to maintain the safety net support levels decreases.

4.8 Livestock Production

In order to determine the expansion in the cattle population if cultivated cropland switches from cereal and oilseed production to forage production, it is necessary to estimate the relative productivity of the additional forage acres in terms of the total digestible nutrients available, and the corresponding cattle carrying capacity of the land.

The cattle population is made up of different categories of animals including cows, bulls, replacement heifers, steers, and calves. Regression analysis was performed using the 1991 Agricultural Census Data for the province of Manitoba to estimate the population dynamics between the different categories of cattle. For the purposes of this study, the cow category includes dairy cows, beef cows, as well as bulls. A replacement heifer refers to yearlings that are retained to replace culled dairy and beef cows. Feeder yearlings refer to both yearling heifers (beef) and steers. Feedlot animals for slaughter refer to animals (feeders or cows) fed on a high concentrate ration in a provincial feedlot to slaughter weight.

The increase in the cattle herd is measured in terms of cow-equivalent units (CEU's). One cow-equivalent unit represents a corresponding number of cows, calves, replacement heifers, feeders or steers, and feedlot animals. The different classes of animals are represented in terms of their population numbers according to the 1991 agricultural census. The procedure for estimating the relationship between the different cattle categories and cows to determine a cow-equivalent measure is described below. After determining the cow equivalent measure it is necessary to determine the corresponding feed requirements of a cow-equivalent unit.

4.8.1 Cow-Equivalent Measurement

Cow-equivalent units are used to represent the potential growth in the cattle herd. In order to determine the relationship between the different categories of cattle, regression analysis was performed using the 1991 Agricultural Census data for the province of Manitoba. The regression results are presented in Table B.7 in Appendix B. The feeding periods and weight information in this section is based on information from the University of Manitoba (1977) publication and Manitoba Agriculture (1993b).

The results from the regression analysis using the 1991 Agriculture Census data indicate an 83 percent calving rate. Therefore one cow-calf unit represents one cow and 0.83 calves. The calves are weaned in October and according to the regression results 53 percent are exported from the province. These calves are exported at a weight of approximately 204 kilograms. The remaining 47 percent of the calf population remain in the province and are fed through the winter (October 15 - May 31). These animals are designated as replacement yearlings or feeder yearlings. The regression results indicate 20 percent of the cows are culled per year. In other words there is one replacement yearling for every 5 cows. It is assumed the replacement heifers are fed through the winter and bred the following summer at 15 months of age to produce their first calf as two year olds. This requires a high level of nutrition during the first winter. General recommendations are that heifers should weigh at least 300 kilograms at breeding and 450 kilograms just before calving. The cows that are culled are exported as feeders or put on a high ration concentrate and treated as slaughter animals. Sixty percent of the yearlings are classified as feeder yearlings while the remaining forty percent are replacement heifers. It is assumed feeder yearlings are fed throughout the winter with a rate of gain of 0.4 kilograms per day. By the end of May they weigh approximately 295 kilograms. They are put out to pasture for the summer months where they gain approximately 0.5 kilograms per day to a weight of approximately 363 kilograms. When these animals come off of pasture, the majority are exported to feedlots in the United States or other parts of Canada.

In 1991, marketings of local slaughter of Manitoba origin cattle to Manitoba packers was 50,203 head (Manitoba Agriculture, 1991b). This indicates that approximately 24 percent of yearlings, or 10 percent of the cow-calf units present in June, are fed to slaughter weight and slaughtered within the province. These animals are classified as slaughter animals. It is assumed they are fed on a high concentrate ration from October through March for approximately 150 days with a rate of gain of approximately 1.3 kilograms per day and a daily roughage requirement of 1.8 kilogram per day.

Using the regression results a cow-equivalent unit is calculated. One cow-equivalent represents one cow-calf (with an 83 percent calf crop), 0.2 replacement heifers, 0.23 feeders yearlings, and 0.1 feedlot animals.

The feed requirements for each category of cattle is outlined in Table B.8 in Appendix B. The feed requirements in Table B.8 are the forage and roughage recommendations for the various categories of animals (University of Manitoba, 1977; Manitoba Government, 1993b). The cow-equivalent feed requirements are calculated assuming a 60 percent feed efficiency during the grazing period, and an 80 percent feed efficiency during the winter months. The winter feeding period is assumed to be from October 15 through May 30 for a total of 226 days, while the grazing period is assumed to last from May 30 until October 15 for a total of 139 days. It is assumed one cow-equivalent unit requires 3.662 tonnes of TDN per year. This assumes that cattle grazing in the summer period remain in the area, and roughage requirements are met during the winter months from within the area.

The coverage levels determined by the provincial crop insurance corporations are used to represent the yield of an alfalfa/grass forage mixture for the different municipalities and soil types. The tonnes of total digestible nutrients that can be harvested is calculated assuming 90 percent of forage is dry matter and 51 percent of dry matter is TDN:

$$TDN = FLTAY \times Acres \times 0.9 \times 0.51 \quad (4.14)$$

where:

TDN = tonnes of TDN produced,

$FLTAY$ = forage long term average yield (tonnes/acre),

$Acres$ = total area switched from annual crop production.

The additional cattle carrying capacity of the area placed in forage production is determined by dividing the tonnes of TDN produced in an area by the total yearly TDN requirement per cow-equivalent unit.

4.9 General Components of the Simulation Model

A schematic representing the general components of the simulation model is illustrated in Figure 4.13. The model is determines the export price FOB Pacific/St. Lawrence based on the available supply Western Canadian export grain. Supply of Prairie exports is the summation of all Prairie regional supplies less domestic consumption. Regional supply is determined based on the farm-gate price of grain which consists of the export price plus any safety net payments less marketing costs.

If the farm-gate price is greater than or equal to grain production costs (short and long run, depending on the scenario) grain production occurs. If the farm-gate price is less than grain production costs, the land is removed from annual crop production and placed in forage crop production. The additional population of cattle that can be supported on this land is then determined.

Grain production costs (the regional supply functions) are determined based on regional input costs, and soil productivity capabilities. Soil productivity is based on long term wheat and forage yields and crop management practices.

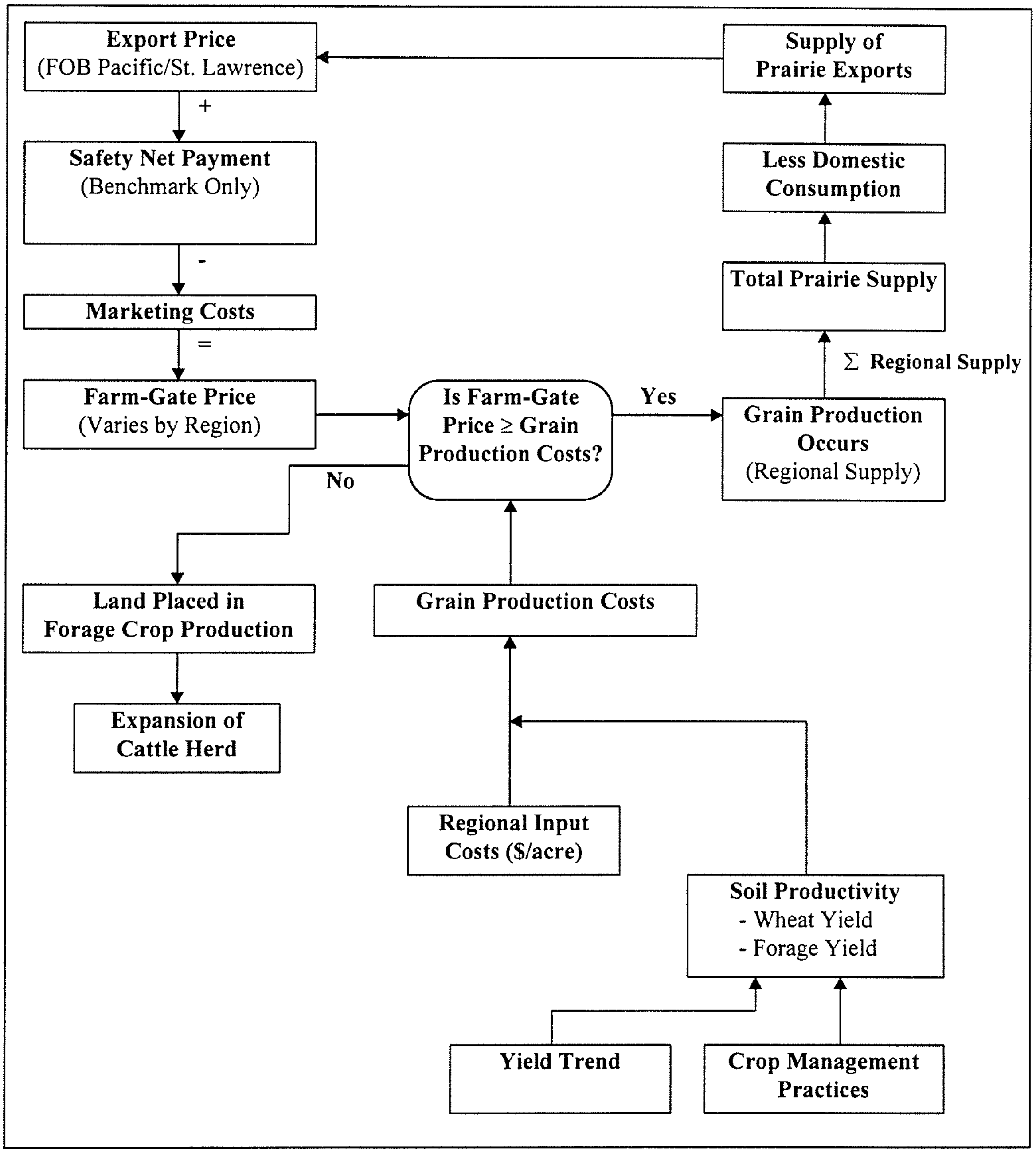

Figure 4.13: General Components of the Simulation Model.

Chapter 5

Results

5. Results

The results of this study are subject to specific input costs, the soil productivity of land seeded to annual and forage crops, yield trends and summerfallow practices. Input costs, soils productivity, yield trends and summerfallow variables are exogenous factors that raise or lower the grain cost functions and affect the area of land that switches from annual to perennial crops. Once the exogenous variables are specified the model endogenously derives the annual price for wheat, and simultaneously solves for the level of grain production and exports in both the short and long run. The model also forecasts the land switched from grain to forage production, and the number of cow equivalent units that can be supported on the added carrying capacity. The results presented in Section 5.2 are based on the wheat equivalent demand function which has a lower price elasticity. The results presented in Section 5.3 test the sensitivity of the less elastic demand function. This analysis substitutes the more elastic demand function based on a crop mix scenario and adjusts the costs to reflect production of a grain and oilseed crop mix. The short and long run supply functions are discussed in Section 5.1.

5.1 Short and Long Run Supply Functions

The short run provincial supply functions for wheat are calculated for a base year of 1993 while the long run supply function is computed for a base year of 2000. Grain yields are projected to the year 2000 assuming a 1.5 percent increase in yield per year. Forage yields are assumed to remain constant. Crop production costs are inflated to the year 2000 assuming a 2.5 percent increase annually. This increase is based on Western Canadian crop production cost projections by Agriculture and Agri-Food Canada (1995c). The composition of land seeded on fallow and stubble is assumed to remain unchanged for both the short- and long-run analysis.

In the short run, only the variable costs of production and the opportunity cost of land in terms of its forage alternative must be exceeded by cereal grain and oilseed receipts in order to maintain their production. In the long run, the variable costs, opportunity costs of land and labour, and fixed costs must be less than the revenues from grain and oilseed production. In the long run, when fixed costs are taken into consideration the supply curve for prairie grain shifts up by approximately $80.00 per tonne. This assumes that unless producers are financially capable of replacing the buildings and equipment used in grain production, and receive adequate compensation for their labour and management they will switch land from annual to perennial crop production.

Figures 4.1 through 4.8 show the aggregate short and long run supply functions derived for Manitoba, Southern and Northern Saskatchewan, and Alberta to be extremely price elastic over a wide range of production. For example, the short run supply function for Manitoba increase by 7 million tonnes for a price increase from $50 per tonne to $100 per tonne. As grain production utilizes relatively less productive land, the costs escalate more rapidly. In Manitoba, the additional production of 7 million to 9 million tonnes comes about only when prices increase from $100 to $150 per tonne. Similar short-run supply functions are derived for Alberta and Saskatchewan. The large price elasticity for a wide range of cereal grain and oilseed supplies occurs because farms are using similar technology and as a result of the relative homogeneity of land for wheat and forage production.

The long-run supply functions are derived on the basis that all inputs required for cereal grain and oilseed production are variable. Explicitly accounting for the opportunity costs of capital (buildings and equipment) and labour (the farm family), the supply function shifts up approximately $80.00 per tonne. While the long run change in production is not observed with year to year changes in cereal grain and oilseed prices, it serves as a reference for the long term maintenance of grain output. Farmers rarely evaluate whether they should discontinue producing grains and oilseeds and sell any under utilized capital. Instead separate machines are replaced as they depreciate and as financial conditions warrant. However, if revenues from grain and oilseed sales are consistently exceeded by long-run average costs, expenditures linked to grain production will decline. Therefore, the long-run grain supply functions should be regarded in the context that average prices over a period of ten to fifteen years must be greater than or equal to the range of prices depicted in Figures 4.2, 4.4, 4.6, and 4.8 in order to maintain the corresponding levels of production.

The aggregation of the provincial wheat supply functions to the Prairie region, shown in Figure 4.9 and 4.10, shows the 1993 grain production capability of Western Canada is estimated to be 46.6 million tonnes. In the long run (2000), the total grain production capacity is estimated to be 51.7 million tonnes. According to values reported in the 1992-1993 Canadian Wheat Board Annual Report, the 10 year (1984-93) average for the production of principal grains in the Western Canadian prairie provinces is approximately 43.9 million tonnes per year, with a low of 30 million tonnes in 1988 and a high of 51 million tonnes in 1991.

Two of the policies analyzed shift the Prairie aggregate supply function upwards when the grain prices (costs) are basis the Pacific or the St. Lawrence (See Figures 4.9 and 4.10). The aggregate short and long-run supply functions shift higher by between $12.00 per tonne in Alberta to $25.00 per tonne in Manitoba. The Manitoba grain exports bear the higher Seaway costs plus the loss in the WGTA subsidy. Higher rail costs for Alberta shipments are partially offset by eliminating any charges for shipments through the Great Lakes. The implications of the higher shipping costs in terms of cereal grain production and exports are analyzed in the context of the export demand for Prairie grains.

5.2 Scenarios Investigated

Four scenarios, based on assumptions regarding the payment of the WGTA subsidy, the CWB pooling point, and payment of government safety net subsidies, are analyzed. The base case represents the resources allocated to grain and oilseed production in 1993. It reflects short and long run wheat production capabilities given the technology reflected in the long term average wheat yields, the soil productivity of the area, and land endowment available for crop production. It represents the average amount of grain that can be produced given the land base and the yield potential of the particular area.

Scenario 1 is the model benchmark. This scenario corresponds to the policy conditions present in the 1994/95 crop year. The Canadian Wheat Board pooling point is basis Thunder Bay or Vancouver meaning all Western Canadian producers share in the cost of moving grain through the Great Lakes to the lower St. Lawrence. The WGTA subsidy also remains in place. Therefore, shippers pay only a portion of the total costs of shipping grain to export position. The government pays the remaining portion of rail costs through the WGTA subsidy. As well, the government safety net program remains in place. This means if revenue falls below a certain level, producers receive a payout. This scenario assumes world prices similar to those in the early 1990's for the short run analysis. Approximately 50 percent of Prairie wheat and barley is exported into subsidized markets.

Scenario 2 assumes the WGTA subsidy has been eliminated, the CWB pooling point has been adjusted to the lower St. Lawrence, and the revenue component of GRIP has been eliminated. Under this scenario, producers pay the full cost of shipping grain by rail to export position and eastern producers pay the full cost of moving grain from Thunder Bay to the lower St. Lawrence. Short run export prices are assumed to remain at levels similar to those in the early 1990's when export subsidies were heavily used by other grain exporters. Long run export prices are based on forecasts by Sparks Commodities (a private consulting firm).

Scenario 3 assumes the same subsidy and support levels as scenario 2. The short run export price is assumed to increase to levels similar to 1995-96 levels. Prices are higher as a result of low global wheat stocks. The use of grain export subsidies by the United States and the European Union (EU) have been temporarily reduced. Grain production is expected to increase in the future and the use of export subsidies is expected to increase to the maximum levels allowable under GATT. Figure 5.1 through Figure 5.4 illustrate the excess world demand and prairie excess supply functions under the different scenarios in the short run and the long run. Table 5.1 provides a summary of the equilibrium world prices under each scenario.

Table 5.1: Export Prices Under Various Government Programs (basis Pacific Coast/St. Lawrence).

	Short Run ($/Tonne)	Long Run ($/Tonne)
1. WGTA Subsidy / TB Pooling/ Safety Net Payment / Export subsidies by other countries	154.65(1)	254.48(1)
2. No WGTA Subsidy / SL Pooling / No Safety Net Payment / High use of export subsidies by competing countries is short run, moderate use in long run.	169.49	260.76
3. No WGTA Subsidy / SL Pooling / No Safety Net Payment / Low use of export subsidies by competing countries	250.11	N/A

(1) The short run export price does not include the government subsidy in terms of the premium paid to the safety net program of $13.23 per tonne. In the long run, the equilibrium export price is greater than the safety net price ($249.00 per tonne) guaranteed through the GRIP program.

As can be seen in Figure 5.1 through Figure 5.4, the prairie excess supply intersects the vertical axis at an export price of between $135 per tonne in the short run and $245 per tonne in the long run. These price levels represent the short and long run costs of supplying grain for export once the domestic requirements have been met from the least costly sources. The primary factor shifting the short run supply function intercept upwards from $134 per tonne in Figure 5.1 to $147 per tonne in Figure 5.2 is the added realized cost of rail services when they are paid in total by the shipper. The slope of the excess supply curve is nearly identical with and without the WGTA subsidy in these two figures. The model assumed limited substitution in terms of alternative transportation and handling systems within regions shipping grain.

When fixed costs are taken into consideration in the long run (Figure 5.3 and Figure 5.4), the excess supply curve for prairie grain shifts upwards by approximately $80 per tonne. This assumes that unless farmers are financially capable of replacing machinery and equipment used in grain production and receive adequate compensation for their labour and management they will switch their land from producing annual to perennial crops. Not only does the excess supply curve for annual crops shift to a higher price in the long run, the price elasticity increases relative to the short run. In the long run, there is time for farmers to alter their investment in machinery, as well as evaluate whether the renumeration from grain production is adequate to remain employed in the industry. The upward shift and the higher elasticity are consistent with economic theory.

Inelasticity in Figures 5.3 and 5.4 is attributable primarily to different capabilities of land in terms of producing annual crops and the areas of available lands.

The excess demand for Canadian exports of cereal grain and oilseeds, in terms of the wheat equivalent, is represented in terms of the wheat market clearing prices of $150 per tonne in the short run and $230 per tonne in the long run for scenario 1 (the model benchmark) and scenario 2. These prices are levels estimated by Sparks Commodities (1994) if Western Canadian exports are 33 and 37 million tonnes in the short and long run respectively. These market clearing export prices assume high use of export subsidies in the short run and levels allowed under GATT in the long run. Under scenario 3, the market clearing price is $250 per tonne in the short run with Western Canadian exports of 33 million tonnes. This export price is based on low global stocks of wheat and low use of export subsidies by competing countries. These prices are indicative of the 1995-96 wheat market. Low world stocks of grain and high prices are not expected to remain into the future. The excess demand curves for Prairie grain (Figures 5.1 through 5.4) were derived after selecting a representative short or long run price elasticity of export demand for Western Canadian grain and the equilibrium prices and quantities outlined above.

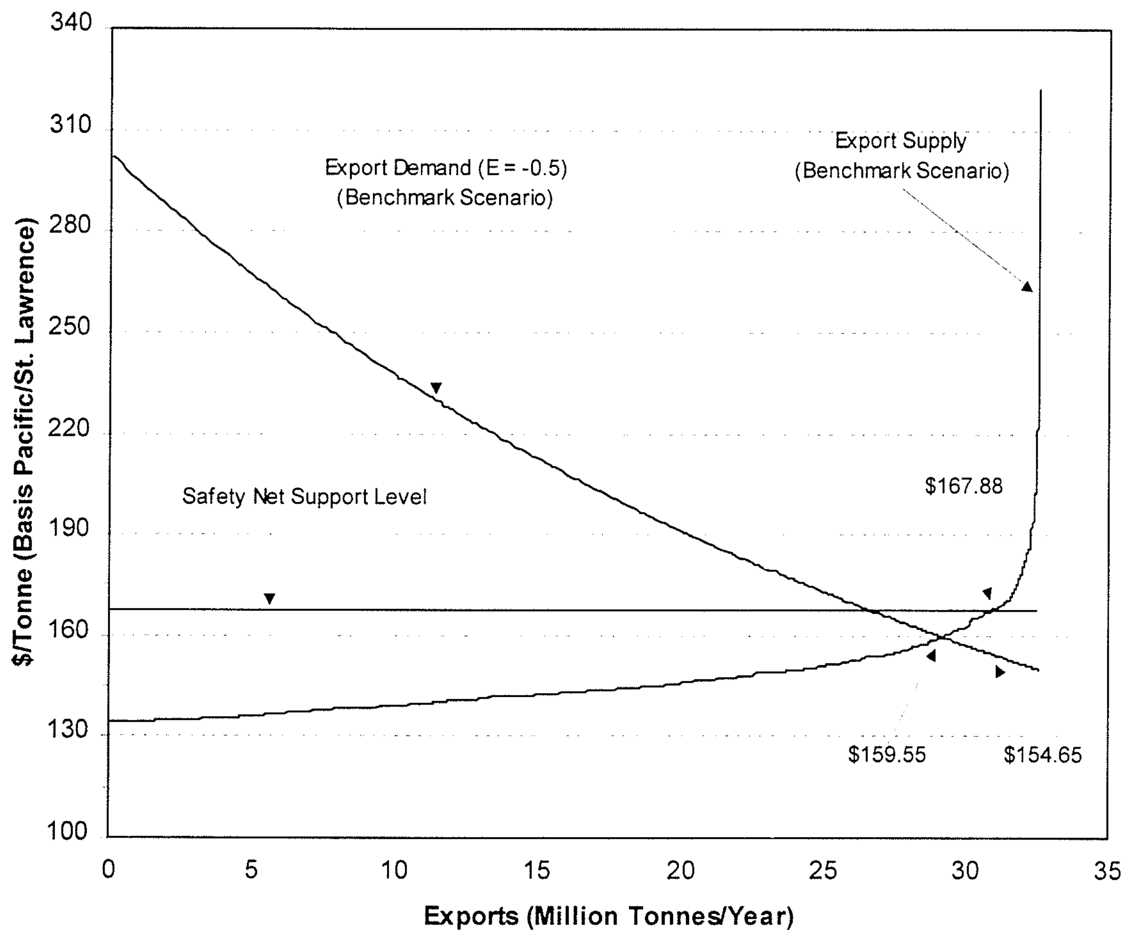

Figure 5.1: Short Run Prairie Exports – Benchmark Scenario (Lower Export Demand, WGTA subsidy and Great Lakes Pooling).

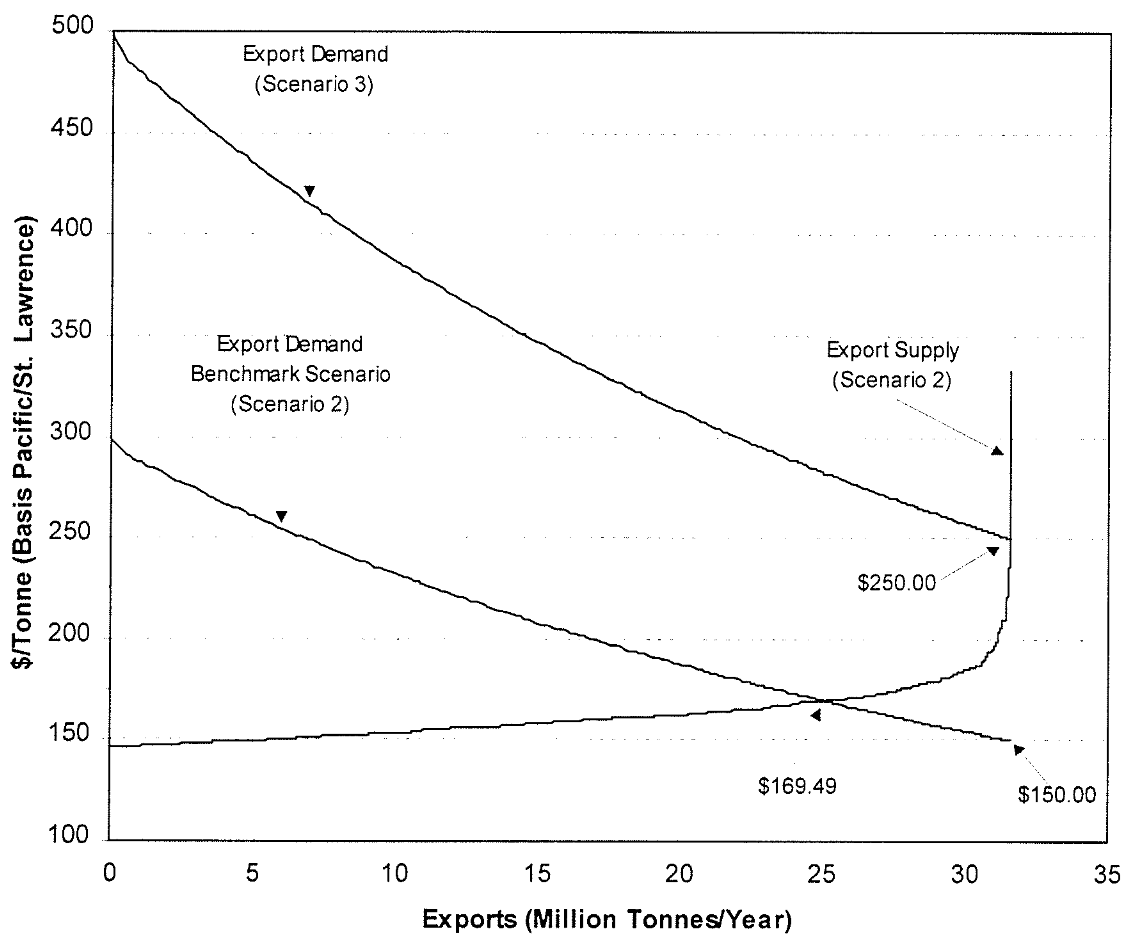

Figure 5.2: Short Run Prairie Exports – Scenario 2 (Lower Export Demand, No WGTA Subsidy and No Great Lakes Pooling) and Scenario 3 (Higher Export Demand, No WGTA Subsidy and No Great Lakes Pooling).

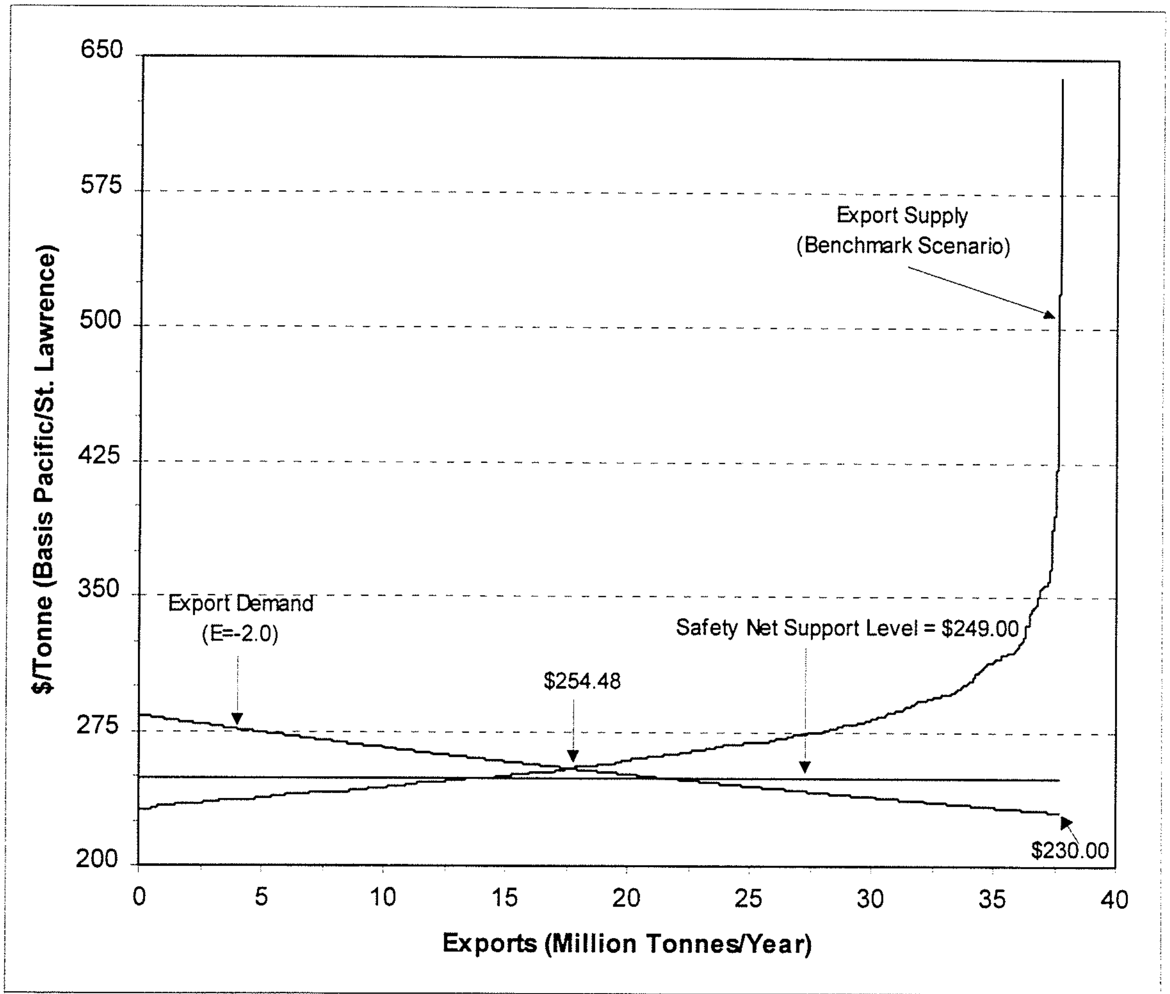

Figure 5.3: Long Run Prairie Exports – Benchmark Scenario (Assuming a Lower Export Demand, WGTA Subsidy and Great Lakes Pooling).

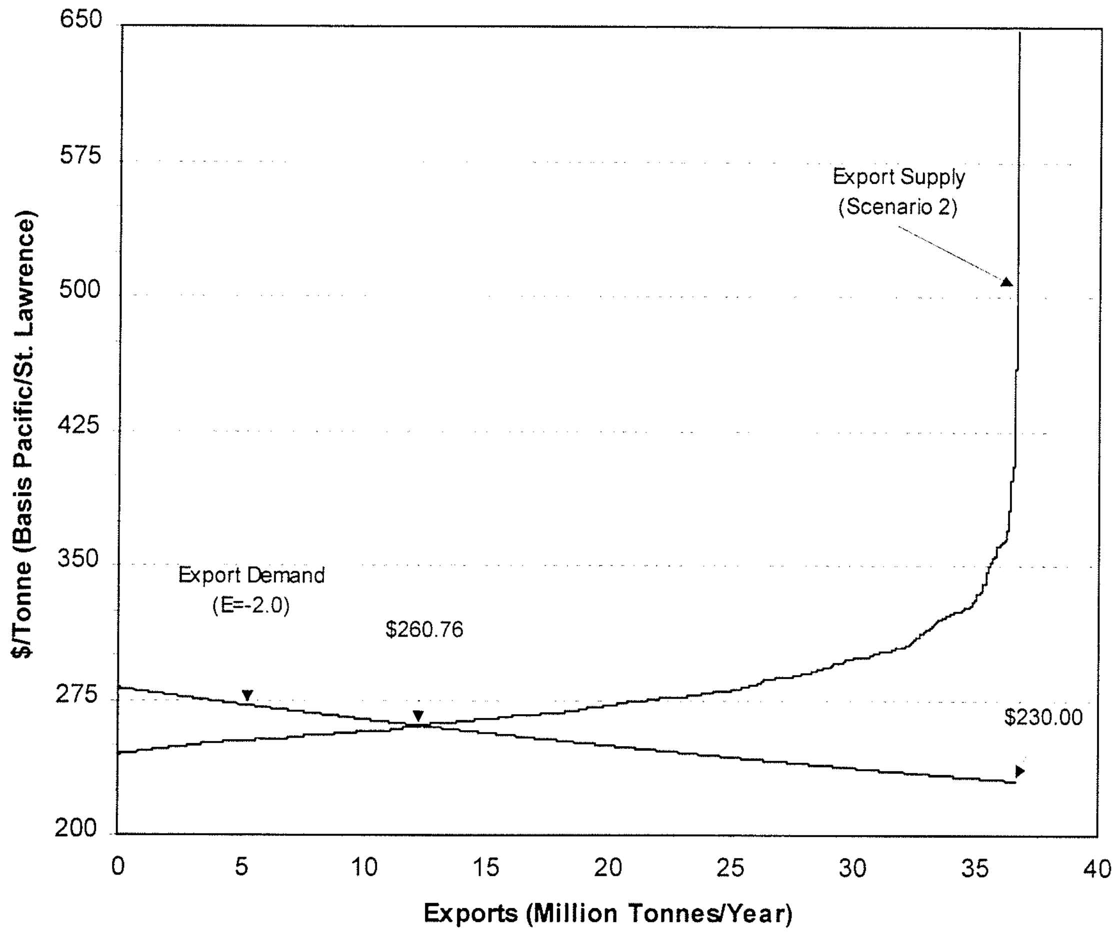

Figure 5.4: Long Run Prairie Exports – Scenario 2 (Assuming a Lower Export Demand, No WGTA Subsidy and No Great Lakes Pooling).

The equilibrium export prices, solved by equating the excess demand and supply functions, solve for the short and long run production levels in the different crop districts across the prairies. While the export equilibrium prices that determine the short and long run production levels are the same for all regions, the resulting farm-gate prices differ. The handling, storage, carrying charges, rail and trucking costs, and applicable Great Lake shipping and handling costs are subtracted from the export price to determine the on-farm price. The point where on-farm price equals the short or long run costs of production reflects the level of production that is economically feasible in the short or long run. Tables C.1 through C.3, in Appendix C, outline the production of grain in the short and long run under the various export prices for the provinces of Manitoba, Saskatchewan, and Alberta as well as the crop districts within these provinces. Also included are the lands removed from grain production, and the cow equivalent units that can be supported if the land is placed into an alfalfa/grass forage mixture.

Table 5.2 provides a summary of total grain production in the provinces, under the different scenarios in both the short and long run. Table 5.3 provides a summary of the land seeded to annual crops while Table 5.4 provides a summary of the area seeded to forage crop production under the different scenarios. Table 5.5 provides a summary of the change in cow-equivalent units under each scenario assuming the land removed from annual crop production is placed in an alfalfa/grass forage mixture. One cow-equivalent unit represents one cow-calf (with an 83 percent calf crop), 0.2 replacement heifers, 0.23 feeder yearlings, and 0.1 feedlot animals. In each table, the model benchmark (scenario 1) is compared to the base production levels. The remaining scenarios are then compared to the forecasts under the model benchmark scenario.

Table 5.2: Grain Production by Province and Scenario.

	Export Price ($/Tonne)	Manitoba (000 Tonnes)	Saskatchewan (000 Tonnes)	Alberta (000 Tonnes)	Western Canadian Totals (000 Tonnes)
Short Run					
Base Production [1/]		9,069	21,682	15,811	46,562
Model Benchmark [2/]	154.65	8,851 (-2.4%)*	20,910 (-3.6%)*	15,436 (-2.4%)*	45,197 (-3.9%)*
Scenario 2 [3/]	169.49	6,975 (-21.2%)**	19,974 (-4.5%)**	14,814 (-4.0%)**	41,763 (-7.6%)**
Scenario 3 [4/]	250.11	9,069 (+2.5%)**	21,658 (+3.6%)**	15,811 (+2.4%)**	46,538 (+3.0%)**
Long Run					
Base Production [1/]		10,066	24,064	17,548	51,678
Model Benchmark [2/]	254.48	8,118 (-19.4%)*	11,159 (-53.6%)*	12,724 (-27.5%)*	32,001 (-38.1%)*
Scenario 2 [3/]	260.76	6,209 (-23.6%)**	9,334 (-16.4%)**	12,426 (-2.3%)**	27,969 (-12.6%)**

Notes:

[1/] Production potential of the area assuming all relevant costs are covered.

[2/] The model benchmark scenario assumes the WGTA subsidy remains in place, the revenue insurance component of GRIP remains in place, and the CWB freight rate pooling is basis Pacific/Thunder Bay.

[3/] Scenario 2 assumes the WGTA is removed, revenue insurance is discontinued, and the CWB freight rate pooling is basis Pacific/St. Lawrence. Export prices are low assuming export subsidies are used by competing countries.

[4/] Scenario 3 assumes the WGTA is removed, revenue insurance is discontinued, and the CWB freight rate pooling is basis Pacific/St. Lawrence. Export prices are based on low use of export subsidies.

* = Change in grain production compared to the base production level.

** = Change in grain production compared to the model benchmark scenario.

Table 5.3: Cereal Grain and Oilseed Area by Province and Scenario.

	Export Price ($/Tonne)	Manitoba (000 Acres)	Saskatchewan (000 Acres)	Alberta (000 Acres)	Western Canadian Totals (000 Acres)
Short Run					
1991 Annual Acres [1/]		9,773	30,828	18,447	59,048
Model Benchmark [2/]	154.65	9,460 (-3.2%)*	29,178 (-5.4%)*	17,747 (-3.5%)*	56,385 (-4.5%)*
Scenario 2 [3/]	169.49	7,279 (-23.1%)**	27,543 (-5.6%)**	16,703 (-5.9%)**	51,525 (-8.6%)**
Scenario 3 [4/]	250.11	9,773 (+3.3%)**	30,751 (+5.4%)**	18,447 (+3.9%)**	58,971 (+4.6%)**
Long Run					
1991 Annual Acres [1/]		9,773	30,828	18,447,	59,048
Model Benchmark [2/]	254.48	7,536 (-22.9%)*	12,669 (-58.9%)*	11,912 (-35.4%)*	32,117 (-45.6%)*
Scenario 2 [3/]	260.76	5,584 (-25.9%)**	10,589 (-16.4%)**	11,461 (-3.8%)**	27,634 (-14.0%)**

Notes:

[1/] Source: Statistics Canada. 1991 Agricultural Census.

[2/] The model benchmark scenario assumes the WGTA subsidy remains in place, the revenue insurance component of GRIP remains in place, and the CWB freight rate deductions are basis Pacific/Thunder Bay.

[3/] Scenario 2 assumes the WGTA is removed, revenue insurance is discontinued, and the CWB freight rate deductions are basis Pacific/St. Lawrence. Export prices are low assuming export subsidies are used by competing countries.

[4/] Scenario 3 assumes the WGTA is removed, revenue insurance is discontinued, and the CWB freight rate deductions are basis Pacific/St. Lawrence. Export prices are based on low use of export subsidies.

* = Change in annual acres as compared to the 1991 level.

** = Change in annual acres as compared to the model benchmark scenario.

Table 5.4: Improved Forage Area by Province and Scenario.

	Export Price ($/Tonne)	Manitoba (000 Acres)	Saskatchewan (000 Acres)	Alberta (000 Acres)	Western Canadian Totals (000 Acres)
Short Run					
1991 Perennial Acres [1/]		2,694	5,087	8,820	16,601
Model Benchmark [2/]	154.65	3,007 (+11.6%)*	6,737 (+32.4%)*	9,520 (+7.9%)*	19,264 (+16.0%)*
Scenario 2 [3/]	169.49	5,188 (+72.5%)**	8,372 (+24.3%)**	10,564 (+11.0%)**	24,124 (+25.2%)**
Scenario 3 [4/]	250.11	2,694 (-10.4%)**	5,164 (-23.3%)**	8,820 (-7.4%)**	16,678 (-13.4%)**
Long Run					
1991 Annual Acres [1/]		2,694	5,087	8,820	16,601
Model Benchmark [2/]	254.48	4,931 (+83.0%)*	23,246 (+357%)*	15,355 (+74.1%)*	43,532 (+162%)*
Scenario 2 [3/]	260.76	6,883 (+39.6%)**	25,326 (+8.9%)**	15,806 (+2.3%)**	48,015 (+10.3%)**

Notes:

[1/] Source: Statistics Canada. 1991 Agricultural Census.

[2/] The model benchmark scenario assumes the WGTA subsidy remains in place, the revenue insurance component of GRIP remains in place, and the CWB freight rate deductions are basis Pacific/Thunder Bay.

[3/] Scenario 2 assumes the WGTA is removed, revenue insurance is discontinued, and the CWB freight rate deductions are basis Pacific/St. Lawrence. Export prices are low assuming export subsidies are used by competing countries.

[4/] Scenario 3 assumes the WGTA is removed, revenue insurance is discontinued, and the CWB freight rate deductions are basis Pacific/St. Lawrence. Export prices are based on low use of export subsidies.

* = Change in annual acres as compared to the 1991 level.

** = Change in annual acres as compared to the model benchmark scenario

Table 5.5: Cow-Equivalent Units (CEU's) by Province and Scenario.

	Export Price ($/Tonne)	Manitoba (000 CEU's)	Saskatchewan (000 CEU's)	Alberta (000 CEU's)	Western Canadian Totals (000 CEU's)
Short Run					
1991 Cow Equivalent Units [1/]		490	996	1,837	3,323
Model Benchmark [2/]	154.65	542 (+10.6%)*	1,148 (+15.3%)*	1,915 (+4.2%)*	3,605 (+8.5%)*
Scenario 2 [3/]	169.49	943 (+74%)**	1,305 (+13.7%)**	2,036 (+6.3%)**	4,284 (+18.8%)**
Scenario 3 [4/]	250.11	490 (-9.6%)**	1,004 (-12.5%)**	1,837 (-4.1%)**	3,331 (-7.6%)**
Long Run					
1991 Cow Equivalent Units [1/]		490	996	1,837	3,323
Model Benchmark [2/]	254.48	856 (+75%)*	2,701 (+171%)*	2,600 (+42%)*	6,157 (+85%)*
Scenario 2 [3/]	260.76	1,202 (+40.4%)**	2,941 (+8.9%)**	2,676 (+2.9%)**	6,819 (+10.8%)**

Notes:

[1/] Estimate based on Statistics Canada 1991 Agricultural Census data. The 1991 cattle population is converted to Cow-Equivalent Units as defined in Chapter 4.
[2/] The model benchmark scenario assumes the WGTA subsidy remains in place, the revenue insurance component of GRIP remains in place, and the CWB freight rate deductions are basis Pacific/Thunder Bay.
[3/] Scenario 2 assumes the WGTA is removed, revenue insurance is discontinued, and the CWB freight rate deductions are basis Pacific/St. Lawrence. Export prices are low assuming export subsidies are used by competing countries.
[4/] Scenario 3 assumes the WGTA is removed, revenue insurance is discontinued, and the CWB freight rate deductions are basis Pacific/St. Lawrence. Export prices are high based on low use of export subsidies.
* = Change in cow-equivalent units (000's) compared to the 1991 population level.
** = Change in cow-equivalent units (000's) compared to the model benchmark scenario.

5.2.1 Short Run Results

Approximately 9.8 million, 30.8 million, and 18.4 million acres of land are seeded to annual crops in Manitoba, Saskatchewan, and Alberta (Statistics Canada, 1992). Based on land endowment and long term average wheat yields, current grain production on the Canadian prairies is estimated to be 46.6 million tonnes annually in the short run. Of this, approximately 9.1 million tonnes is produced in Manitoba, 21.7 million tonnes in Saskatchewan, and 15.8 million tonnes is produced in Alberta. Based on Prairie consumption level of 14 million tonnes, the export potential for the Canadian prairies is 32.6 million tonnes.

Approximately 16.6 million acres of Western Canadian land is devoted to perennial crop production (Statistics Canada, 1992) with over half of this land in the province of Alberta. The total cattle population in Western Canada is over 8.1 million head with 58 percent of the population in Alberta, 28 percent of the population in Saskatchewan, and 14 percent of the population in Manitoba (Statistics Canada, 1992). The 1991 population estimates using the cow-equivalent measure are shown in Table 5.5. The total number of cow equivalent units is estimated at 3.3 million units. The number of CEU's in each province differs slightly from the true 1991 population because the CEU measure is based on the composition of cattle in Manitoba. The estimated cattle population using the CEU measure is approximately 8 percent lower than the true 1991 cattle population.

5.2.1.1 Model Benchmark Results

The model benchmark scenario assumes the Canadian Wheat Board freight rate deductions are basis Thunder Bay/Vancouver, the WGTA subsidy remains in place, and contracts for the GRIP safety net program are available. Approximately 4.5 percent (2.7 million acres) of Western Canadian annual cropped acres is switched from annual crop production to forage crop production under the model benchmark scenario. This represents a 16 percent increase in perennial acres. The greatest decrease occurs in Saskatchewan where 1.65 million acres are removed from annual crop production and placed in forage crop production. According to the model, the increase in Western Canadian forage acres could support an additional 0.3 million cow-equivalent units. This represents an 8.5 percent increase over the 1991 cattle population.

Grain production is estimated to be approximately 45.2 million tonnes under the model benchmark short run equilibrium. This represents prairie exports of 31.2 million tonnes. The model derived equilibrium level of exports are 1.4 million tonnes below the potential of 32.6. Assuming an average export price of $150 per tonne and a safety net subsidy of $17.88 per tonne the combined revenue was insufficient to cover the short run costs incurred on lands producing 1.4 million tonnes of grain. Once this production of grain does not occur, the model estimated world price increases to $154.65 per tonne and the safety net subsidy drop to $13.23 per tonne. On a provincial basis, production decreases by 2.4 percent in Manitoba, 3.6 percent in Saskatchewan, and 2.4 percent in Alberta. The model benchmark results indicate that Western Canadian producers are currently producing 1.4 million tonnes of grain that according to the model is economically unviable. This uneconomical production is likely associated with low yielding marginal land.

On a percentage basis, the greatest decrease in production occurs in Manitoba Crop District 10 in Eastern Manitoba followed by Alberta Agricultural Region 1 in South-Eastern Alberta where there is a 70 percent and 18 percent reduction in annual crop production over baseline production respectively. In terms of the actual volume of grain production, the greatest reductions occur in Alberta Agricultural Regions 1 and 4 (190 and 121 thousand tonnes respectively) and Saskatchewan Crop Districts 5 and 6 (136 and 145 thousand tonnes respectively). Crop district maps and regional maps are provided in Appendix A.

In the short-run, the difference between baseline production assuming all short run costs are covered and the model benchmark represents approximately four percent of the current prairie production capacity. The equilibrium export price with all subsidies in place under this scenario is determined to be $154.65 per tonne. This is $14.84 per tonne below the export price if neither the WGTA nor the safety net programs (scenario 2) were available in the short-run. The model estimates the world price will rise more in the short run than the long run as prairie farmers switch land from annuals to perennials because of the lower price elasticity of demand.

5.2.1.2 Results under Scenario 2 and Scenario 3

Scenario 2 and scenario 3 assume the WGTA subsidy has been eliminated, the CWB eastern freight rate deductions are basis the lower St. Lawrence, and the revenue component of the GRIP program has been discontinued in all three provinces. Scenario 2 assumes the short run equilibrium export price and quantity for the world grain market is $150 per tonne and 110 million tonnes respectively. These levels are similar to those in the early 1990's based on the assumption that export subsidies continue to be used at the maximum levels allowed under the GATT agreement and world excess demand for grain remains at similar levels. Scenario 3 assumes the short run equilibrium price and quantity for the world grain market is $250 and 110 million tonnes respectively. This price assumes lower world supplies of grain and minimal use of export subsidies. These are the price and quantity levels prior to taking into account the Canadian supply response.

Under scenario 2, short run Western Canadian grain production levels are estimated to decrease by approximately 3.4 million tonnes or 7.6 percent from the model benchmark level of production if (1) export prices are based on the St. Lawrence rather than Thunder Bay, (2) WGTA subsidy is eliminated on all grain exports, and (3) guaranteed per acre revenue under the GRIP program is discontinued. Of this decrease, 1.88 million tonnes occurs in Manitoba, while 936 thousand tonnes occurs in Saskatchewan and 622 thousand tonnes occurs in Alberta. This represents a 21 percent decrease in grain production in Manitoba, a 5 percent reduction in Saskatchewan, and a 4 percent reduction in Alberta. Cereal grain and oilseed production levels decrease in all crop districts across the prairies. In terms of volumes, the greatest decreases occur in Eastern Saskatchewan (crop district 5 and 1), and in Central Manitoba (crop districts 7 and 6). Crop production in Central Alberta (census divisions 5 and 6) are the least effected by changes to the above policies. Production levels decrease by 8 thousand tonnes in total in these two areas. On a percentage basis, grain production decreases by 100 percent in Manitoba crop district 10 (the most easterly area) and 93 percent in Manitoba's Interlake area. Production decreases by 60 and 58 percent in Manitoba crop district 6 and 11 respectively.

Canadian grain exports decrease to 26.8 million tonnes under scenario 2. This is a decrease of 4.4 million tonnes over grain export estimates under the model benchmark, and a decrease of 5.8 million tonnes over the short run export potential of the Canadian prairies. One million tonnes of the decrease is due to the assumed increase in domestic grain requirements from 14 to 15 million tonnes, when the subsidies are eliminated. Eliminating the WGTA subsidy, changing the CWB pooling point, and eliminating the commodity specific safety net program causes export price to rise to $169.49 per tonne in response to a 4.4 million tonne drop in Canadian exports.

According to the model, approximately 4.9 million acres of land switches from annual crop production to forage crop production under scenario 2 as compared to the model benchmark. In Manitoba, annual cropped acres decrease by approximately 2.2 million acres, while in Saskatchewan and Alberta there is a 1.6 and 1.0 million acre decrease respectively compared to the model benchmark. If this land is placed in forage production there is a 25 percent increase in perennial acres in Western Canada. This represents a 73 percent, 24 percent, and 11 percent increase in perennial acres in Manitoba, Saskatchewan, and Alberta respectively. The increase in perennial acres across Western Canada can support an additional 679 thousand cow-equivalent units (401 CEU's in Manitoba, 157 CEU's in Saskatchewan, and 121 CEU's in Alberta).

The largest adjustment in cereal grain and oilseed production occurs in Manitoba. This is mainly due to the additional shipping and handling costs associated with moving grain beyond Thunder Bay to transfer elevators in the lower St. Lawrence. The change in the CWB eastern pooling point to the lower St. Lawrence means that Seaway costs that were previously pooled are now born entirely by shipments from eastern prairie producers. In fact, revenue in Alberta and Saskatchewan increases when the pooling basis is moved to the St. Lawrence as the export wheat and barley prices are no longer assigned a share of the export shipping costs through the Great Lakes. In order to determine how much of the decrease in Manitoba grain production is attributable to the change in the eastern CWB pooling point, the model is used to test a scenario where the WGTA subsidy remains in place and the pooling point is basis St. Lawrence. Under this scenario, there is an 850 thousand tonne decrease in Manitoba exports. This indicates that 850 thousand tonnes of the forecasted 1.9 million tonne decrease in grain production in the province of Manitoba is attributable to the change in basis from Thunder Bay to the lower St. Lawrence.

Under scenario 3, grain production levels increase relative to the model benchmark in all regions of the prairies. Overall, grain production increases by approximately 1.3 million tonnes as compared to the model benchmark. This level of production is only 24 thousand tonnes less than the short run production potential of the prairies when all short run costs are covered (baseline production). The world export price is estimated to increase slightly to $250.11 per tonne while Canadian grain exports are estimated to be approximately 31.5 million tonnes. Grain exports are only 0.3 million tonnes more than exports under the model benchmark scenario due to the assumption that domestic grain consumption increases when the WGTA is removed. The higher export price ($250.11 per tonne) is sufficient to cover the short run grain production costs on all but 78 thousand acres of land in Western Canada. The majority of this land is in Eastern Saskatchewan.

The results under scenario 3 are representative of actual production levels and grain prices in the year following the removal of the subsidies (crop year 1995/96). Grain prices are currently high due to low global stocks and low use of export subsidies by the United States and the European Union. The high export prices more than offset the $15 to $30 per tonne increase in transportation costs resulting from the elimination of the WGTA subsidy and the change in CWB pooling point. As a result, on-farm prices are high enough to cover short run costs in most areas of the prairies and production levels have not change dramatically in response to substantially higher transportation costs.

5.2.2 Long Run Results

In the long-run (2000), Western Canadian cereal grain and oilseed production is forecast to increase to 51.7 million tonnes if realized crop revenues are sufficient to meet all costs of production. Table 5.2 provides a summary of long run provincial grain production under the different scenarios. Table 5.3 provides a summary of the land seeded to annual crops, Table 5.4 provides a summary of the land seeded to forage production, and Table 5.5 provides a summary of the change in cow-equivalent units under each scenario. Export prices are forecast to rise in the long run, compared to the short run model benchmark scenario, as the export demand and supply functions shift up. Export demand for Canadian grain shifts because of lower export subsidies, slower growth in production levels of other exporting countries because of reduced domestic subsidies, and higher growth of imports from areas of deficit production (Sparks Commodities, 1994). The export supply function shifts upwards as a result of the assumption that prairie farmers will not continue to grow cereal grains and oilseeds unless all resources (land, labour and capital) are rewarded in accordance to their opportunity costs. The equilibrium export price in terms of wheat ranges between $254 per tonne and $261 per tonne in the long run under the two scenarios analyzed. The long run guaranteed safety net support level under the GRIP program is forecast to be $249 per tonne. The safety net support level is less than the projected model benchmark equilibrium export price of $254.48 per tonne. Therefore, safety net payments under the GRIP program are non-existent under the long run model benchmark scenario. The long-run prices are $90 per tonne to $107 per tonne higher than the short run prices under the model benchmark scenario and scenario 2. The long run prices are $5 per tonne to $10 per tonne higher than the short run prices under scenario 3.

In spite of the higher export prices for cereal grains and oilseeds, production is forecast to decline in the long run. Table 5.3 shows the existing land base producing annual crops. Total area seeded to annual crop production in the prairie provinces in 1991 was approximately 59 million acres (Statistics Canada, 1992). Assuming an average yield increase of 1.5 percent per year, long run potential grain production in Western Canada is approximately 51.7 million tonnes per year. Even by maintaining the former WGTA subsidy and leaving the CWB pooling point basis Thunder Bay (the model benchmark scenario), annual crop production in the long run is forecast to drop 19.7 million tonnes below the prairie potential of 51.7 million tonnes. Under this scenario, prairie farmers are forecast to receive $254.48 per tonne for their exports and continue to receive transportation subsidies. Despite this, the model projects 26.9 million acres in Western Canada is removed from grain production because revenues from annual crops do not exceed all long run costs.

Of this 19.7 million tonne decrease in grain production under the long run model benchmark scenario, there is a 1.9 million tonne decrease in production in Manitoba, a 12.9 million tonne decrease in Saskatchewan, and a 4.8 million tonne decrease in Alberta. This decrease in grain production represents a 19 percent decrease in Manitoba's long run production potential, a 54 percent decrease in the production potential in Saskatchewan, and a 28 percent decrease in the production potential of Alberta. Grain production levels decrease in all crop districts in Manitoba and Saskatchewan, and all agricultural regions in Alberta. The greatest decrease in production over base production levels occurs in South-Eastern Saskatchewan (Crop Districts 3, 5, 6 and 1). In Alberta, the greatest decrease occurs in the South-East (Agricultural Region 1). The greatest decrease in production in the province of Manitoba occurs in the Central Region (Crop District 7). On a percentage basis however, production in Eastern Manitoba and South-Eastern Alberta decreases by 100 percent while production in Southern Saskatchewan (Crop District 1, 4, and 3) decreases by approximately 85 percent.

The decrease in grain production across the prairies represents a 26.9 million acre reduction in annual cropped area. Of this total, 2.2 million acres is removed from annual crop production in Manitoba, 18.2 million acres in Saskatchewan, and 6.5 million acres in Alberta. This represents a 162 percent increase in forage acres in Western Canada if this land is placed into an alfalfa/grass forage crop. The added carrying capacity for cattle under these conditions is approximately 2.8 million cow equivalent units. This represents a 75 percent increase in the cattle population in Manitoba, a 171 percent increase in the cattle population in Saskatchewan, and 42 percent increase in the cattle population in Alberta. Under these conditions, and assuming domestic consumption of grain to be 14 million tonnes, grain exports are estimated to be approximately 18 million tonnes.

The 19.7 million tonne decrease in grain production, that the model determines to be uneconomical under the model benchmark scenario, results from a combination of world price levels and costs of production. The long run results hinge on farmers switching from annual crop production if all costs of producing cereals and oilseeds are not recovered through market sales and subsidies. Costs are defined to be; the rental value for land growing forages, the recovery of all operating expenditures and depreciation incurred from capital requirements, and wages necessary to maintain a family of four. Costs are adjusted by a cost index to the year 2000 to account for a 2.5 percent increase in costs per year.

If farmers knew in advance that receipts from grain and oilseed sales would be insufficient to recover realized and opportunity costs over a number of years, they would likely reach the same decisions assumed in the analysis. No one has perfect foresight, especially with respect to future grain and oilseed prices. An expectation that grain and oilseed revenues will be sufficient to justify investing in specialized machinery and equipment, as well as choosing a farming vocation, results in committing resources to annual crop production that are inflexible to change when the revenue expectations are not realized. Even following a number of years where revenues fall short of costs, the belief in cereal grain and oilseed production is reinforced when prices periodically rally and exceed all costs.

The export demand function assumed in the analysis is relatively optimistic since it generates prices 45 percent above those observed between 1983 to 1994 and levels similar to those in 1995/96. Whereas the export demand for prairie grain specified in this study may be confirmed in the future, many farmers will commit resources to grains and oilseeds today while harbouring expectations of higher prices. Therefore, the model's estimate of a 19.7 million tonne reduction from potential output in the long run (even under the assumption that the WGTA subsidy and Thunder Bay pooling are still in existence), is likely an overestimation of the most probable change. There is a tendency for prairie farmers to believe that cereal grain and oilseed production will provide the most profitable cropping alternative.

The long-run production level of 32.0 million tonnes under the model benchmark assumes all farmers' expectations coincide with the assumptions in the model. To the extent that some farmers believe export prices will exceed the levels forecast or do not take into account all costs of production when making production decisions, the production of cereals and oilseeds will exceed the levels predicted by the model. If the long run export price (basis St. Lawrence/Pacific Coast) increases to $286.97 as a result of a shift in the excess demand for cereal grains and oilseeds, the model predicts prairie production under the long run model benchmark at levels similar to production levels predicted under the short run model benchmark (45.2 million tonnes). Alternatively, if costs of production increase by 0.75 percent per year as opposed to 2.5 percent per year, long run production under the model benchmark is forecast at 42.2 million tonnes assuming a safety net support level of $249.00 per tonne.

Under scenario 2 where the WGTA subsidy is eliminated and the CWB pooling point is changed from Thunder Bay to the lower St. Lawrence, the world export price (basis Vancouver/St. Lawrence) is forecast to increase to $260.76 per tonne as compared to $254.48 per tonne under the long run model benchmark. The increase in world price is due to a drop in prairie exports of 5.0 million tonnes under this scenario. Prairie grain production falls from 32.0 million tonnes to 28.0 million tonnes which represents a 4.0 million tonne decrease in exports from the model benchmark scenario. Exports drop a further 1 million tonnes because domestic consumption is assumed to increase by this amount when the WGTA subsidy is eliminated. The vast majority of the decrease in production occurs in the provinces of Manitoba and Saskatchewan (1.9 and 1.8 million tonnes respectively). Production decreases by approximately 0.3 million tonnes in the province of Alberta. These decreases represent a production decrease of 23.5 percent in Manitoba, 16.4 percent in Saskatchewan, and 2.3 percent in Alberta compared to production under the long run model benchmark. This analysis indicates that a 4.0 million tonne drop in long run production is linked to changes in government support of the prairie grain economy and changes in producer cross-subsidization through the CWB pool accounts.

Under scenario 2, approximately 4.5 million acres is projected to switch from grain production to forage production relative to the long run model benchmark. This represents an added carrying capacity of approximately 0.6 million CEU's. The cattle population increases by approximately 40 percent in Manitoba compared to the model benchmark, 9 percent in Saskatchewan, and 3 percent in Alberta. Under these conditions grain exports decrease by 5 million tonnes as compared to exports under the long run model benchmark, to a level of 13 million tonnes.

Approximately 19.6 million tonnes of the decrease in grain production from the long run production capabilities of the prairie provinces is attributed to long run production costs exceeding international grain prices of cereal grains and oilseeds. If prairie farmers are willing to continue to accept lower earnings from grains and oilseed production relative to forages than some of the forecasted decrease is not likely to happen.

In order for Western Canadian production to remain at the short run model benchmark level of 45.2 million tonnes per year, the export price basis Pacific Coast/St. Lawrence has to increase to $298.44 per tonne. This export price covers all long run costs of production for 45.2 million tonnes of grain as well as all marketing costs associated with getting grain from prairie point to export location (Pacific Coast/St. Lawrence). At this export price, Western Canadian exports are approximately 30.2 million tonnes per year assuming domestic consumption of 15 million tonnes per year. Alternatively, if costs of production increase by 0.75 percent per year as opposed to 2.5 percent per year, long run production levels are forecast to be approximately 35.8 million tonnes after the WGTA subsidy is removed and the CWB pooling point is adjusted to the lower St. Lawrence. This level of production is associated with exports of approximately 20.8 million tonnes per year and an equilibrium export price of $249.09 per tonne.

The long-run adjustments in production are more sensitive to lower subsidies than the short-run adjustments. This occurs because the assumptions underpinning the long-run demand and supply functions imply prairie farmers, as well as importers of prairie grains are more flexible with respect to decisions committing resources to production or with respect to purchasing Canadian exports. In the short-run, fewer options exist and the relatively smaller drop in production and exports reflect such restrictions, while the long-run setting is devoid of many constraints limiting producers' and importers' decisions. Subsequently, the comparative static changes are greater. It also should be remembered the changes may be larger but the transition occurs over a longer time interval.

5.3 A Mix of Crop Exports

The following analysis was performed to determine how a cereal/oilseed crop mix affects the world equilibrium export prices and Western Canadian grain production. The base model assumes wheat is representative of prairie grain and oilseed production. This analysis investigates how the results change when other crops (represented by canola) are included, assuming a rotation of three acres of cereals to every one acre seeded to canola. This rotation assumes 75 percent of cropped acreage is seeded to wheat while the remaining 25 percent is seeded to canola. Canola acreage is limited due to the increased incidence of disease when land seeded to canola is more frequent than once every four years (Campbell et al. 1990).

The ratio of wheat yields to canola varies from 1.3 to 1.5 (Provincial Crop Insurance Corporations). These values indicate that on a volume basis, a harvested acre of wheat yields between 30 to 50 percent more grain than a harvested acre of canola. Over the past 20 years, the annual price ratio of wheat to canola varied from 0.5 to 0.7 (Provincial Crop Insurance Corporations). This indicates that the price of wheat ranges from 50 to 70 percent of the price of canola. Therefore, the ratio of expected total receipts from an area of land seeded to canola relative to an area of land seeded to wheat ranges from 0.94 to 1.5.

The short and long run supply functions used in the wheat equivalent analysis are based on the yield potential of the prairie provinces in terms of wheat, and the short and long run costs associated with the production of wheat. These supply functions are assumed to be representative of the supply functions associated with a crop mix of wheat and other crops. However, because there is generally a decrease in the volume of grain produced per acre for other crops, such as canola and flax, some adjustments need to be made. The higher costs of producing oilseed crops and lower yields would result in an upward shift of the export supply function. In order to account for the lower yield potential (in tonnes/acre) and the higher input cost requirements of canola and other special corps, it is assumed there is an equivalent downward shift in the excess demand curve as opposed to an upward shift in the supply curve. The supply curve continues to be based on wheat yields and costs of production, however the demand curve is adjusted to reflect the lower yields and higher input costs associated with other crops. The costs of producing wheat and canola on an area basis are assumed to be the same, however, the costs on a per tonne basis differ due to the lower yield of canola relative to wheat. Canola yields were not provided for each quarter section in terms of the coverage levels determined for wheat. Therefore it was impossible to estimate a cost per tonne for wheat and canola for each parcel of land. A weighted average cost per tonne (based on the percent of land seeded to each crop) is determined for both crop yields to determine the average cost structure per tonne when canola is included in the rotations. The equilibrium world export price received for other crops is reduced by 10 percent to account for the reduced yields and increased input costs on other crops relative to wheat. It is assumed producers receive only 90 percent of the equilibrium world export price for other crops.

The demand equation for wheat and other grains is the same as specified in equation (4.13). The methodology used to determine the equilibrium world export prices and Canadian export levels, assuming a crop mix of 70 percent wheat and 30 percent other crops, is outlined in Section 0.

Figure 5.5 through Figure 5.8 illustrate the world demand for grains and oilseeds, and the Canadian export supply function for a crop mix under the different scenarios in the short run and the long run. These figures show the equilibrium export levels corresponding to higher valued crops with a greater price elasticity than in the previous analysis. Table 5.6 provides a summary of the equilibrium world prices under each scenario.

Table 5.6: Export Prices Under Various Government Programs (basis Pacific Coast/St. Lawrence).

	Short Run ($/Tonne)	Long Run ($/Tonne)
1. WGTA Subsidy / TB Pooling/ Safety Net Payment / Export subsidies by other countries	160.08[1]	248.43[1]
2. No WGTA Subsidy / SL Pooling / No Safety Net Payment / High use of export subsidies by competing countries is short run, moderate use in long run.	169.43	255.09
3. No WGTA Subsidy / SL Pooling / No Safety Net Payment / Low use of export subsidies by competing countries	250.39	N/A

[1] These prices do not include the government subsidy in terms of premiums paid to safety net programs of $16.80 per tonne in the short run and $6.42 per tonne in the long run.

These equilibrium prices are used to determine the short and long run production levels in the three prairie provinces assuming a crop mix of 70 percent wheat and 30 percent other crops. The production values are compared to the production values attained assuming wheat is representative of prairie grain production. The handling, storage, carrying charges, rail and trucking costs, and Great Lake shipping and handling costs are subtracted from the world prices to determine the on-farm price. The point where the on-farm price is equal to the short or long run costs of production reflects the level of production that is economically feasible in the short or long run.

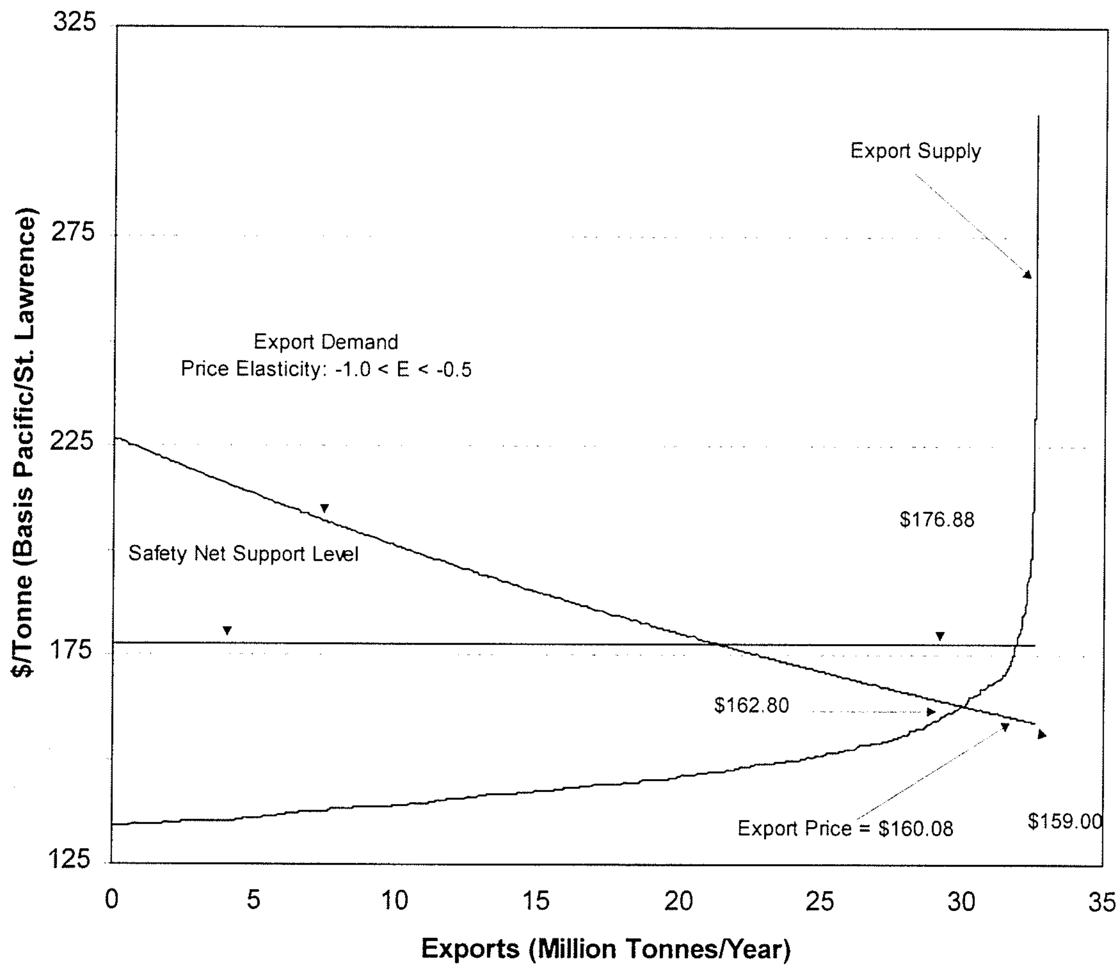

Figure 5.5: Short Run Prairie Exports – Model Benchmark Scenario Assuming a Higher Demand Price Elasticity

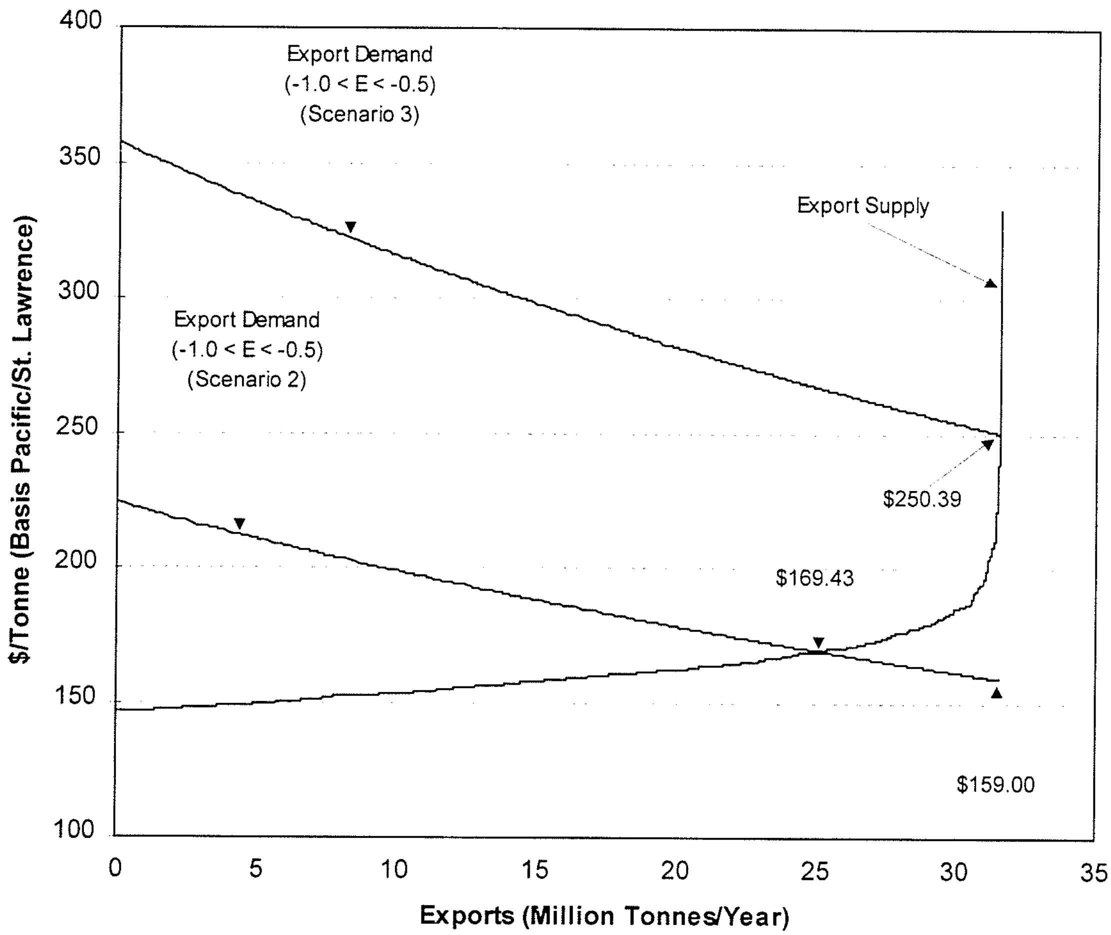

Figure 5.6: Short Run Prairie Exports – Scenarios 2 and 3 Assuming a Higher Demand Price Elasticity

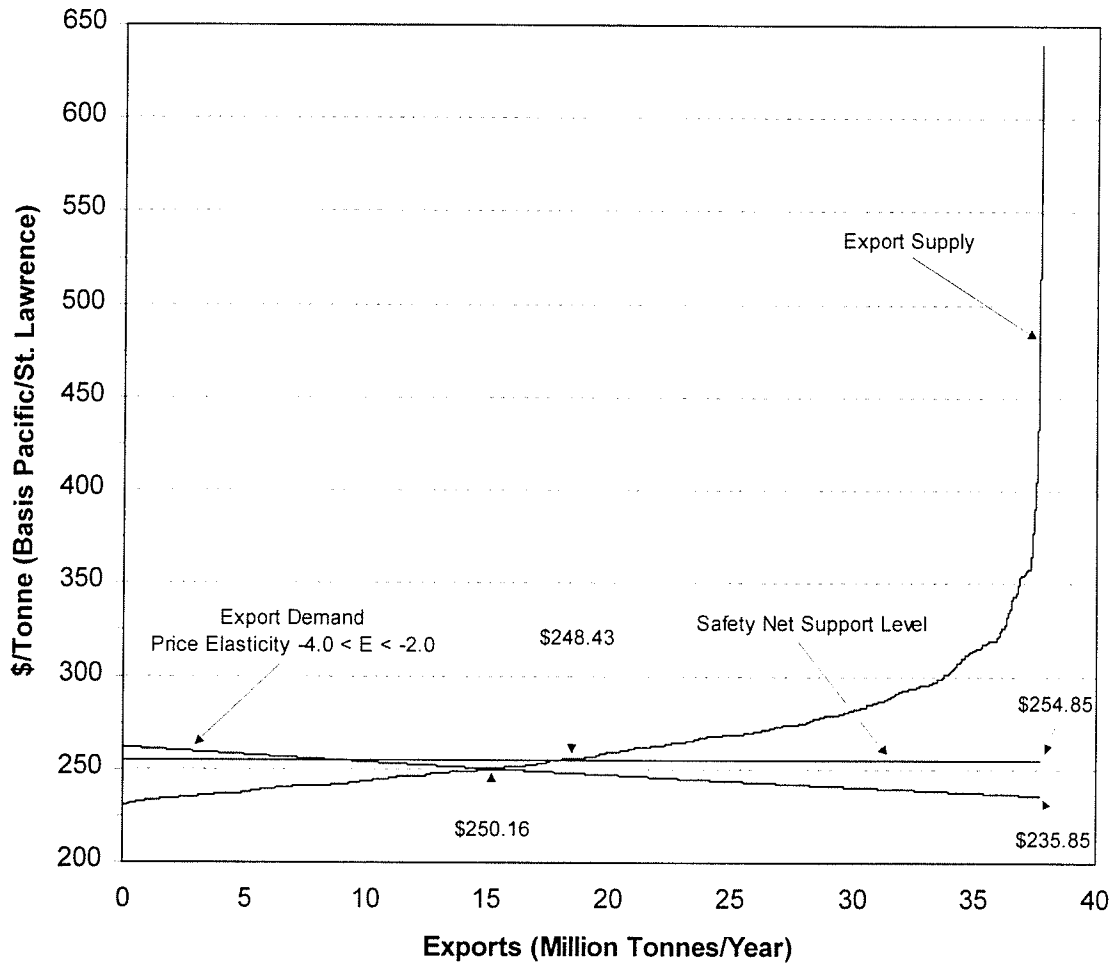

Figure 5.7: Long Run Prairie Exports – Model Benchmark Scenario Assuming a Higher Demand Price Elasticity

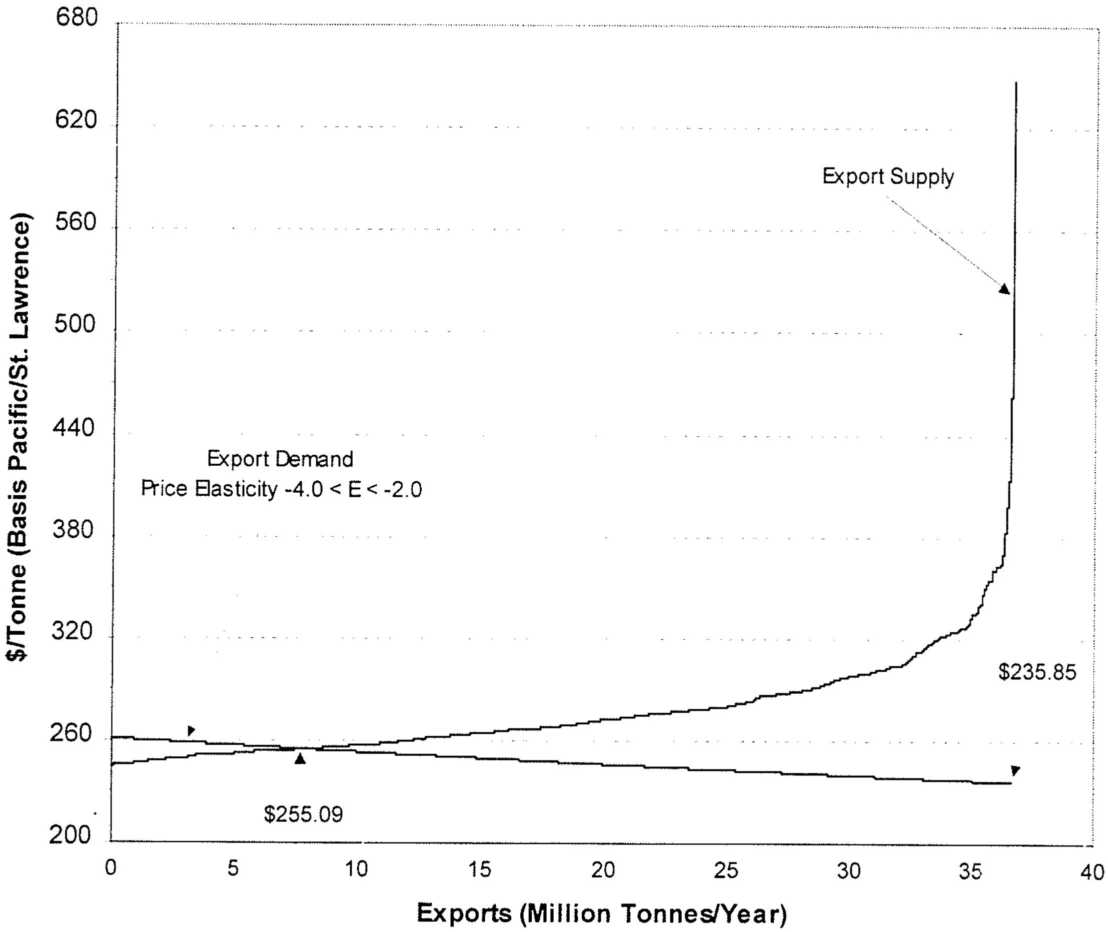

Figure 5.8: Long Run Prairie Exports – Scenarios Assuming a Higher Demand Price Elasticity

5.3.1 Provincial Grains and Oilseed Summary

Table 5.7 provides a summary of the provincial totals for grain production in the short and long run using a crop mix in determining the export price.

The analysis suggests the equilibrium grain production and export levels are not affected greatly in the short run when higher world prices and elasticities are taken into account. Prairie grain production levels are fairly consistent with levels determined using wheat as the sole export crop. Under the assumption that the WGTA subsidy and safety net payments remain in place and the CWB freight deductions are basis Thunder Bay/Pacific production is approximately 760 thousand tonnes greater under the crop mix scenario as compared to the wheat equivalent estimates. The larger initial export prices for the crop mix scenario result in higher safety net support levels as compared to levels associated with the wheat equivalent analysis. Under scenario 2 production estimates under the crop mix scenario are approximately 50 thousand tonnes greater than under the wheat equivalent analysis.

Table 5.7: Prairie Grain and Oilseed Production by Province and Scenario.

	Export Price ($/Tonne)	Manitoba (000 Tonnes)	Saskatchewan (000 Tonnes)	Alberta (000 Tonnes)	Western Canadian Totals (000 Tonnes)
Short Run					
Base Production [1/]		9,069	21,682	15,811	46,562
Model Benchmark [2/]	160.08	8,985 (8,851)	21,268 (20,910)	15,707 (15,436)	45,960 (45,197)
Scenario 2 [3/]	169.43	6,975 (6,975)	19,927 (19,974)	14,814 (14,814)	41,716 (41,763)
Scenario 3 [4/]	250.39	9,069 (9,069)	21,658 (21,658)	15,811 (15,811)	46,538 (46,538)
Long Run					
Base Production [1/]		10,066	24,064	17,548	51,678
Model Benchmark [2/]	248.43	8,120 (8,118)	11,346 (11,159)	12,724 (12,724)	32,005 (32,001)
Scenario 2 [3/]	255.09	4,773 (6,209)	7,989 (9,334)	10,792 (12,426)	23,554 (27,969)

Notes:

The numbers in parenthesis represent the prairie production levels calculated using the wheat equivalent as the representative export crop.

[1/] Production potential of the area assuming all relevant costs are covered.

[2/] The model benchmark scenario assumes the WGTA subsidy remains in place, the revenue insurance component of GRIP remains in place, and the CWB freight rate deductions are basis Pacific/Thunder Bay.

[3/] Scenario 2 assumes the WGTA is removed, revenue insurance is discontinued, and the CWB freight rate deductions are basis Pacific/St. Lawrence. Export prices are low assuming export subsidies are used by competing countries.

[4/] Scenario 3 assumes the WGTA is removed, revenue insurance is discontinued, and the CWB freight rate deductions are basis Pacific/St. Lawrence. Export prices are based on low use of export subsidies.

The long run benchmark results assuming higher prices and a larger price elasticity for the export crops are similar to the results when the initial prices and elasticities are lower. However, the long run results under scenario 2 with the higher prices and greater price elasticity for export crops are different. Under the benchmark scenario, where the WGTA subsidy and the safety net payments remain in place and the CWB freight deductions are basis Thunder Bay/Pacific, prairie grain production is approximately 32.0 million tonnes. This is a level of production is equivalent to the situation where wheat is used to represent all grains. Under scenario 2, where both the WGTA subsidy and the safety net payment are eliminated and the CWB freight deductions are basis St. Lawrence, grain production is approximately 4.4 million tonnes less when the more price elastic export demand function is assumed.

A mix of exports (wheat and other crops) results in higher initial prices for traditional export volumes as compared to the wheat equivalent initial export prices. The higher initial export prices for the crop mix result in higher safety net support levels as compared to levels associated with the wheat equivalent assumption. The safety net support level under scenario 1 for the crop mix is $254.85 per tonne in the long run as compared to a support level of $249 per tonne under the wheat equivalent analysis. The equilibrium export price ($254.48 per tonne) under the wheat equivalent analysis is higher than the safety net support level after the supply response is taken into account. The benchmark equilibrium long run price under the crop mix scenario is $248.43. The government safety net support guarantee offsets the lower equilibrium export price associated with the crop mix and grain production under the crop mix assumption is almost identical to production under the wheat equivalent assumptions.

When the WGTA subsidy and government safety net subsidy are eliminated and the CWB pooling point changed to St. Lawrence (scenario 2), the long run equilibrium export price for the crop mix is lower than for the wheat equivalent. The lower equilibrium export price with the crop mix as compared to the wheat equivalent analysis results in decreased production of 4.4 million tonnes. The net effect of larger initial prices for traditional export volumes of the crop mix is offset in scenario 2 by smaller price increases as exports decline. This is a result of a larger price elasticity of demand for the mix of crops as compared to the wheat equivalent. The larger price elasticity mitigates the effects of the larger initial prices for the crop mix, and production of grain increases only when the safety net subsidy remains in place (the benchmark scenario).

Chapter 6

Summary, Conclusions, and Limitations

6. Summary, Conclusions, and Limitations

6.1 Summary

Grain and livestock production in Western Canada has been largely influenced largely by domestic agricultural policy. This study simulates a partial equilibrium model to determine how grain production may change in different regions of Western Canada in response to various government policy and market scenarios in both the short run and the long run. In particular, the study analyzes the impact of the elimination of the WGTA subsidy, the change in CWB freight rate deductions, and the affects of government safety net programs on Western Canadian grain production and grain exports, as well as on land use and cattle populations. Annual crop production is estimated in terms of wheat equivalents. Wheat yields are determined for each soil rating assigned by the provincial crop insurance agencies. Short and long run production costs are estimated for each soil capability. Assuming farmers are rational, cereal grain and oilseed production in the short run will occur as long as the variable costs of producing annual crops and the opportunity costs of land (short run costs) are less than or equal to the revenue received from grain. In the long run, crop revenues must exceed all costs of production associated with direct variable costs, fixed costs, and the opportunity costs of land and labour. Cattle populations are estimated in terms of a cow-equivalent measure and their numbers are tied to the availability of forage and the feed requirements of a cow-equivalent unit. The projected crop production levels are based on underlying trends in crop yields and the allocation of land between annual and perennial crops. The allocation of land between annual and perennial crops is determined according to prices received for annual crops and the rental value of land growing perennial crops. Prices for annual crops are forecast to change with a drop in the exportable supply of Prairie grains.

The results indicate prairie grain supply may be more sensitive to price changes than previously estimated. Results from MacGregor, Junkins and Barber (1994) indicate that grain production could drop by 3.4 million tonnes in the long run under a scenario where the WGTA subsidy is eliminated and the Canadian Wheat Board pooling point is moved to the lower St. Lawrence. These results are similar to the short-run decrease in grain production of 3.4 million tonnes estimated for a similar policy setting in this study (scenario 2). When the framework for change is extended to the long run where cereal grain and oilseed revenue must exceed all costs in order to maintain production, the findings suggest that the grain industry will be under financial pressure and output will decline.

The increased sensitivity of grain production to higher transportation costs and lower safety net payments in the long run reflect the assumptions of more flexibility by prairie farmers and importers of Canadian grain when decisions are made within a longer time frame. The price elasticity of prairie grain supply and export demand both increase in a longer term setting. The results determined for the long run scenario indicate the potential for large shifts in production from annual to perennial crops. Accompanying the movement away from producing cereal grains and oilseeds would be a shift from primary exports of wheat, feed grains, and oilseeds to increased exports of live cattle and beef.

6.2 Conclusions

According to the analysis, approximately 10.3 percent of Western Canadian cereal grain and oilseed production is, at the margin, dependent upon subsidies for transportation and safety net premiums in the short run. This assumes short run export prices similar to those during the 1985 to 1994 period. Prairie grain production decreases by 4.8 million tonnes as compared to the short run production potential of the prairies. Approximately 44 percent of the subsidy dependent production occurs in Manitoba, 36 percent occurs in Saskatchewan, and 21 percent occurs in Alberta. The loss of revenue from the above subsidy sources results in 23 percent of Manitoba cropland switching from annual crop production to perennial crop production in the short run. The comparable short-run changes forecast for the Saskatchewan and Alberta grains and oilseeds industry are minimal. Approximately 5.6 percent of annual cropland in Saskatchewan, and 5.9 percent of annual crop land in Alberta is forecast to switch to perennial crops. Transportation costs increase by almost $10.00 per tonne more in Manitoba as compared to Saskatchewan and Alberta due to the change in CWB pooling points.

Under scenario 3, the short run export price is based on the equilibrium wheat export prices during the 1995/96 crop year (the year following the change in transportation policies). Grain production remains near the short run prairie production capacity despite the fact the transportation subsidies are removed. In fact, these price levels result in increased production as compared to the model benchmark scenario where the subsidies are assumed to remain in place and export prices are based on the prices in crop year 1994/95. Wheat prices increased dramatically from crop year 1994/95 to 1995/96 meaning grain producers did not see a decrease in their returns as a result of the removal of the transportation subsidies. Higher wheat prices more than offset the increase in transportation costs. Higher grain prices over the long term would reduce the amount of crop land taken out of production. The current high prices are associated with low global stocks and low use of export subsidies. It is expected that the current high prices are temporary (Miner et al. 1996). Both the United States and the European Union have retained the right to use export subsidies in the future at reduced levels in accordance with GATT. If grain prices fall in the future, the impact of the elimination of the freight rate subsidies will be felt by grain producers and grain production will not remain at these levels.

The long run results indicate prairie farmers earn relatively low returns on their fixed inputs (family labour, management, and equity capital). If crop production is expected to cover all costs of production and return earnings available from perennial crops and off-farm employment, grain and oilseed acres in Western Canada are forecast to decrease by 46 percent from 1991 levels even if the transportation and safety net subsidies remain in place. The area seeded to grain production decreases by 23 percent in Manitoba, 59 percent in Saskatchewan, and 35 percent in Alberta. This long run reduction in annual cropped acres corresponds to a 19.7 million tonne reduction in annual crop production. Termination of the WGTA subsidy and government safety net program and changes to the CWB pooling point results in a further 13 percent drop in production in Western Canada in the long run. The majority of this decrease in production occurs in the province of Manitoba (47 percent) and the province of Saskatchewan (45 percent). Long run grain production in Alberta is less sensitive to the policy changes than production in Manitoba and Saskatchewan at the prices assumed under these scenarios.

Sensitivity analysis was performed to determine how a cereal/oilseed crop mix affects world equilibrium export prices and Western Canadian grain production. The main analysis is based on production and exports represented by wheat. The sensitivity analysis suggests that Prairie export levels are not affected greatly in the short run when higher world prices and export demand elasticities are taken into account under the crop mix scenario. A mix of exports (wheat and other crops) results in a higher weighted average price for historical export volumes as compared to the wheat export price. The higher export prices for the crop mix result in higher safety net support levels as compared to levels associated with the wheat equivalent assumption. The net effect of higher initial prices for traditional export volumes of the crop mix is offset in long run scenario 2 by smaller price increases as exports decline. This is a result of a higher price elasticity of demand for the mix of crops as compared to the wheat equivalent. The higher price elasticity mitigates the effects of the higher initial prices for the crop mix. The long run Western Canadian grain production forecasts under subsidy reductions are lower under this analysis than when production and exports are based upon wheat equivalent.

In the long run, grain production is simulated to occur only when grain receipts exceed all variable costs of production as well as the opportunity costs of land in the short run, plus associated fixed costs of capital, and the opportunity costs of labour. In the past, crop production has been linked to ongoing policies which subsidize production as well as institutions which reinforce faith in the grain economy. Over the past 10 years (1983/84-1993/94), #1 CWRS final payments through the pool accounts have averaged approximately $160 per tonne (CWB Annual Reports). Despite low earnings from annual crop production, farmers continue to produce grain crops with the assistance of subsidies, expectations of higher prices in the future, and an unwillingness to change. Eliminating transportation and safety net subsidies may cause farmers to evaluate their expectations of profit from grain and oilseed production. If producers consider all costs of production in their short and long run production decisions, future prairie production levels of grain and oilseeds will fall below present levels unless export prices remain at the 1995/96 levels. The model results indicate the prairie agricultural economy will become less reliant on grain and oilseed exports as land switches to perennial crop production. The prairie beef cattle population is projected to increase by 19 percent in the short run if the grain related subsidies are eliminated and export prices remain at 1990-1995 levels. In the long run, the Western Canadian cattle population is estimated to increase 85 percent if producers choose to cover all costs of production (and the subsidies remain in place), and a further 11 percent as a result of the elimination of the grain support programs. Given previous expansion in the prairie cattle herd, the short-run increase would take four to five years and the long run ten to fifteen years.

6.3 Limitations

This analysis rests upon the assumption that farmers rationally choose to produce annual crops on the basis of expected profitability. Expected profitability incorporates a subjective dimension. Subjective factors and the extent to which other motives enter into the crop production decision were not incorporated into this study. Future grain and forage markets and production opportunities are unknown. In addition, the views assumed in this study with respect to future prices and costs will not coincide with the expectations of all prairie farmers.

The study derives a number of short and long run equilibrium states of the prairie agricultural economy. The time dimension in the short run includes the decisions which can change input use in a one to two year time frame. The long-run spans a much longer time frame. The year 2000 was used as a basis for discussion of the long run results. The long run time frame is more likely at least 10 years. Therefore, the equilibrium determined in the short run will be targets which the prairie agricultural economy moves towards in a two to three year setting if nothing else changes except the subsidies identified. Long-run equilibrium are even less clear as this requires stability in all other factors for a much longer time period.

Future production forecasts determined in the analysis represent a setting where the production costs estimated for every quarter section of land are representative of current farming practices, grain shipping and handling costs only change because of branch line abandonment, and export markets for grains and oilseeds remain at their 1990-94 levels in the short run. Long run export prices are assumed to increase (as compared to average prices during the past 10 years) by approximately 40 percent. This may or may not be a reasonable assumption. The assumptions on short and long run export prices are critical to the results of this analysis. The impact will be larger if grain prices remain low over the long term. Higher grain prices over the long term would reduce the amount of crop land taken out of production. Future export prices can not be known with certainty and therefore the results of the study may not be an accurate reflection of future prairie production levels.

Other changes in the grain handling and transportation system will also affect prairie production. Rationalization of the grain elevator system, and rail car allocation methods may result in lower handling and rail costs which may mitigate the price impacts of the WGTA and CWB pooling changes. In addition, prairie grain exports through the US may increase depending on exchange rates and future incentives offered by US companies. These factors have not been considered in this study.

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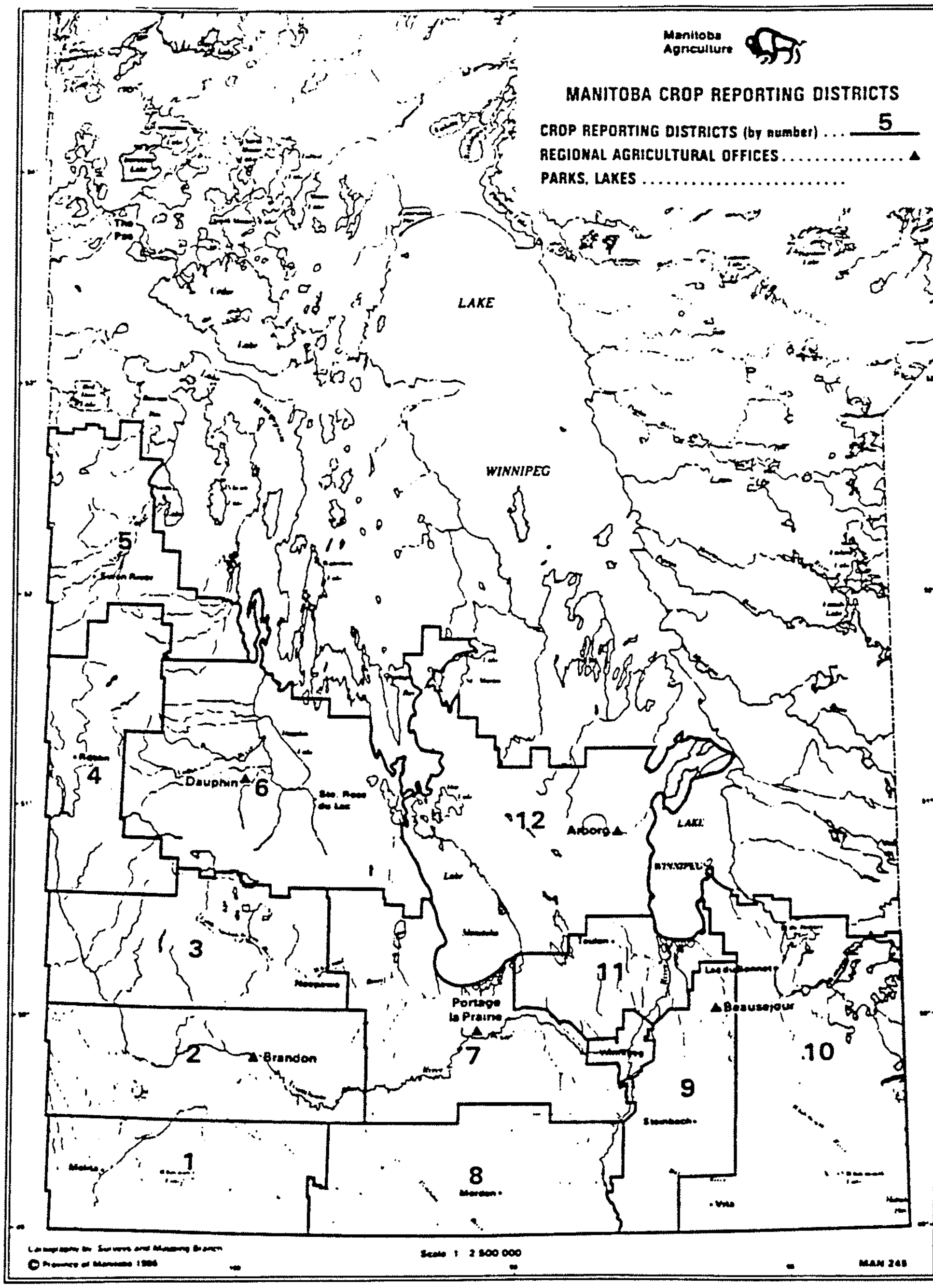
APPENDIX A

Manitoba, Alberta, and Saskatchewan Crop District Maps.

Manitoba Risk Area and Soil Productivity Classification Maps.

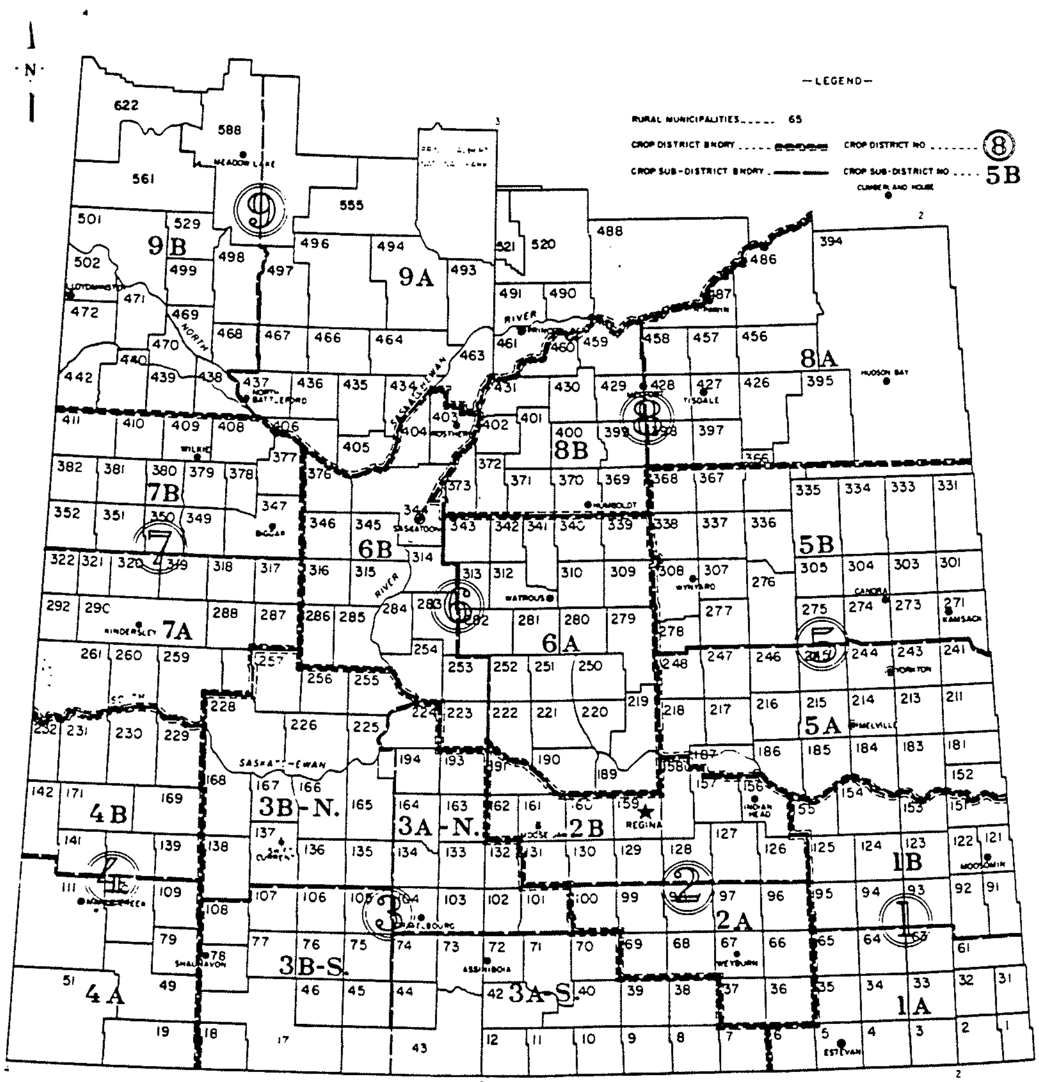
Western Canadian Soil Zone Map.

Map A.1: Manitoba Crop District Map.



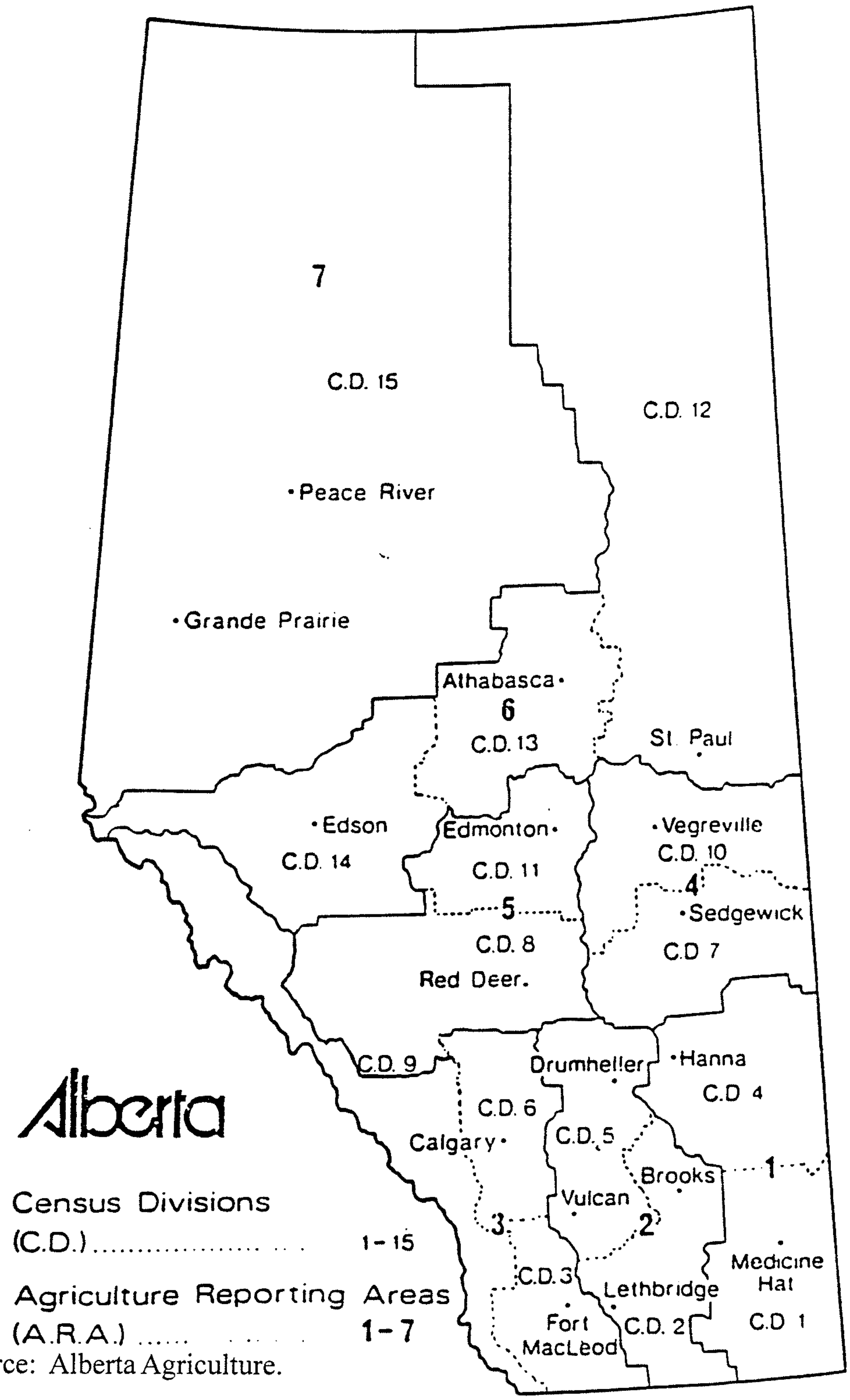
Source: Manitoba Agriculture (1991b).

Map A.2: Saskatchewan Crop District Map.



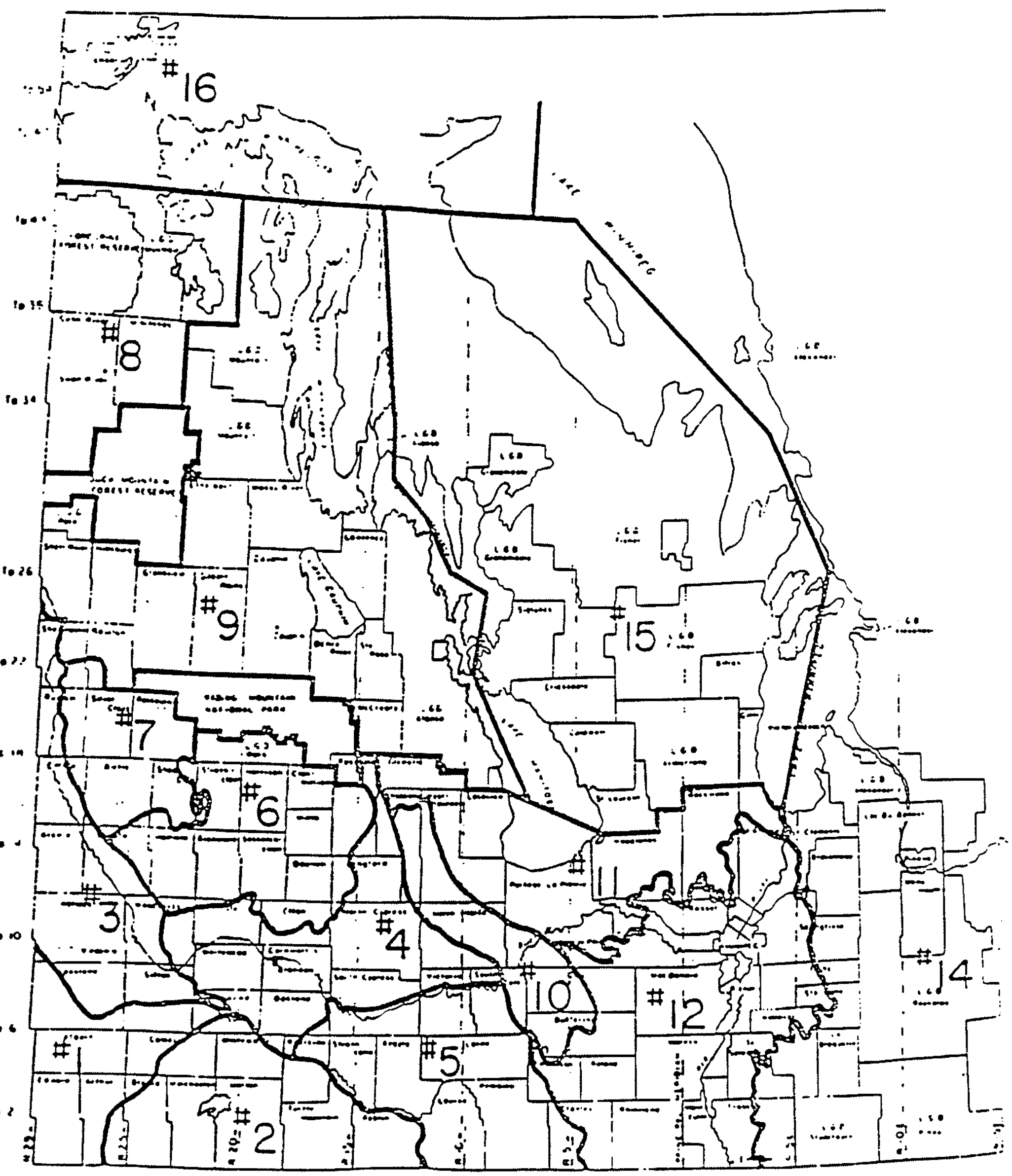
Source: Saskatchewan Agriculture and Food (1995).

Map A.3: Alberta Agricultural Region Map (Agricultural Reporting Areas).



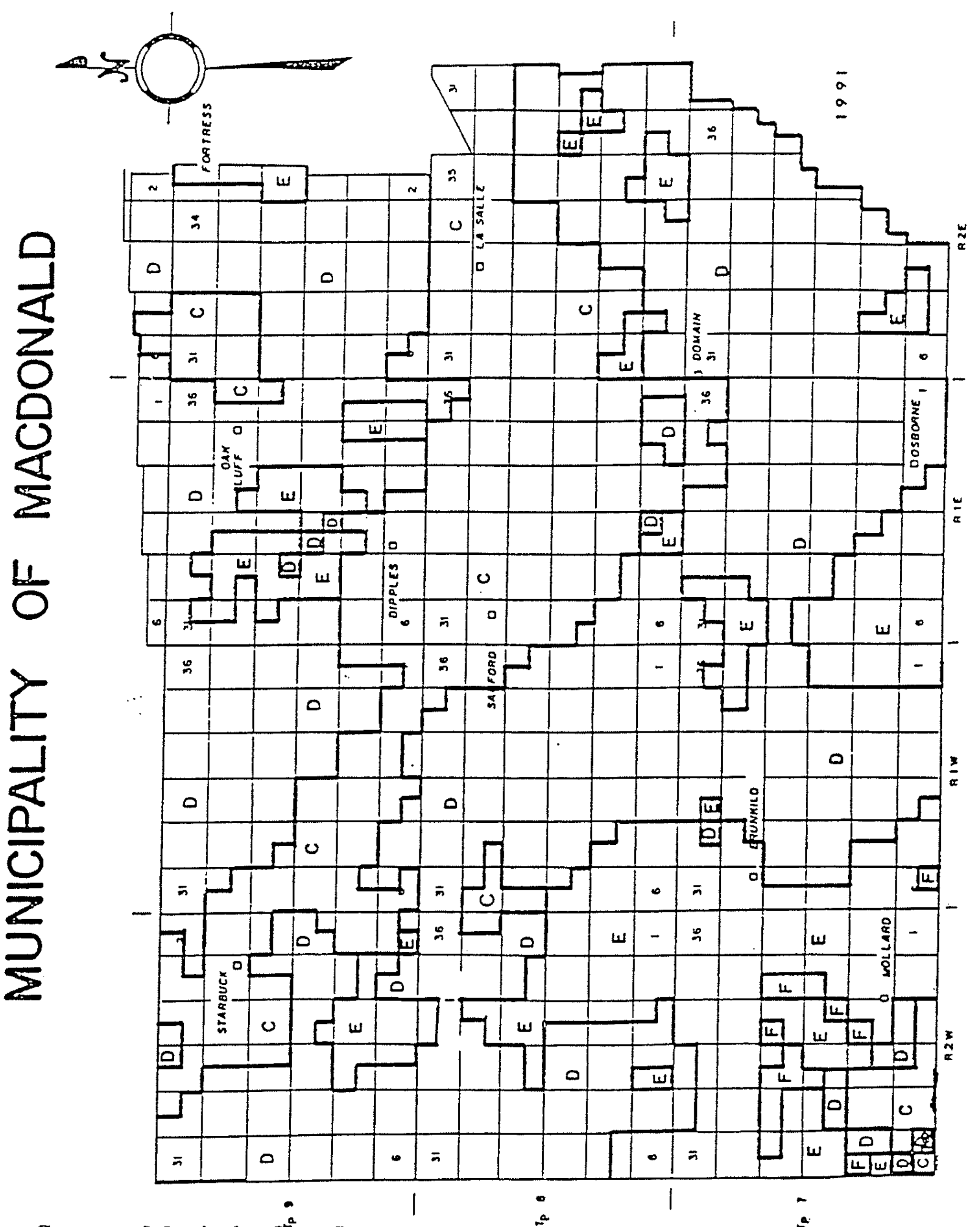
Source: Alberta Agriculture.

Map A.4: Manitoba Crop Insurance Corporation Risk Area Map.



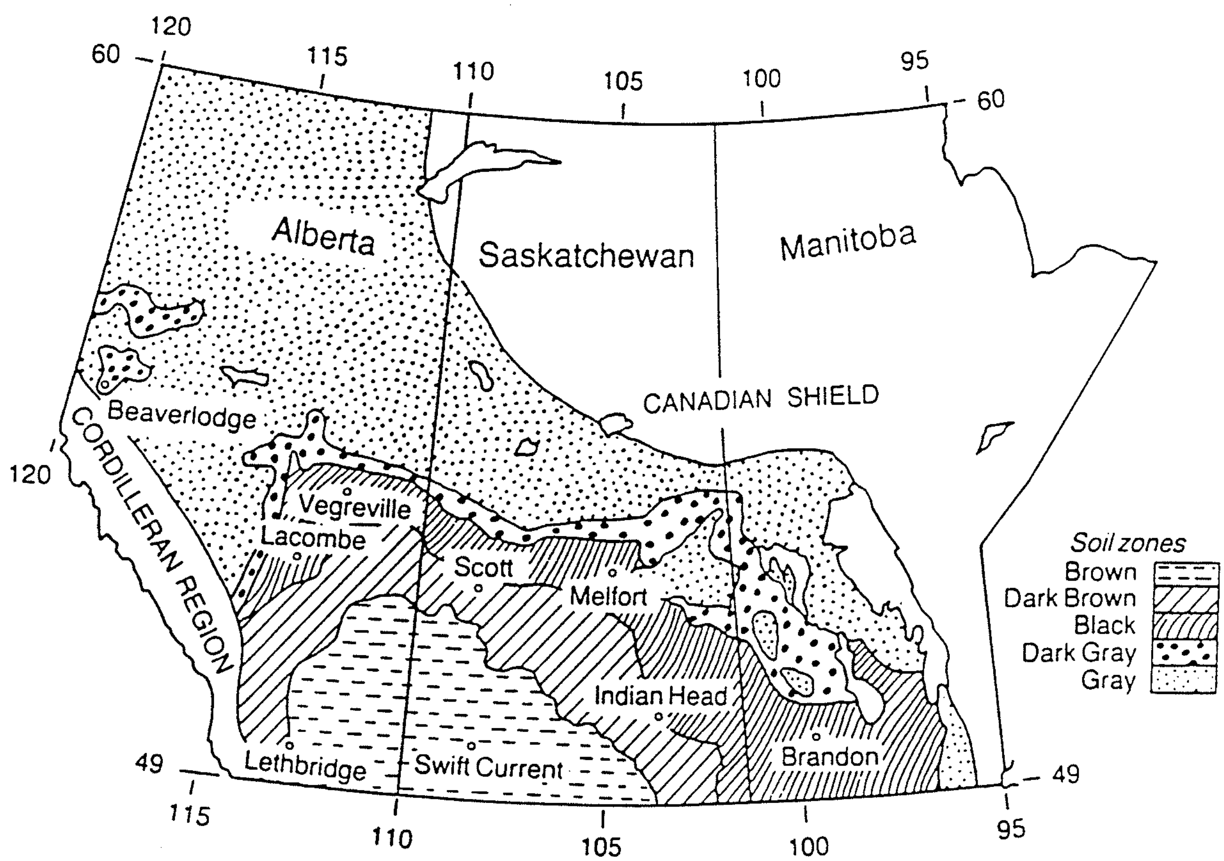
Source: Manitoba Crop Insurance Corporation. (1993)

Map A.5: Manitoba Crop Insurance Corporation Soil Productivity Classifications in the Municipality of MacDonald.



Source: Manitoba Crop Insurance Corporation (1993).

Map A.6: Major Soil Zones in the Western Canadian Prairie Provinces.



Source: Campbell et al. (1990).

APPENDIX B

Regression Results - Short and Long Run Costs

Manitoba, Saskatchewan, and Alberta Rail Rate Zones and Production Costs

Cow-Equivalent Regression Results

Feed Requirements per Cow-Equivalent

Table B.1: Regression Results for Interest on Operating Expenses.

	R^2	Constant	Forage Acres	Annual Acres
Saskatchewan	0.68	4788 (106013)	8.16* (0.681)	3.42* (0.181)
Alberta	0.46	-318772 (1213176)	11.69* (4.12)	7.03* (0.97)

Note: - Standard errors are in parentheses.
- One asterisk indicates statistical significance at 5 percent significance level.

Table B.2: Manitoba Variable Cost Regression Results by Crop District.

	Crop District 1 and 2	Crop District 3 and 4	Crop District 5 and 6	Crop District 7 and 8	Crop District 9, 10, 11, and 12
Fertilizer					
Annual Acres	14.01* (0.96)	16.51* (0.51)	19.92* (0.58)	21.49* (0.67)	24.21* (0.55)
R^2	0.52	0.87	0.97	0.91	0.96
Pesticides					
Annual Acres	8.85* (0.40)	11.17* (0.27)	13.15* (0.47)	13.44* (0.53)	14.42* (0.37)
R^2	0.72	0.93	0.96	0.87	0.96
Fuel					
Annual Acres	9.14* (0.73)	12.21* (0.50)	12.38* (0.56)	12.03* (0.92)	13.28* (0.92)
Forage Acres	21.58* (5.27)	17.48* (2.81)	15.51* (2.07)	21.95* (8.71)	18.98* (2.32)
R^2	0.78	0.91	0.97	0.86	0.90
Repairs					
Annual Acres	10.03* (0.99)	11.11* (0.52)	11.29* (0.38)	13.72* (1.36)	14.71* (1.49)
Forage Acres	24.52* (7.17)	25.60* (2.95)	14.80* (1.40)	28.10* (12.88)	17.20* (3.76)
R^2	0.70	0.92	0.99	0.80	0.80

Note: - Standard errors are in parentheses.
- One asterisk indicates statistical significance at 5 percent significance level.

Table B.3: Saskatchewan Variable Costs Regression Results.

	R^2	Constant	Forage Acres	Annual Acres	DB x Annual Acres	Black x Annual Acres
Fertilizer	0.86	-267831 (248237)	17.57* (1.70)	4.78* (0.50)	2.89* (0.37)	8.19* (0.36)
Pesticides	0.84	-112015 (144992)	1.60 (0.99)	6.79* (0.29)	0.73* (0.21)	2.48* (0.21)
Fuel	0.88	124944 (154716)	15.20* (1.06)	9.48* (0.31)	-0.23 (0.23)	1.01* (0.22)
Repairs	0.87	56370 (158988)	13.80* (1.09)	10.15* (0.32)	-0.02 (0.23)	-0.06 (0.23)

Note: - Standard errors are in parentheses.
- One asterisk indicates statistical significance at 5 percent significance level.
- DB = Dark Brown

Table B.4: Alberta Variable Cost Regression Results.

	R^2	Constant	Irrigated Acres	Forage Acres	Annual Acres	DB x Annual Acres	GW x Annual Acres	Brown x Annual Acres
Fertilizer	0.87	-684563 (1065385)	22.84* (4.22)	16.62* (3.99)	16.76* (0.94)	-5.29* (1.08)	-7.71* (3.12)	-10.98* (1.49)
Pesticides	0.91	-201125 (519158)	10.78* (2.06)	1.51 (1.95)	9.77* (0.46)	-2.31* (0.53)	-2.12 (1.52)	-4.26* (0.73)
Fuel	0.93	-8918 (516763)	13.89* (2.05)	23.03* (1.94)	9.86* (0.46)	-1.62* (0.52)	-2.95** (1.51)	-1.47* (0.72)
Repairs	0.94	-55510 (644896)	29.79* (2.55)	29.73* (2.42)	12.58* (0.57)	-1.57* (0.65)	-7.08* (1.89)	-1.38 (0.90)

Note: - Standard errors are in parentheses.
- One asterisk indicates statistical significance at 5 percent significance level.
- Two asterisks indicate statistical significance at 10 percent significance level.
- DB = Dark Brown
- GW = Grey Wooded

Table B.5: Machinery Regression Results by Province.

	R^2	Constant	Forage Acres	Annual Acres
Manitoba	0.92	-780082 (3683335)	212.89* (30.22)	213.83* (6.03)
Saskatchewan	0.89	-289140 (2540860)	105.72* (16.33)	202.18* (4.34)
Alberta	0.74	261973 (22975553)	374.39* (77.98)	242.57* (18.41)

Note: - Standard errors are in parentheses.
- One asterisk indicates statistical significance at 5 percent significance level

Table B.6: Rail Transportation Costs From to Export Position.

	Rate Group Zone	Total Cost (94/95) ($/tonne)	Govt. Cost (94/95) ($/tonne)	Shipper Cost (94/95) ($/tonne)
Manitoba Rail Costs to Thunder Bay				
Crop District 1	389	22.48	11.58	10.90
Crop District 2	373	21.56	11.10	10.46
Crop District 3	381	22.02	11.34	10.68
Crop District 4	397	22.95	11.82	11.13
Crop District 5	421	24.33	12.53	11.80
Crop District 6	389	22.48	11.58	10.90
Crop District 7	341	19.71	10.15	9.56
Crop District 8	357	20.63	10.62	10.01
Crop District 9	325	18.79	9.68	9.11
Crop District 10	309	17.86	9.20	8.66
Crop District 11	333	19.25	9.91	9.34
Crop District 12	349	20.17	10.39	9.78
Saskatchewan Rail Costs to Vancouver.				
Crop District 1	657	38.34	19.92	18.42
Crop District 2	595	34.78	18.10	16.68
Crop District 3	557	32.43	16.82	15.61
Crop District 4	517	29.88	15.39	14.49
Crop District 5	681	39.36	20.27	19.09
Crop District 6	557	32.19	16.58	15.61
Crop District 7	549	31.97	16.58	15.39
Crop District 8	595	34.39	17.71	16.68
Crop District 9	549	31.73	16.34	15.39
Alberta Rail Costs to Vancouver.				
Census Agricultural Region #1	493	28.50	14.68	13.82
Census Agricultural Region #2	477	27.57	14.20	13.37
Census Agricultural Region #3	453	26.18	13.48	12.70
Census Agricultural Region #4	469	27.11	13.96	13.15
Census Agricultural Region #5	477	27.57	14.20	13.37
Census Agricultural Region #6	469	27.11	13.96	13.15
Census Agricultural Region #7	509	29.42	15.15	14.27

Source: Grain Transportation Agency. 1994. Canadian Freight Tariff Report: Crop Year 1994/95. July, 1994.

Table B.7: Regression Results for Manitoba Cow-Equivalent Relationship.

Dependent Variable	Independent Variable	R^2	Constant	Independent Variable Coefficient
Calves	Cow	0.98	-52 (348)	0.83* (0.01)
Yearlings	Calf	0.59	251 (906)	0.47* (0.04)
Replacement Yearlings	Cow	0.66	-12 (393)	0.20* (0.01)
Feeder Yearlings	Yearlings	0.85	-64 (356)	0.60* (0.02)

Note: - Standard errors are in parentheses.
- One asterisk indicates statistical significance at 5 percent significance level.

Table B.8: Feed Requirements per Cow-Equivalent Unit (C.E.U.).

	Dry Feed Period 225 Days Oct 15-May 31 (Tonnes TDN)	Pasture Period 139 Days May 31-Oct 15 (Tonnes TDN)	Yearly TDN Required per Head (Tonnes TDN)	Cow-Equivalent Relationship (Units per Cow-Calf)	Yearly TDN Required per C.E.U. (Tonnes TDN)
Cow-Calf	1.38	1.51	2.89	1.0	2.89
Replacement Heifers	0.71	1.16	1.87	0.2	0.37
Feeder Yearlings	0.52	1.16	1.68	0.23	0.39
Feedlot Animals	0.12	0	1.67	0.103	0.01
Total Tonnes of TDN Required per C.E.U.					3.66

APPENDIX C

Grain Production, Change in Forage Acres, and Change in Cattle Carrying Capacity by Province and Crop District.

Table C.1: Province of Manitoba Model Results.

Provincial Area and Scenario	Short Run				Long Run			
	On-Farm Revenue ($/tonne)	Grain Produced (000 Tonnes)	Annual Acres (000) *	CEU (000) **	On-Farm Revenue ($/tonne)	Grain Produced (000 Tonnes)	Annual Acres (000) *	CEU (000) **
Manitoba Total								
Baseline		9069	9773	490		10066	9773	490
Model Benchmark	123.31	8851	313	52	209.91	8118	2237	366
Scenario 1	101.32	6975	2494	453	194.09	6209	4189	712
Scenario 2	181.94	9069	1	0.1				
Crop District 1								
Base Case		1010	1231			1121		
Model Benchmark	122.60	1010	1	0	209.20	975	193	22
Scenario 1	99.86	980	47	5	192.63	720	480	65
Scenario 2	180.48	1010	0	0				
Crop District 2								
Base Case		914	1111			1014		
Model Benchmark	123.04	903	20	2	209.64	896	162	21
Scenario 1	99.86	852	101	13	192.63	564	541	77
Scenario 2	180.48	914	0	0				
Crop District 3								
Base Case		944	1049			1048		
Model Benchmark	122.82	938	11	1	209.42	909	165	23
Scenario 1	99.86	871	99	14	192.63	710	370	58
Scenario 2	180.48	944	0	0				
Crop District 4								
Base Case		379	415			421		
Model Benchmark	122.37	379	1	0	208.97	392	34	5
Scenario 1	99.86	358	29	4	192.63	323	108	16
Scenario 2	180.48	379	0	0				
Crop District 5								
Base Case		430	423			477		
Model Benchmark	121.70	429	1	0	208.30	443	38	6
Scenario 1	99.86	394	44	7	192.63	365	114	21
Scenario 2	180.48	430	0	0				

Crop District 6								
Base Case		599	694			665		
Model Benchmark	122.60	598	2	0	209.20	402	300	43
Scenario 1	99.86	239	441	66	192.63	164	541	84
Scenario 2	180.48	599	0	0				
Crop District 7								
Base Case		1435	1483			1592		
Model Benchmark	123.94	1378	83	14	210.54	1185	459	83
Scenario 1	102.63	919	618	119	195.40	977	659	126
Scenario 2	183.25	1434	1	0				
Crop District 8								
Base Case		1893	1827			2101		
Model Benchmark	123.49	1891	2	0	210.09	1839	286	47
Scenario 1	102.63	1652	292	48	195.40	1766	36	60
Scenario 1	183.25	1893	0	0				
Crop District 9								
Base Case		692	691			768		
Model Benchmark	124.39	662	41	7	210.99	639	139	30
Scenario 1	102.63	434	280	62	195.40	566	205	45
Scenario 2	183.25	692	0	0				
Crop District 10								
Base Case		81	103			90		
Model Benchmark	124.84	24	75	14	211.44	0	103	21
Scenario 1	102.63	0	103	21	195.40	0	103	21
Scenario 2	183.25	81	0	0				
Crop District 11								
Base Case		459	481			509		
Model Benchmark	124.16	433	38	6	210.76	363	159	33
Scenario 1	102.63	184	306	65	195.40	204	306	65
Scenario 2	183.25	459	0	0				
Crop District 12								
Base Case		234	266			260		
Model Benchmark	123.72	206	38	5	210.32	76	195	32
Scenario 1	102.63	15	251	42	195.40	17	251	42
Scenario 2	183.25	234	0	0				

Note: A summation of the regional results may not equal the provincial results due to the different rail costs used to determine each regions on-farm costs.

* Baseline acres represent total area under annual crop production in 1991 (Statistics Canada, 1992). The annual acres values under scenario 1 and 2 represent the decrease in annual acres from the baseline acres.

** These values represent the Increase in CEU's from the 1991 cattle population.

Table C.2: Province of Saskatchewan Model Results.

Provincial Area And Scenario	SHORT RUN				LONG RUN			
	On Farm Revenue $/Tonne	Grain Produced (000 Tonnes)	Annual Acres (000) *	CEU (000) **	On-Farm Revenue $/Tonne	Grain Produced (000 Tonnes)	Annual Acres (000) *	CEU (000) **
Saskatchewan Total								
Baseline		21682	30828	996		24064	30828	996
Model Benchmark		20910	1650	152	204.22	11159	18159	1705
Scenario 1		19974	3285	308	200.48	9334	20239	1942
Scenario 2		21658	43	7				
Crop District 1								
Baseline		1750	2613			1943		
Model Benchmark	115.08	1651	206	22	201.68	100	2498	269
Scenario 1	102.15	1277	808	85	194.92	52	2554	275
Scenario 2	182.77	1743	23	2				
Crop District 2								
Baseline		1843	2768			2046		
Model Benchmark	116.82	1728	259	21	203.42	961	1622	137
Scenario 1	105.71	1610	478	39	198.48	833	1780	151
Scenario 2	186.33	1837	20	2				
Crop District 3								
Baseline		3075	4811			3413		
Model Benchmark	117.89	2990	194	85	204.49	687	4010	311
Scenario 1	108.06	2827	507	248	200.83	613	4100	318
Scenario 2	188.68	3075	1	0				
Crop District 4								
Baseline		863	1444			958		
Model Benchmark	119.01	807	136	56	205.61	143	1270	87
Scenario 1	110.61	760	231	103	203.38	133	1284	88
Scenario 2	191.23	863	0	0				
Crop District 5								
Baseline		3392	4648			3764		
Model Benchmark	114.41	3256	247	136	201.01	1384	3088	354
Scenario 1	101.13	2745	1017	647	193.90	706	3874	449
Scenario 2	181.75	3389	9	3				

Crop District 6								
Baseline		2848	4186			3161		
Model Benchmark	117.89	2703	326	145	204.49	1038	3013	284
Scenario 1	108.30	2566	568	282	201.07	917	3163	298
Scenario 2	188.92	2842	21	6				
Crop District 7								
Baseline		2158	2951			2395		
Model Benchmark	118.11	2112	107	46	204.71	1705	1016	69
Scenario 1	108.52	2073	181	85	201.29	1680	1047	72
Scenario 2	189.14	2156	5	2				
Crop District 8								
Baseline		2712	3301			3010		
Model Benchmark	116.82	2694	33	18	207.42	2478	693	79
Scenario 1	106.10	2645	110	67	198.87	2209	1009	118
Scenario 2	186.72	2712	0	0				
Crop District 9								
Baseline		3041	3883			3375		
Model Benchmark	118.11	2997	81	44	204.71	2592	1033	120
Scenario 1	108.76	2903	229	138	201.53	2191	1510	177
Scenario 2	189.38	2041	0	0				

Note: A summation of the regional results may not equal the provincial results due to the different rail costs used to determine each regions on-farm costs.
* Baseline acres represent total area under annual crop production in 1991 (Statistics Canada, 1992). The annual acres values under scenario 1 and 2 represent the decrease in annual acres from the baseline acres.
** These values represent the Increase in CEU's from the 1991 cattle population.

Table C.3: Province of Alberta: Model Results

Provincial Area And Scenario	Short Run				Long Run			
	On Farm Revenue $/Tonne	Grain Produced (000 Tonnes)	Annual Acres (000) *	CEU (000) **	On Farm Revenue $/Tonne	Grain Produced (000 Tonnes)	Annual Acres (000) *	CEU (000) **
Alberta								
Baseline		15811	18447			17548	18447	
Model Benchmark	120.10	15436	700	78	207.70	12724	6535	763
Scenario 1	112.85	14814	1744	200	205.62	12426	6986	839
Scenario 2	193.47	15811	0	0				
Region 1								
Baseline		1086	1839			1206		
Model Benchmark	119.68	896	377	35	206.28	0.2	1839	166
Scenario 1	111.99	778	588	56	204.76	0.2	1839	166
Scenario 2	192.61	1086	0	0				
Region 2								
Baseline		2705	3407			3002		
Model Benchmark	120.13	2687	33	4	206.73	1922	1516	140
Scenario 1	112.92	2592	221	20	205.69	1922	1516	140
Scenario 2	193.54	2705	0	0				
Region 3								
Baseline		2016	2152			2238		
Model Benchmark	120.80	1962	91	15	207.40	1739	637	93
Scenario 1	114.31	1936	128	21	207.08	1739	637	93
Scenario 2	194.93	2016	0	0				
Region 4								
Baseline		4030	4663			4473		
Model Benchmark	120.35	3909	216	26	206.95	3792	951	116
Scenario 1	113.38	3694	573	68	206.15	3770	976	119
Scenario 2	194.00	4030	0	0				
Region 5								
Baseline		2263	1946			2511		
Model Benchmark	120.13	2263	0	18	206.73	2478	37	8
Scenario 1	112.92	2262	1	160	205.69	2478	37	8
Scenario 2	193.54	2263	0	0				

Region 6								
Baseline		1400	1486			1554		
Model Benchmark	120.35	1400	0	0	206.95	1387	189	31
Scenario 1	113.38	1393	11	2	206.15	1387	189	31
Scenario 2	194.00	1400	0	0				
Region 7								
Baseline		2310	2825			2563		
Model Benchmark	119.23	2309	1	0	205.83	1407	1366	210
Scenario 1	111.07	2125	260	40	203.84	977	1817	286
Scenario 2	191.69	2310	0	0				

Note: A summation of the regional results may not equal the provincial results due to the different rail costs used to determine each regions on-farm costs.

* Baseline acres represent total area under annual crop production in 1991 (Statistics Canada, 1992). The annual acres values under scenario 1 and 2 represent the decrease in annual acres from the baseline acres.

** These values represent the Increase in CEU's from the 1991 cattle population.